

GLMVArchitecture

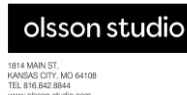
PROJECT MANUAL

**City of Lee's Summit
Lee's Summit - Market Plaza
Lee's Summit, Missouri**

100 PERCENT CONSTRUCTION DOCUMENTS SUBMITTAL

Architect's Project Number: 18225R21006

Date: November 1, 2023



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Lee's Summit, MO 64086
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HENDERSON
ENGINEERS

PROJECT MANUAL

**CITY OF LEE'S SUMMIT
LEE'S SUMMIT - MARKET PLAZA
LEE'S SUMMIT, MISSOURI**

90 PERCENT CONSTRUCTION DOCUMENTS SUBMITTAL

ARCHITECT'S PROJECT NUMBER: 18225R21006.

DATE: NOVEMBER 1, 2023

PREPARED BY:

COLLINS | WEBB ARCHITECTURE

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072500 - Weather Barriers
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072726 - Fluid-Applied Membrane Air Barriers
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074243 - Composite Wall Panels
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076100 - Sheet Metal Roofing
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DOCUMENT 000110 - DISCLAIMER OF RESPONSIBILITY

CIVIL ENGINEERING DISCLAIMER OF RESPONSIBILITY

I, David L. Eickman, hereby specify, pursuant to RSMo. 327.411 that the documents intended to be authenticated by my seal are limited to:

DRAWINGS

L-100: EXISTING CONDITIONS AND DEMOLITION PLAN
C-100: OVERALL GRADING PLAN
C-101: GRADING PLAN
C-102: GRADING PLAN
C-103: GRADING PLAN
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SPECIFICATIONS

No project-specific specifications for civil engineering scope. Proposed work follows Design & Construction Manual of the City of Lee's Summit.

And I hereby disclaim any responsibility for all other drawings, specifications, estimates, reports, or other documents or instruments relating to or intended to be used for any part or parts of the Lee's Summit – Market Plaza.

By:

David L. Eickman, P.E.



END OF DISCLAIMER

DOCUMENT 000110 - DISCLAIMER OF RESPONSIBILITY

LANDSCAPE ARCHITECTURAL DISCLAIMER OF RESPONSIBILITY

I, Korey Schulz, hereby specify, pursuant to RSMo. 327.411 that the documents intended to be authenticated by my seal are limited to:

DRAWINGS

L001 - PROJECT SHEET
L002 - PROJECT SHEET
L003 - PROJECT SHEET
L200 - OVERALL HARDSCAPE PLAN
L201 - HARDSCAPE PLAN
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18225R21006

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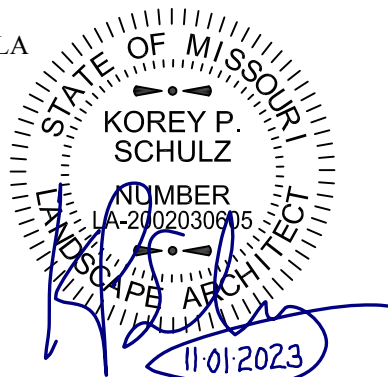
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323300 - SITE FURNISHINGS
328400 - PLANTING IRRIGATION
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And I hereby disclaim any responsibility for all other drawings, specifications, estimates, reports, or other documents or instruments relating to or intended to be used for any part or parts of Lee's Summit – Market Plaza.

By: Korey P. Schulz, PLA, ASLA

END OF DISCLAIMER



DISCLAIMER OF RESPONSIBILITY

STRUCTURAL DISCLAIMER OF RESPONSIBILITY

I, Adam C. O'Kane, P.E., hereby specify, pursuant to RSMo. 327.411 that the documents intended to be authenticated by my seal are limited to:

DRAWINGS

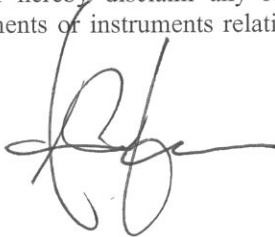
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And I hereby disclaim any responsibility for all other drawings, specifications, estimates, reports, or other documents of instruments relating to or intended to be used for any part or parts of the Lee's Summit – Market Plaza.

By:



END OF DISCLAIMER

DOCUMENT 000110 - DISCLAIMER OF RESPONSIBILITY

ARCHITECTURAL DISCLAIMER OF RESPONSIBILITY

I, Chaz Prunte, hereby specify, pursuant to RSMo. 327.411 that the documents intended to be authenticated by my seal are limited to:

DRAWINGS

GENERAL:

G-001 COVER SHEET

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017839 - Project Record Documents
017900 - Demonstration and Training

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024100 - Demolition

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DIVISION 04

042613 - Masonry Veneer 047200 - Cast Stone Masonry

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055100 - Metal Stairs
055133 - Metal Ladders
055213 - Pipe and Tube Railings
057500 - Decorative Formed Metal

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062000 - Finish Carpentry
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092216 - Non-Structural Metal Framing
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095100 - Acoustical Ceilings
099113 - Exterior Painting
099123 - Interior Painting
099600 - High-Performance Coatings
099723 - Concrete and Masonry Coatings

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101419 - Dimensional Letter Signage - FF& E ITEM
102113.19 - Plastic Toilet Compartments
102600 - Wall and Door Protection
102800 - Toilet, Bath, and Laundry Accessories
104400 - Fire Protection Specialties

DIVISION 12

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END OF SPECIFICATIONS

And I hereby disclaim any responsibility for all other drawings, specifications, estimates, reports, or other documents or instruments relating to or intended to be used for any part or parts of Lee's Summit – Market Plaza.

By:



END OF DISCLAIMER

DOCUMENT 000110 - DISCLAIMER OF RESPONSIBILITY

MECHANICAL, ELECTRICAL, AND PLUMBING DISCLAIMER OF RESPONSIBILITY

I, Brian Olliges, hereby specify, pursuant to RSMo. 327.411 that the documents intended to be authenticated by my seal are limited to:

DRAWINGS

E-000	ELECTRICAL GENERAL NOTES AND LEGEND
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E-502	ELECTRICAL DETAILS AND LIGHTING SCHEDULES

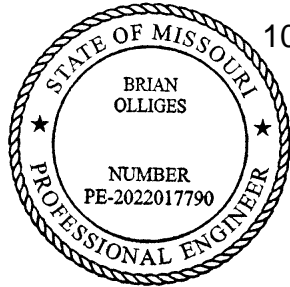
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263600	TRANSFER SWITCHES
264313	SURGE PROTECTIVE DEVICES
265100	INTERIOR LIGHTING
265600	EXTERIOR LIGHTING

And I hereby disclaim any responsibility for all other drawings, specifications, estimates, reports, or other documents or instruments relating to or intended to be used for any part or parts of Lee's Summit – Market Plaza.

By:



10/31/2023

END OF DISCLAIMER

City of Lee's Summit
Lee's Summit - Market Plaza

DOCUMENT 000110 - DISCLAIMER OF RESPONSIBILITY

MECHANICAL, ELECTRICAL, AND PLUMBING DISCLAIMER OF RESPONSIBILITY

I, Al Spinelli, hereby specify, pursuant to RSMo. 327.411 that the documents intended to be authenticated by my seal are limited to:

DRAWINGS

	MECHANICAL GENERAL NOTES &
M-000	LEGEND
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M-102	HVAC ROOF PLAN
M-301	MECHANICAL SCHEDULES
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230550	VIBRATION ISOLATION FOR HVAC
230553	IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
230593	TESTING, ADJUSTING, AND BALANCING FOR HVAC
230700	HVAC INSULATION
230800	COMMISSIONING OF HVAC SYSTEMS
230913	INSTRUMENTATION AND CONTROL DEVICES FOR HVAC
230923	DIRECT-DIGITAL CONTROL FOR HVAC
232300	REFRIGERANT PIPING
233113	METAL DUCTS
233300	AIR DUCT ACCESSORIES
233413	AXIAL HVAC FANS
233423	HVAC POWER VENTILATORS
233713	DIFFUSERS, REGISTERS & GRILLES
238126	SPLIT SYSTEM AIR CONDITIONERS

And I hereby disclaim any responsibility for all other drawings, specifications, estimates, reports, or other documents or instruments relating to or intended to be used for any part or parts of Lee's Summit – Market Plaza.

By:



10/30/2023

END OF DISCLAIMER

City of Lee's Summit
Lee's Summit - Market Plaza

DOCUMENT 000110 - DISCLAIMER OF RESPONSIBILITY

MECHANICAL, ELECTRICAL, AND PLUMBING DISCLAIMER OF RESPONSIBILITY

I, Al Spinelli, hereby specify, pursuant to RSMo. 327.411 that the documents intended to be authenticated by my seal are limited to:

DRAWINGS

P-000	PLUMBING GENERAL NOTES AND LEGEND
P-101	PLUMBING PLAN
P-102	PLUMBING ROOF PLAN
P-201	PLUMBING ENLARGED PLANS
P-301	PLUMBING DOMESTIC WATER ISOMETRIC
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P-303	PLUMBING GAS ISOMETRIC
P-304	PLUMBING STORM ISOMETRIC
P-401	PLUMBING SCHEDULES
P-501	PLUMBING DETAILS

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220523	GENERAL-DUTY VALVES FOR PLUMBING PIPING
220529	HANGERS AND SUPPORTS FOR PLUMBING PIPING
220553	IDENTIFICATION FOR PLUMBING PIPING & EQUIPMENT
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227000	NATURAL GAS SYSTEMS
227010	MECHANICALLY JOINED NATURAL GAS PIPING SYSTEMS

And I hereby disclaim any responsibility for all other drawings, specifications, estimates, reports, or other documents or instruments relating to or intended to be used for any part or parts of Lee's Summit – Market Plaza.

By:



10/30/2023

END OF DISCLAIMER

DOCUMENT 000110 - DISCLAIMER OF RESPONSIBILITY

FIRE PROTECTION DISCLAIMER OF RESPONSIBILITY

I, Christopher Culp, hereby specify, pursuant to RSMo. 327.411 that the documents intended to be authenticated by my seal are limited to:

DRAWINGS

FP-000	FIRE PROTECTION GENERAL NOTES AND LEGEND
FP-101	FIRE PROTECTION PLAN
FP-102	FIRE PROTECTION ROOF PLAN

SPECIFICATIONS

DIVISION 21

210010	GENERAL FIRE SUPPRESSION REQUIREMENTS
210500	COMMON WORK RESULTS FOR FIRE SUPPRESSION
210515	BASIC FIRE SUPPRESSION PIPING METHODS AND MATERIALS
210553	IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT
211100	FIRE SUPPRESSION WATER SERVICE PIPING
211313	WATER BASED FIRE SUPPRESSION SYSTEMS

DIVISION 28

284600 FIRE DETECTION AND ALARM

And I hereby disclaim any responsibility for all other drawings, specifications, estimates, reports, or other documents or instruments relating to or intended to be used for any part or parts of Lee's Summit – Market Plaza.

By:



10/31/2023

END OF DISCLAIMER

DOCUMENT 000110 - DISCLAIMER OF RESPONSIBILITY

AUDIO-VIDEO , COMMUNICATIONS, AND SECURITY DISCLAIMER OF RESPONSIBILITY

I, Brian Olliges, hereby specify, pursuant to RSMo. 327.411 that the documents intended to be authenticated by my seal are limited to:

DRAWINGS

TA-000	AUDIO-VIDEO GENERAL NOTES AND LEGEND
TA-001	AUDIO-VIDEO PLATE REQUIREMENTS
TA-100	AUDIO-VIDEO SITE PLAN
TA-101	AUDIO-VIDEO PLAN
TA-201	AUDIO-VIDEO RCP
TA-401	AUDIO-VIDEO SECTIONS
TA-501	AUDIO-VIDEO DETAILS
TA-701	AUDIO-VIDEO SIGNAL FLOWS
TN000	TECHNOLOGY GENERAL NOTES AND LEGEND
TN001	TECHNOLOGY SITE PLAN
TN101	TECHNOLOGY PLAN
	TECHNOLOGY - MDF ROOM ENLARGED PLAN AND
TN201	ELEVATION
TN401	TECHNOLOGY RISER DIAGRAM
TN501	TECHNOLOGY DETAILS - 1
TN502	TECHNOLOGY DETAILS - 2
TN503	TECHNOLOGY DETAILS - 3

SPECIFICATIONS

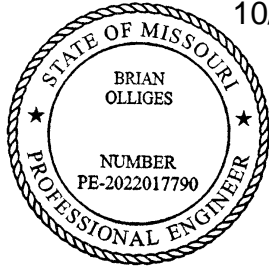
DIVISION 27

270010	GENERAL COMMUNICATIONS REQUIREMENTS
270500	COMMON WORK RESULTS FOR COMMUNICATIONS
270543	UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS
271000	STRUCTURED CABLING SYSTEM
271100	TELECOMMUNICATIONS EQUIPMENT ROOM FITTINGS
271300	COMMUNICATIONS BACKBONE CABLING
271500	COMMUNICATIONS HORIZONTAL CABLING
274100	AUDIO VIDEO SYSTEMS
274116	AUDIO VIDEO SYSTEMS EQUIPMENT

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By:

10/31/2023



END OF DISCLAIMER

City of Lee's Summit
Lee's Summit - Market Plaza

DOCUMENT 000110 - DISCLAIMER OF RESPONSIBILITY

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DRAWINGS

TY000	SECURITY GENERAL NOTES AND LEGEND
TY101	SECURITY PLAN
TY501	SECURITY DETAILS

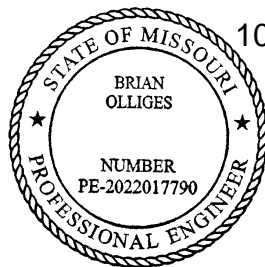
SPECIFICATIONS

DIVISION 28

281010 CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY

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By:



10/31/2023

END OF DISCLAIMER

DISCLAIMER OF RESPONSIBILITY

INTERIOR DESIGN DISCLAIMER OF RESPONSIBILITY

I, Sam Collins, hereby specify, pursuant to RSMo. 327.411 that the documents intended to be authenticated by my seal are limited to:

DRAWINGS

I-101
I-201
I-202
I-301

And I hereby disclaim any responsibility for all other drawings, specifications, estimates, reports, or other documents or instruments relating to or intended to be used for any part or parts of the Lee's Summit – Market Plaza.

By: Sam Collins, Architect – A-2017002629



END OF DISCLAIMER

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SECTION 003132 - 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. A geotechnical investigation report for Project, prepared by Alpha-Omega, dated July 7, 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.

END OF SECTION 003132



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GEOTECHNICAL ENGINEERING REPORT
DOWNTOWN LEE'S SUMMIT REDEVELOPMENT

BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
LEE'S SUMMIT, MISSOURI
(AOG 230378 E)

Date: July 07, 2023

Submitted to: GLMV Architecture
Chaz Prunte, AIA
9229 Ward Parkway, Suite 210
Kansas City, MO 64114

Submitted by: ALPHA-OMEGA GEOTECH, INC.

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BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
LEE'S SUMMIT, MISSOURI
(AOG 230378 E)

Chaz,

Alpha Omega Geotech, Inc. (AOG) has completed its geotechnical engineering investigation for the above-referenced project.

Attached are the following items that were utilized in the analysis and evaluation of the subsurface conditions at this site: a sketch giving the approximate location of the twenty-two (22) auger borings completed during this investigation with reference to the existing site features; detailed laboratory results of eight (8) moisture contents (ASTM D2216), eight (8) dry densities (ASTM D7263), eight (8) sets of Atterberg limits (ASTM D4318), five (5) unconfined compression (ASTM D2166) tests, twenty-three (23) calibrated pocket penetrometer readings, and twenty-two (22) auger boring (ASTM D1452) logs that describe the materials encountered, their approximate thicknesses, and the sampling depths where Standard Penetration (ASTM D1586) tests were performed.

Representatives of AOG located each of the selected borings by measuring from the existing site features, and these measurements should be considered accurate only to the extent implied by the method of measurement. Elevations were not determined in the field at the time of drilling. Each of the borings was completed by AOG using a CME 55 high-torque drill rig.

1.0 PROJECT DESCRIPTION

Alpha Omega Geotech (AOG) understands the **conceptual project** will include multiple new structures including a covered Farmers Market Area with an overall footprint of about 18,700 sq ft with slab on grade and light steel construction with a finished floor elevation of 1014.5 ft. There will be a canopy covered greenspace with synthetic turf and portable stage area will be on the north side of the Farmer's Market building covering an area of approximately 12,000 sq ft. There will also be new parking, and a restructuring of Green St. as a walking and pedestrian area for open air functions. A summary of the restructuring of Green St. includes pier footings for light poles and overhead structures, playground structures, monument columns ~6' height range, small walls that range from 18" to 7' tall. Walls are anticipated to be cast-in-place construction and will be both retaining and seating walls. There will also be pavements; concrete, pavers on concrete base, and compacted decomposed granite. There will also be pavements/pavers that will be in vehicular areas. There are public utilities that will be replaced which will be installed below grade throughout the site.

Based on the conceptual plan there are four (4) additional pad sites that will not be evaluated at this time, within the downtown redevelopment plan.

AOG drilled five (5) preliminary borings in April of 2022 and a preliminary subsurface condition report for the was issued for a multiple-story Hotel and Mixed-use Building, a multiple-story Multi-family Mixed-use building, a Conservatory/Events Center, a Mixed-use Building, and covered Farmers Market Area.

Final plans have not been provided at this time at this time, AOG assumes that cuts and fills to reach desired construction grade will be in the range of about two (2) to six (6) feet.

2.0 SUBSURFACE INVESTIGATION

Based on the information provided, AOG drilled twenty-two (22) auger borings at the proposed site. The borings were advanced to their planned depths or auger refusal, whichever occurred first. Refusal depths are shown on the following table:

Table 1: Auger Refusal Depths

ROCK REFUSAL TABLE (FT)			
Boring #	Boring Location	Depth to Top of Weathered Rock	Practical Refusal Depth
B1	SEE SITE SKETCH	~ 8.5	NONE (15.0)*
B2	SEE SITE SKETCH	~ 12.5	NONE (14.0)*
B3	SEE SITE SKETCH	NOT DRILLED	
B4	SEE SITE SKETCH	~ 13.0	~ 13.1*
B5	SEE SITE SKETCH	N/A	NONE (10.0)
B6	SEE SITE SKETCH	~ 8.5	NONE (10.0)*
B7	SEE SITE SKETCH	~ 8.5	~ 9.7*
B8	SEE SITE SKETCH	~ 6.7	~ 9.5*
B9	SEE SITE SKETCH	~ 7.0	NONE (9.9)*



Boring #	Boring Location	Depth to Top of Weathered Rock	Practical Refusal Depth
B10	SEE SITE SKETCH	~ 13.5	~ 13.9*
B11	SEE SITE SKETCH	~ 13.5	~ 13.8*
B12	SEE SITE SKETCH	~ 13.5	~ 13.9*
B13	SEE SITE SKETCH	~ 11.0	~ 14.3*
B14	SEE SITE SKETCH	~ 7.0	NONE (10.0)*
B15	SEE SITE SKETCH	~ 8.5	~ 9.5*
B16	SEE SITE SKETCH	~ 7.7	~ 10.0*
B17	SEE SITE SKETCH	~ 5.0	~ 9.3*
B18	SEE SITE SKETCH	~ 5.0	~ 9.0*
B19	SEE SITE SKETCH	~ 8.5	~ 13.8*
S2	SEE SITE SKETCH	~ 7.8	~ 13.7*
S3	SEE SITE SKETCH	~ 7.2	~ 13.9*
S4	SEE SITE SKETCH	~ 8.5	11.3*
S5	SEE SITE SKETCH	~ 13.5	NONE (15.0)*
(*) Very hard, weathered limestone and shale that was penetrable using our high-torque drilling equipment was encountered above the auger refusal depths shown above (see the boring logs enclosed in Appendix Section 1 of this report).			

It should be understood that the depth of boring, split-spoon refusal or auger refusal reported herein applies to the type of drilling equipment that was used. As such, it might be possible to extend some of these borings deeper using different drilling equipment and/or techniques. Conversely, residual sandstone, shale and limestone materials through which AOG's drill rig penetrated, without achieving refusal, may be difficult to excavate depending upon the equipment being used. As such, Alpha-Omega Geotech, Inc. shall not be responsible, for the determination of Others, regarding the rippability, or ease of excavation, of the in-situ subgrade, bedrock and/or geo-intermediate materials.

Above the depth, at which, boring termination occurred, predominantly clay soils were encountered in the borings. Standard Penetration tests (SPT) (ASTM D1586) were also used to sample and evaluate the consistency of the in-situ subgrade materials encountered in these test borings. Standard Penetration Tests are conducted by advancing a hollow, split spoon sampler into the base of the auger hole by means of dropping a 140-pound hammer a distance of 30 inches onto the drill rods. Each drop of the hammer is one blow, and these blow counts are recorded for each of three, 6-inch advances of the sampler. The first 6-inch advance is the seating drive, and the summation of the blow counts of the final two, 6-inch advances is taken as the standard penetration resistance. The standard penetration resistance, or N-value, as it is known, along with the soil classification, can be used to estimate the density, shear strength and other engineering properties of the materials encountered.

The N-values obtained from each of the SPT's completed in these borings using a CME automatic hammer are included on the boring logs and summarized in the Summary of Laboratory Testing sheet found in Appendix B. Samples retrieved during drilling efforts were returned to AOG's laboratory for testing and evaluation.



3.0 LABORATORY TESTING PROGRAM

Laboratory testing on materials collected during drilling was performed on samples selected by AOG. Results from these tests can be found in Appendix B and on the boring logs in Appendix C. The following laboratory tests were performed by qualified AOG personnel in accordance with ASTM specifications to determine pertinent engineering properties of the soils:

- Visual classification (ASTM D2488)
- Moisture content tests (ASTM D2216)
- Atterberg limits tests (ASTM D4318)
- Dry Unit Weight (ASTM D7263)
- Unconfined compression tests on soil (ASTM D2166)

The dry unit weights of specimens cut from the Shelby tube samples were found to be moderate, ranging from 93.9 pounds per cubic foot (pcf) to 100.2 pcf. Depending upon the material composition and depth below existing grade, the moisture content of the specimens extracted from these tube samples ranged from 22.9 to 27.4 percent. The unconfined compressive strength of the specimen cut from the Shelby tube sample ranged from 1626 to 4493 pounds per square foot (psf). Calibrated pocket penetrometer readings ranging from 1.25 tons per square foot (tsf) (2,500 psf) to 3.5 tsf (7,000 psf) were obtained on the recovered Shelby tube samples. However, it should be noted that the pocket penetrometer values tend to over-estimate the strength of in-situ subgrade materials relative to the actual unconfined compressive strength test.

The Atterberg consistency limits were determined for five (5) generally, representative sample taken at relatively shallow depth from within the proposed structures' footprints. Based on the Atterberg limits, the samples were classified in accordance with the Unified Soil Classification System (USCS) as Fat Clay (CH) classification materials. The results of these laboratory analyses are presented in the following table:

Table 2: Atterberg Limits Results

ATTERBERG LIMITS TESTS					
Sample	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	USCS Classification
B1 ST-2	3.0-5.0	54	21	33	Fat Clay (CH)
B2 ST-3	5.0-7.0	69	23	46	Fat Clay (CH)
B10 ST-2	3.0-5.0	50	22	28	Fat Clay (CH)
B11 ST-3	5.0-7.0	55	21	34	Fat Clay (CH)
B12 ST-2	3.0-5.0	53	22	31	Fat Clay (CH)



Based on the Atterberg limits, it is anticipated most of the onsite soil materials generally possess a high swelling potential. The swelling potential of a clay soil is an indication of the volume changes that may take place with variations in the soil moisture content.

Except for the samples for which the Atterberg limits were determined, all of the other soil classifications given throughout the laboratory test data, as well as, the boring logs, were made using the visual and tactile techniques described in ASTM D2488. As a result, additional analyses could reveal other soil types of different classification and potentially higher plasticity and swelling potential both onsite and within the nearby vicinity.

4.0 GROUNDWATER

Free was encountered at about 9.7 fbeg in boring B7 while drilling. Free water was not encountered in any of the remaining borings while drilling. However, a twenty-four-hour water level was not established in these borings due to time restrictions, as well as potential safety hazards associated with open bore holes.

Although the ground water levels given on the boring logs reflect the conditions observed at the time the borings were made, they should not be construed to represent an accurate or permanent condition. There is uncertainty involved with short-term water level observations in bore holes especially in clay soils of relatively low permeability. The groundwater level should be expected to fluctuate with variations in precipitation, site grading and drainage conditions. In addition, it is also possible that seasonal perched ground water may be encountered within these soil deposits and bedrock formations at different depths during other times of the year based on drainage conditions, seasonal snowmelt and rainwater infiltration.

5.0 GEOTECHNICAL CONSIDERATIONS

The following considerations are given based on observations made by AOG at the time of drilling, during reconnaissance trips, and based on the project requirements and description as stated above:

- 1) Expansive Materials: Expansive clays were encountered during this exploration. Expansive clays are known to experience significant volume changes with changes in moisture. Expansive clays located beneath any slabs on grade should be removed in accordance with Section 8.0, "SLABS ON GRADE," of this report.
- 2) Shallow Bedrock: Shallow bedrock may impact the foundations and deeper utilities depending on the final finished floor elevations.



6.0 SITE DEVELOPMENT

6.1 Site Preparation

Based on the information provided, AOG anticipates minimal amounts of cut and fill amounts of about one (1) to two (2) feet (+/-) from the existing ground surface elevation, within the proposed project limits at each park, will be required to achieve design grades. It is possible that additional cuts and fills may be required to obtain improved surface drainage.

Appropriate erosion control measures, such as proper site contouring during grading activities, as well as, silt fences, should be maintained to help keep any eroded materials onsite.

Within the footprint of the proposed new structures, it is recommended that any topsoil, vegetation, utility backfill, and other deleterious material (i.e. concrete slabs, relic foundations, utilities, etc.) or pavements should be stripped and removed prior to the placement of any fill required to achieve the finished floor elevation. In accordance with the local building code, this should be verified by a representative of Alpha-Omega Geotech, Inc. prior to the placement of fill.

Once initial site stripping operations have been completed and prior to the placement of any engineered fill in this area, it is recommended that the exposed subgrade be moisture conditioned and recompact, as needed, and be thoroughly evaluated by means of a proof-roll with a fully loaded, tandem-axle dump truck to locate any soft, compressible areas within the proposed project site. Any soft, compressible areas identified on the proposed project site must be corrected by over-excavation to a suitable subgrade and replaced with an acceptable material. Although it is not anticipated that any extensive removal and replacement would be necessary, it is possible that some effort may be required to develop a stable platform on which to place the necessary fill material and address any other existing site conditions that become known during construction. It is generally anticipated that the extent of these efforts would strongly depend upon the ground moisture conditions at the time the site work begins. In the event that the ground is generally dry, it is possible that only a minimal amount of stabilization would be required, which may be possible to accomplish by simple moisture conditioning and re-compaction efforts. Nevertheless, it is recommended that a representative of Alpha-Omega Geotech, Inc. should be onsite to witness this proof-rolling and offer recommendations, as needed, to correct any problem areas identified.

6.2 Undocumented Fill

Undocumented fill is a foreign material, of which no records of testing or evaluation by a qualified professional during the time of placement exist. Undocumented fill is, generally, unsuitable beneath structures, and if encountered during development, should be fully removed, and replaced with engineered fill in accordance with this report. Undocumented fill beneath pavements and hardscape areas should be undercut to a minimum depth of two (2) feet, and the exposed subgrade should be thoroughly evaluated by a registered professional engineer.



6.3 Engineered Fill Placement

It is assumed that any fill material needed will come from cut areas and, if necessary, on-site, or nearby borrow sources of similar material. It is recommended that un-weathered shales should NOT be used to construct any of the necessary fill within either the new building or paved portions of the site. Assuming they are properly moisture conditioned and compacted, it generally appears that the clean clay soils encountered in the borings that are free of rubble, trash, concrete, asphalt, and other debris would be acceptable for use as controlled fill. However, due to their very high swelling potential, detailed recommendations for the placement of a non-expansive subbase are provided in Section 8.0, SLABS ON GRADE of this report.

Any imported fill materials for use as structural fill should be tested by Alpha-Omega Geotech, Inc. to determine if they are acceptable for the intended use. Any ground water seeps that are encountered must be diverted prior to placing fill.

In addition, no compaction of soil fill material should be performed during freezing weather. Nevertheless, as weather conditions dictate, it may be possible to substitute crusher-run limestone in lieu of soil fill to allow placement of engineered controlled fill material to continue during the cold fall and winter months. However, any frozen fill material must be stripped prior to placing subsequent lifts.

All general fill within the area of the new building (except for the upper 24-inches, as discussed in Section 8.0, SLABS ON GRADE of this report, should be placed in lifts not exceeding 6 inches in thickness, and compacted to a minimum density of 95 percent of the Standard Proctor (ASTM D698) maximum dry density at a moisture content within ± 3 percent of the optimum moisture content.

As required by the local building code, the compaction of any structural fill beneath the new buildings, pavements, and any other areas where settlement control is necessary, as well as any slopes that are steeper than 4:1 (H:V) should be tested lift-by-lift by a representative of Alpha-Omega Geotech, Inc.

6.4 Drainage Considerations

Fluctuations of the ground water level can occur due to seasonal variations in the amount of rainfall and other climatic factors that were not evident at the time the borings were made. The possibility of ground water level fluctuations should be considered when developing the design and construction plans for the project. In spring and late fall, soil moisture contents may be abnormally high and drying of the soils that are exposed and/or undercutting may be required to develop a suitable base for the placement and compaction of engineered fill. Disking and aeration of the exposed soils may be sufficient to develop a stable base. However, if site grading begins during the summer or early fall, moisture contents may be abnormally low and the plastic clay soils encountered during this exploration may undergo significant volume changes with subsequent increases in their moisture content. Therefore, when these conditions exist, disking and moisture conditioning of the exposed subgrade soils may be required.



It is important to consider drainage and construction elements that will help to inhibit future slab on grade problems, foundation cracks, as well as intolerable settlements due to volume changes of the onsite soils. The surface drainage must be designed to prevent ponding and effectively move water away from both the new and existing buildings, pavements, and other structures. It is also very important to place all materials under carefully controlled conditions of moisture and density to inhibit significant soil volume changes. Shrubs and trees with deep root systems and requiring large quantities of water should not be planted within 20 feet of the building lines. Any planters located near the building should have impermeable bases with weep holes to discharge water away from the wall lines. Down spouts should be connected to subsurface drains to carry the water to safe exits beyond the building lines, retaining walls, pavements, slopes and other site features or structures that could be adversely affected by water seepage.

6.5 General

Permanent slopes should not be steeper than 3:1 (H:V) to help ensure their future stability and accommodate normal mowing equipment. The responsibility for excavation safety and stability of temporary construction slopes should lie solely with the contractor and should follow the OSHA regulations given in 29 CFR Part 1926.650 - .652, Subpart P. The stability of open excavations is dependent upon a number of factors including but not limited to the presence of gravel, sand and/or silt seams, ground water seepage, strength characteristics of the soil layers, slickensides and other unique geological features, the slope and height of the cut, surcharge loading and vibrations during construction, weather conditions, as well as the length of time the excavation is left open. Alpha-Omega Geotech, Inc. does not assume any responsibility for construction site safety or the contractor's or other parties' compliance with all local, state, and federal safety or other regulations including imprudent excavating practices that results in any damage to nearby structures, roadways, utilities, as well as onsite or offsite improvements.

7.0 FOUNDATIONS

7.1 Spread Footings Foundations

Based on the laboratory test data, the available subsurface information that has been obtained and our understanding of the project requirements, it is our opinion that a shallow foundation system consisting of either earth-formed trench or spread footings may be used for this structure as economical foundation elements for relatively lightly loaded structures.

Perimeter footings, and any footings in unheated areas, should be placed at least 3 feet below final exterior grade to provide adequate frost protection and place them in a more stable moisture environment. Under heated areas, the interior footings can be founded at shallower depths of at least 18 inches below the finished floor elevation. The footing excavations should be carried to undisturbed, inorganic soil or engineered fill.

7.2 Allowable Bearing Pressure

Provided all design and inspection recommendations as given in this report are closely followed and good construction practices are exercised, it is recommended an allowable bearing value of 2,000 psf may be used for design purposes to proportion the spread/wall footings. A twenty-percent increase, i.e., 2,400 psf, may be used for individual column footings. These allowable bearing capacity values, which are based on shear strength alone and not on settlement, incorporate a factor of safety of 3.0. The actual bearing capacity of all subgrade supporting the



foundation elements must be confirmed by a representative of Alpha-Omega Geotech, Inc. as the excavations for the load-bearing wall and column footings are completed and prior to placement of reinforcing steel and concrete. For transient loading conditions, such as un-sustained wind and earthquake, a 33 percent increase may be applied to the above-referenced allowable bearing capacity values.

Based on the subsurface conditions that have been identified, Site Class C conditions (IBC 2018) may be assumed for seismic considerations.

7.3 Anticipated Settlement

Uniform bearing conditions should be provided beneath the footings to minimize differential settlements. If any soft or otherwise unsuitable material is encountered in the footing excavations, it will have to be removed and replaced with engineered controlled fill. Recommendations for the over-excavation and replacement with engineered controlled fill can be made when the footing excavations are inspected during construction, if needed. A representative of Alpha-Omega Geotech, Inc. should inspect all of the footing excavations to verify that uniform and competent bearing material is present beneath all of the foundation elements prior to the placement of any reinforcing steel and concrete.

For spread footings designed and constructed in accordance with this report, it is anticipated that settlements will be limited to 0.75 inches of differential and 1.0 inches in total.

7.4 General

Except for the moisture conditioning discussed in the "Slab On Grade" section of this report, it is recommended that all fill within the new building and paved areas of the site should be constructed as engineered controlled fill placed in lifts not exceeding 6 inches in thickness and compacted to a minimum density of 95 percent of the Standard Proctor (ASTM D698) maximum dry density at a moisture content within ± 3 percent of the optimum moisture content. In accordance with the local building code, a representative of Alpha-Omega Geotech, Inc. should be onsite during placement of all engineered controlled fill within the new building and paved areas to confirm lift thickness and test the compaction of the engineered controlled fill lift-by-lift as it is being placed.

If possible, the over-excavated footings should not be left open for more than 24 hours. The base of the footing excavations should be free of water and loose soil prior to placing reinforcing steel and concrete. No ground water is expected in the footing excavations since ground water was not encountered in any of the borings that were made at the time of drilling. However, if ground water is encountered within the expected depth of excavation for the footings, it is generally anticipated that it can be removed by the use of sumps and pumps. Based on the subsurface conditions that have been identified, it is anticipated that earth-formed trench footing excavations may be used effectively on this project. However, due to the possible presence of existing rocky fill material, it may become necessary to utilize formed footings. A minimum width of 12 inches should be used for trenched wall footings to allow for steel placement and inspection. Minimum widths of 16 and 24 inches should be used for formed wall and column footings, respectively.



8.0 SLABS ON GRADE

8.1 Slab Thicknesses

Slabs on grade that will be subjected to repeated wheel loads, such as passenger vehicles, should be at least 6 inches in thickness. Slabs that are **not** exposed to repeated wheel loads, should be at least 4 inches in thickness. Slabs in storage areas may need to be thicker due to shelving post and other concentrated floor loads. Actual slab thicknesses should be determined by the project structural engineer.

8.2 Low Volume Change (LVC)

The following recommendations provided to help protect the slabs from damage caused by volume changes within the underlying subgrade, and should be implemented in conjunction with Section 7.0, FOUNDATIONS of this report:

- 1) Cut the subgrade a minimum of 24-inches beneath the base of slab elevation to allow placement of a 20-inch subbase and a 4-inch base course beneath the slab-on-grade.
- 2) Scarify and recompact the upper 9 inches of exposed subgrade to within 95 to 100 percent of the Standard Proctor (ASTM D698) maximum dry density at a moisture content wet of the optimum moisture content 0 to 3 percent.
- 3) For the 20-inch granular subbase, place crusher-run limestone or rock dust in three (3) approximately equal lifts and compact to a minimum density of 95 percent of the Standard Proctor (ASTM D698) maximum dry density. The moisture content of this material at the time of placement must be sufficient to achieve the specified level of compaction.
- 4) Place a 4-inch base course of clean, open-graded crushed limestone. This granular base course should be compacted with a suitable vibratory steel wheel roller.

8.3 General

It is recommended that under-slab utility trenches should be backfilled with impermeable clay soil (*), flowable fill or lean concrete to help reduce the potential of these trenches acting as aqueducts transmitting groundwater beneath the new building, pavements, retaining walls and other structures.

- (*) If impermeable clay soil is used as backfill, it should be placed in lifts not exceeding 6 inches in thickness and compacted to a minimum density of 95 percent of the Standard Proctor (ASTM D698) maximum dry density at a moisture content within ± 3 percent of the optimum moisture content, which should be verified lift-by-lift during placement by a representative of Alpha-Omega Geotech, Inc. Although clay soil may be less costly than flowable fill or lean concrete, the OSHA excavation safety regulations given in 29 CFR Part 1926.650 - .652, Subpart P must be followed in the event that clay soil is used to backfill any utility trenches.

Finally, it should be noted that the recommendations given, herein, regarding placement of low-volume change fill to help protect the slabs on grade from volume changes associated with fluctuations within the moisture content of the underlying subgrade materials, would still apply.



Plumbing lines and other water leaks occurring beneath the structure's slab-on-grade floor can induce volume changes within the underlying subgrade materials. Therefore, it is recommended that all water supply and wastewater lines should be tested for leaks prior to backfilling the utility trenches. In addition, it is also recommended that every effort should be made to maintain the plumbing in good working order and prevent or minimize water leaks and discharges.

It is assumed the concrete will be reinforced with properly placed steel reinforcement, such as #4 bars, and control joints will be cut during or shortly after finishing (to be designed by the project structural engineer). Properly placed wire mesh may be used as secondary reinforcement. Fiber reinforcement may also be considered to help control shrinkage cracking and the use of other admixtures may be considered to enhance the workability and performance of the concrete. Suitable construction and sawed joints should be used to control cracking of the slab. In addition, it is recommended that the slump and temperature of the concrete at the time of placement should be limited to standard American Concrete Institute (ACI) guidelines. Furthermore, it is also recommended that proper concrete curing techniques should be utilized and the addition of jobsite water to the concrete be avoided or very closely controlled to within acceptable parameters. Nevertheless, it should be noted that cracking of concrete used for slabs on grade is a normal occurrence and should be expected.

If a 20-inch-thick subbase layer of crusher-run limestone (AB-3) or rock dust is used, as recommended, a modulus of subgrade reaction of 150 pounds per cubic inch (pci) may be assumed for reinforcement and thickness design to support surface loads. If a higher modulus of subgrade reaction were desired, we would be pleased to work with the project's structural engineer to develop recommendations for alternate bases and/or subbases to achieve a higher modulus of subgrade reaction.

9.0 EARTH PRESSURE COEFFICIENTS

A coefficient of sliding friction over the in-situ clay soils at this site may be taken as 0.32. A minimum factor of safety of 1.5 should be used when considering sliding resistance.

Active, passive and at-rest earth pressure coefficients of 0.25, 4.2 and 0.4 may be assumed for backfills of clean, open-graded crushed limestone.

Active, passive and at-rest earth pressure coefficients of 0.5, 1.9 and 1.0 may be assumed for the in-situ clay soils at this site.

However, some of the in-situ soils encountered during this exploration are classified as a Fat Clay and possess a high swelling potential, and, as such, should not be used as backfill since considerable lateral loads may develop with the addition of water.

If deflection of extended foundation walls or retaining walls is not tolerable, at rest earth pressures should be assumed.

These earth pressure coefficients do not include the effect of surcharge loads, hydrostatic loading or a sloping backfill nor do they incorporate a factor of safety. Also, these earth pressure coefficients do not account for high lateral pressures that may result from volume changes when expansive clay soils are used as backfill behind walls with unbalanced fill depths. In addition, any disturbed soils that are relied upon to provide some level of passive



resistance should be placed in lifts not exceeding 6 inches in thickness and compacted to a minimum density of 95 percent of the Standard Proctor (ASTM D698) maximum dry density at a moisture content within ± 3 percent of the optimum moisture content. It is recommended that a representative of Alpha-Omega Geotech, Inc. should verify the compaction of any such materials relied upon to provide passive pressure lift-by-lift during placement.

10.0 PAVEMENTS

10.1 Subgrade Preparation

Please note, a formal pavement design is beyond AOG's scope of service. Standard asphaltic concrete and concrete pavement designs for a given service life requires evaluation of the soil by means of a California Bearing Ratio (CBR) test or other methods, estimates of traffic volumes and axle weights, drainage requirements, and the desired level of maintenance. As such, some standard pavement design options based on assumptions made for materials of this nature are included in this section.

Without stabilization or treatment, the subgrade soils at this site are considered to be poor subgrade materials for the support of pavements. California Bearing Ratio (CBR) values we have obtained rarely exceed 5, soaked, for these materials. Pavements, either total strength flexible or rigid, do not usually perform well when they are placed directly on highly expansive, poor soil subgrades. Soft areas can develop during wet periods and differential shrinkage can occur during dry periods. As a result, no pavement can avoid damage from wheel loads under these circumstances.

Unless the subgrade is chemically stabilized with Class C flyash or cement, the subgrade for all pavements should consist of at least 9 inches of properly compacted soil, which will require tilling and recompacting in cut sections. It is recommended that any untreated aggregate base or chemically stabilized subgrade layers should extend at least 2 feet beyond the pavement and curb lines. The subgrade should be compacted to a minimum density of 95 percent of the Standard Proctor (ASTM D698) maximum dry density at a moisture content within ± 3 percent of the optimum moisture content. Any additional fill that is required to develop the paved areas should also be placed in loose lifts not exceeding 8 inches in thickness and compacted in accordance with these recommendations. The subgrade should be proof-rolled with a loaded tandem-axle dump truck after the final subgrade elevation has been established throughout the paved area. A representative of Alpha-Omega Geotech, Inc. should witness this proof-rolling.

Please note, if asphaltic pavements are used, annual maintenance including, but not limited to, crack sealing, fog sealing, and possible patch with overlay should be anticipated. In addition, the quality of the aggregates and overall composition of the asphalt or concrete mix, as well as drainage conditions can have a profound effect upon the durability of the pavement section.



10.2 Pavement Sections

Table 3: Recompacted Subgrade Section

RECOMPACTED SUBGRADE SECTIONS (INCHES)			
PAVEMENT MATERIALS	CAR PARKING	DRIVE LANES	HEAVY DUTY AREAS (i.e. Dumpster pads, approach lanes, etc.)
Asphaltic Surface Course	2	2	NA
Asphaltic Base Course	3	5.5	NA
Portland Cement Concrete	5	7	8
Crushed Stone (3/4-inch minus)	4	4	4

*Reference Section 10.3, "Recompacted Subgrade Sections"

Table 4: Recommended Thicknesses with Flyash Subgrade Stabilization

FLYASH/CEMENT SUBGRADE STABILIZATION SECTIONS (INCHES)			
PAVEMENT MATERIALS	CAR PARKING	DRIVE LANES	HEAVY DUTY AREAS (i.e. Dumpster pads, approach lanes, etc.)
Asphaltic Surface Course	2	2	NA
Asphaltic Base Course	2	4	NA
Flyash Stabilization	12	12	NA
Portland Cement Concrete	4	6	7
Crushed Stone (3/4-inch minus)	4	4	4
Flyash Stabilization	12	12	12

*Reference Section 10.4, "Subgrade Stabilization Sections"

Table 5: Recommended Thicknesses with Geogrid Reinforcement & Baserock

GEOGRID REINFORCEMENT AND BASEROCK SUBGRADE STABILIZATION SECTIONS (INCHES)			
PAVEMENT MATERIALS	CAR PARKING	DRIVE LANES	HEAVY DUTY AREAS (i.e. Dumpster pads, approach lanes, etc.)
Asphaltic Surface Course	2	2	NA
Asphaltic Base Course	2	4	NA
Crushed Stone (3/4-inch minus)	6	6	NA
Portland Cement Concrete	4	6	7
Crushed Stone (3/4-inch minus)	6	6	6

*Reference Section 10.4, "Subgrade Stabilization Sections"



10.3 Recompacted Subgrade Sections

10.3.1 Flexible Pavements Sections

From an initial cost perspective, flexible asphaltic concrete pavement is the most economical pavement section. However, treating the subgrade with Class C flyash, cement, or using a geogrid reinforced base course can provide a higher quality pavement section, having a much longer service life. Nevertheless, if the subgrade is untreated and asphaltic pavement is used, areas used exclusively for automobile parking should consist of at least 5.0 inches of asphaltic concrete (2.0 inches of surface mix and 3.0 inches of base mix). Drives should be constructed of at least 7.5 inches of asphaltic concrete (2.0 inches of surface and 5.5 inches of base mix). The above-referenced pavement section represents minimum design thicknesses and, as such, periodic maintenance should be anticipated. If an increased pavement performance is desired, as described in Section 10.4, "Subgrade Stabilization," chemical stabilization or the use of a layer of base rock and geogrid reinforcement may be considered. Asphaltic cement concrete should NOT be used in areas where heavy truck loads/concentrations are expected.

It is also recommended that an asphalt binder grade of PG 64-28 should be considered to help reduce the potential of thermal cracking based on the climatic conditions of this region. However, for base mix asphalt placed at least 4 inches below the surface, an asphalt binder grade of PG 64-22 should be sufficient.

10.3.2 Rigid Pavement Sections

As an alternative, rigid Portland Cement concrete with a 4-inch-thick base course of crushed limestone may also be used with minimum thicknesses of 5.0 and 7.0 inches for automobile parking areas and drive lanes, respectively. The above-referenced pavement section represents minimum design thicknesses and, as such, periodic maintenance should be anticipated. If a better pavement is desired, as described in Section 10.4, "Subgrade Stabilization," flyash stabilization or the use of a layer of base rock and geogrid reinforcement may be considered.

The crusher-run limestone base course should be compacted to a minimum density of 95 percent of the Standard Proctor (ASTM D698) maximum dry density at a moisture content sufficient to achieve the specified level of compaction.

For areas where heavy truck loads/concentrations are anticipated, Portland Cement concrete is recommended. Portland cement concrete slabs having a thickness of 8 inches over a 4-inch, minimum, compacted, crusher-run limestone base should be used for dumpster stations, parking lot entrances, areas where a high concentration of heavily loaded trucks are anticipated, as well as any areas where trucks accelerate/decelerate and execute sharp turning maneuvers.

10.4 Subgrade Stabilization Sections

Alternate pavement sections utilizing stabilization, geogrids, granular base and/or subbase courses should be considered. Treating the subgrade with Class C flyash, cement or using a geogrid reinforced base course can provide a pavement section having a much longer service life.

If specific pavement performance standards are to be met, AOG would be pleased to be of further assistance once the actual design loading conditions, service-life and maintenance expectations have been defined.



10.4.1 Flyash/Cement

The use of flyash/cement is usually not effective during cold winter months. Notwithstanding this weather limitation, assuming the flyash is thoroughly and uniformly mixed with the subgrade, flyash stabilization can greatly reduce the swelling potential and improve the strength of the subgrade soil.

If the subgrade is stabilized with Class C flyash or cement to a depth of 12 inches, full depth asphalt pavements with thicknesses of 4.0 and 6.0 inches for parking and drive lanes, respectively, can be used. Likewise, if the subgrade is stabilized with flyash, the Portland cement concrete pavement sections over a 4-inch-thick base course of crushed limestone may also be reduced to 4.0 and 6.0 inches, respectively. The crushed limestone base course should be compacted to the specifications given in Section 10.3, "Rigid Pavement Sections," of this report.

Based on experience with similar projects, adding more flyash does not always increase the stiffness of the subgrade. In fact, too much flyash in the subgrade may cause excessive brittleness, which may result in reflective cracking problems to develop. It is usually cost effective to determine the optimum amount of flyash necessary by laboratory testing; however, it usually ranges from about 12 to 15 percent by weight (5% for Portland Cement). The Class C flyash should be thoroughly mixed with the subgrade soil by means of a Bomag tiller or other similar equipment specifically designed for such procedures and compacted to a minimum density of 95 percent of the Standard Proctor (ASTM D698) maximum dry density at a moisture content within ± 3 percent of the optimum moisture content.

10.4.2 Geogrid Reinforcement & Base Rock

Soft areas can develop even when the subgrade is stabilized with Class C flyash or cement. An even better pavement section can be developed by the use of a tri-axial geogrid over a properly compacted subgrade, as discussed in this report, and a layer of untreated crushed limestone base rock under either flexible or rigid pavements. The purpose of the geogrid is to help span soft spots that will inevitably develop in the subgrade. The geogrid helps to confine the base rock and acts as a "snowshoe," distributing the loads over the subgrade in a tri-axial direction. The layer of base rock, which is placed over the geogrid, must be thick enough to support construction traffic and paving equipment so the geogrid does not become exposed. In general, the crushed limestone base rock should not be less than approximately 6 inches in thickness. If this option is chosen, it is recommended that Tensar TX-140, which is a tri-axial polypropylene geogrid, be used. The geogrid reinforcement should be placed and overlapped as needed in accordance with the manufacturer's recommendations, which should be verified by a representative of Alpha-Omega Geotech, Inc.

Asphaltic concrete thicknesses of 4.0 and 6.0 inches for parking areas and drive lanes, respectively, can be used if geogrid and base rock stabilization are used. Similarly, the Portland cement concrete sections can be reduced to 4.0 and 6.0 inches for the respective areas. Although these thicknesses are the same as given if the subgrade is treated with Class C flyash, the use of a tri-axial geogrid and base rock usually represents the most effective, reasonable pavement section.



10.5 General

If asphaltic pavements are used, periodic maintenance including, but not limited to, crack sealing, fog sealing, and possible patch with overlay should be anticipated. In addition, the quality of the aggregates and overall composition of the asphalt or concrete mix, as well as drainage conditions can have a profound effect upon the durability of the pavement section.

Where engineered controlled fill is placed beneath paved areas, it is recommended the compacted fill should extend a minimum distance of two (2) feet beyond the pavement edge or curb line, or a distance equal to the depth of the fill, whichever is greater.

Asphalt mixes meeting KCAPWA specifications may be used for surface and base mixes, respectively. Compaction testing of each pavement layer is recommended to help ensure compliance with the mix design specifications.

For areas where heavy truck loads/concentrations are anticipated, Portland Cement concrete is should be used. It is recommended that load-transfer devices should be installed where construction joints are required. For dumpster stations, the concrete slabs should be large enough to accommodate the dumpster and at least the rear wheels of the disposal vehicle. Rigid pavements should have No. 4 bars on at least 2-foot centers and positioned in the upper third of the slab. Joints should be tooled or cut within 4 hours of hardening to a depth of at least one fourth of the thickness.

The subgrade should be moistened prior to placement of concrete. Fresh concrete should be properly cured as recommended by the American Concrete Institute (ACI). To help provide resistance to damage caused by alternating cycles of freezing and thawing, it is recommended that any exposed concrete should be properly air entrained; typically at 5 to 7 percent. In addition, it is also recommended the outer edges of pavement slabs should be thickened to help resist cracking associated with heavy wheel loads near these unrestrained areas.

If full-depth pavement is used, it is important the moisture content of the subgrade should be kept as constant as possible from the time of recompacting until the pavement is laid. However, if the subgrade becomes dry, it should be moistened for at least 72 hours prior to paving, but it should not be saturated. In all cases, pavements should be sloped to inhibit ponding and provide rapid surface drainage. If water is allowed to pond on or adjacent to the pavement, the subgrade could become saturated and lose its bearing capacity which would contribute to premature pavement deterioration under a single cycle of heavy wheel loads or a number of cycles of lighter wheel loads.



11.0 TESTING AND INSPECTION RECOMMENDATIONS

Unless Alpha-Omega Geotech, Inc. is retained to provide the construction observation, monitoring and testing services for this project, we cannot accept any responsibility for any conditions that deviate from those identified in this subsurface investigation nor for the performance of the foundations, pavements and other structures including any retaining walls that are a part of this project. Alpha-Omega Geotech, Inc. is accredited by AASHTO and we are experienced in construction quality control and have a fully-equipped soil, concrete, aggregate, rock and asphalt testing laboratory, as well as qualified field technicians to provide these field services.

It is not economically practical to perform enough exploratory borings on any site to identify all subsurface conditions. Some conditions affecting the design and/or construction may not become known until the project is underway. The boring logs, field SPT and laboratory test results depict subsurface conditions only at the specified locations and depths at the site. The boundaries between soil and rock layers indicated on the boring logs are based on observations made during drilling and an interpretation of the laboratory testing results. The exact depths of these boundaries are approximate and the transitions between soil and rock types may be gradual rather than being clearly defined. Also, due to the prior development at this site, as well as, the natural conditions of the formation of soils and rock, it is possible that unanticipated subsurface conditions may be encountered during construction.

Monitoring of the subsurface conditions that are revealed during construction is needed to verify that subsurface conditions are consistent with those conditions identified in this preliminary geotechnical investigation. If variations in subsurface conditions are encountered, it will be necessary for Alpha-Omega Geotech, Inc. to re-evaluate the recommendations that have been made in this report.

Special Inspections should be performed in accordance with the local building code under which the project is designed, as adopted by Lee's Summit, MO.

Prior to filling, it is recommended that a representative of Alpha-Omega Geotech, Inc. should verify that the site has been properly stripped of all topsoil and other deleterious material, benched as needed and prepared for the placement of fill. The compaction of any structural fill beneath the new building, pavements, and any other areas where settlement control is necessary should be tested lift-by-lift by a representative of Alpha-Omega Geotech, Inc. as it is being placed. This should include the prepared subgrade layers beneath the building's slab-on-grade, as well as any other fill material relied upon to provide passive resistance. Also, in accordance with the local building code, any fill that is used to construct slopes steeper than 4:1 (H:V) must be placed as engineered controlled fill and the compaction tested lift-by-lift during placement.

Assuming that uniform fill material is used, nuclear density gauges (ASTM D2922/D3017) should be used to test compaction wherever necessary. However, if fill material of non-uniform consistency is used, other evaluation methods may be required. Such methods may include, but not be limited to, the use of a GeoGauge Stiffness meter, Dynamic Cone Penetrometer (DCP), proof-rolling or other visual inspection techniques.

Any geotextile fabric and geogrid reinforcement that is utilized should be placed and overlapped as needed in accordance with the manufacturer's recommendations, which should be verified by a representative of Alpha-Omega Geotech, Inc. Proper placement of the reinforcing steel for drilled piers, grade beams, pier caps, foundation walls and other structural elements including any necessary wing walls and retaining walls should be verified prior to the placement of concrete. The subgrade under the slabs on grade and pavements should be checked to verify



they are in compliance with the density and moisture requirements. Wherever possible, in addition to compaction testing, cut and fill areas should be proof-rolled with a loaded tandem-axle dump truck to identify soft areas that will need to be corrected. A representative of Alpha-Omega Geotech, Inc. should observe this proof-rolling. Checks should also be made of the subbases, concrete and any pavement materials.

Finally, the inspection and testing services listed herein are given as a minimum and it should be understood that additional inspection and testing services might also be required or otherwise beneficial.

10.0 LIMITATIONS

This report is presented in broad terms to provide a comprehensive assessment of the interpreted subsurface conditions and their potential effect on the adequate design and economical construction of the proposed Lee's Summit Downtown Re-development project located in Lee's Summit, MO, as discussed herein. This report has been prepared for the exclusive use of our client for specific application to the project discussed herein and has been prepared within our client's directive and budgetary constraints and in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made.

It should be noted that the concept of risk is an important aspect of the geotechnical engineering evaluation and report since the recommendations given in this report are not based on exact science but rather analytical tools and empirical methods in conjunction with engineering judgment and experience. Therefore, the recommendations given herein should not be considered risk-free and, more importantly, are not a guarantee that the interaction between the soil materials and the proposed structures will perform as planned. Nevertheless, the geotechnical engineering recommendations presented herein are Alpha-Omega Geotech, Inc.'s professional opinion of those measures that are necessary for the proposed structures to perform according to the proposed design based on the information provided to Alpha-Omega Geotech, Inc., the referenced information gathered during the course of this investigation and our experience with these conditions.

Any significant structural changes to the proposed new structure or its location on this site relative to where these test borings were completed shall be assumed to invalidate the conclusions and recommendations given in this report until we have had the opportunity to review these changes and, if necessary, modify our conclusions and recommendations accordingly. It is also strongly suggested that Alpha-Omega Geotech, Inc. should review your plans and specifications dealing with the earthwork, foundations, as well as any pavements prior to construction to confirm compliance with the recommendations given herein. Particular details of foundation design, construction specifications or quality control may develop, and we would be pleased to respond to any questions regarding these details.

If Alpha-Omega Geotech, Inc. is not retained to review the project plans and specifications, address to the proposed structures or their location on the site relative to where these test borings were completed, provide the recommended construction phase observation, monitoring and testing services and respond to any subsurface conditions that are identified during construction to evaluate whether or not changes in the recommendations given in this report are needed, we cannot be held responsible for the impact of those conditions on the project or the future performance of the buildings, pavements and/or structures that may be involved.



The scope of our services did not include any environmental assessment or investigation for the presence of hazardous or toxic materials in the soil, surface water, ground water or air, either on, below or adjacent to this site. In addition, no determination regarding the presence or absence of wetlands was made. Furthermore, it should be understood that the scope of geotechnical services for this project does not include either specifically or by implication any biological (i.e., mold, fungi, or bacteria) assessment of the site or the proposed construction. Any statements in this report or included on the boring logs regarding odors, colors and unusual or suspicious items or conditions are strictly for informational purposes only.

We appreciate the opportunity to be of service to GLMV Architecture, as well as the project developers and look forward to working with you throughout the construction process. We are prepared to provide the Special Inspection services that will be required by the local building code under which this project is designed, as adopted by the City of Lee's Summit, Missouri as well as the other necessary construction observation, monitoring and testing services discussed in this report. If you have any questions concerning this report, or if we may be of further assistance, please call us at (913) 371-0000.

Sincerely,
ALPHA-OMEGA GEOTECH, INC.



Garic Abendroth, P.E.
Engineering Director

Enclosures




Appendix Section A

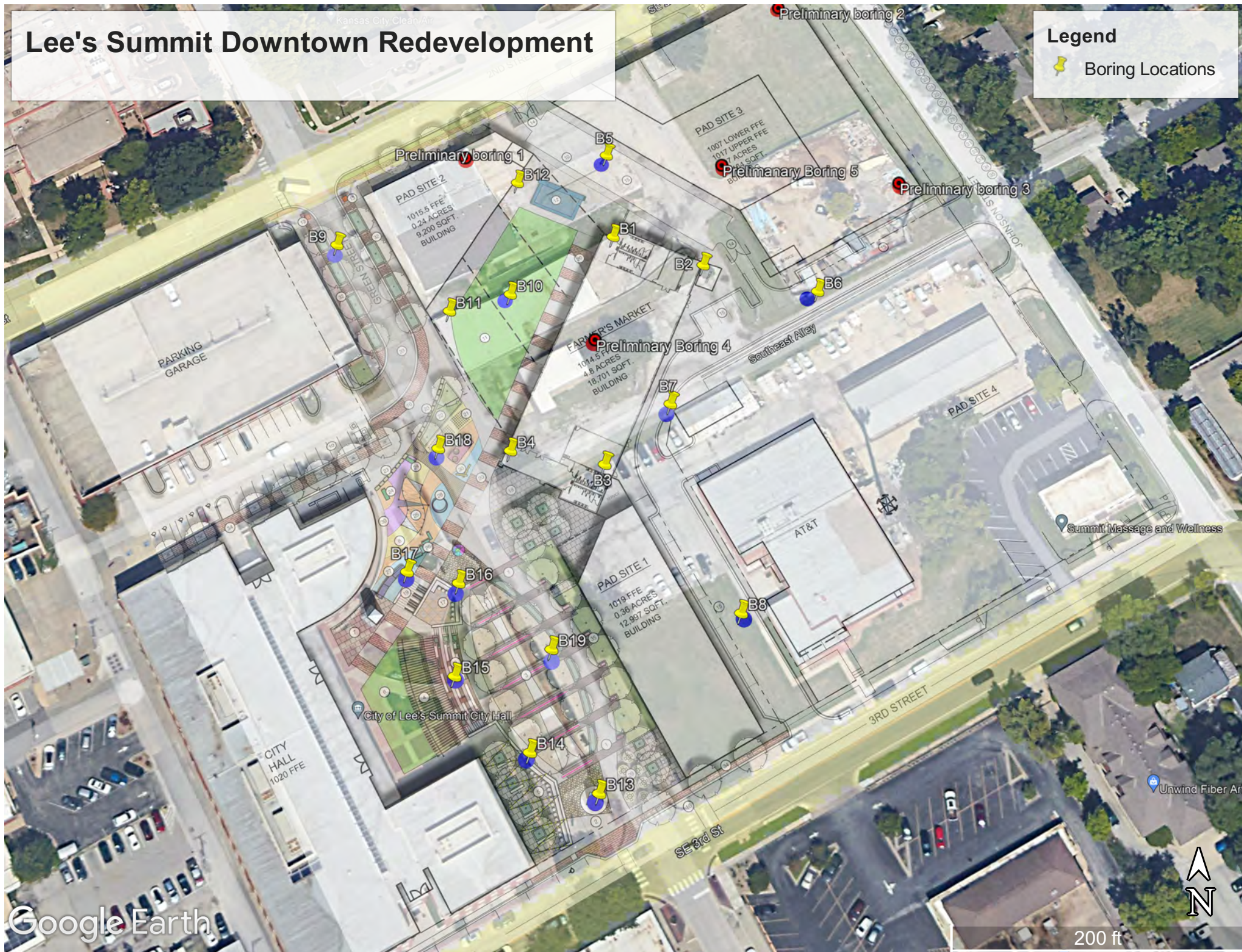
SITE SKETCH

Site and Boring Location Plans

Lee's Summit Downtown Redevelopment

Legend


 Boring Locations

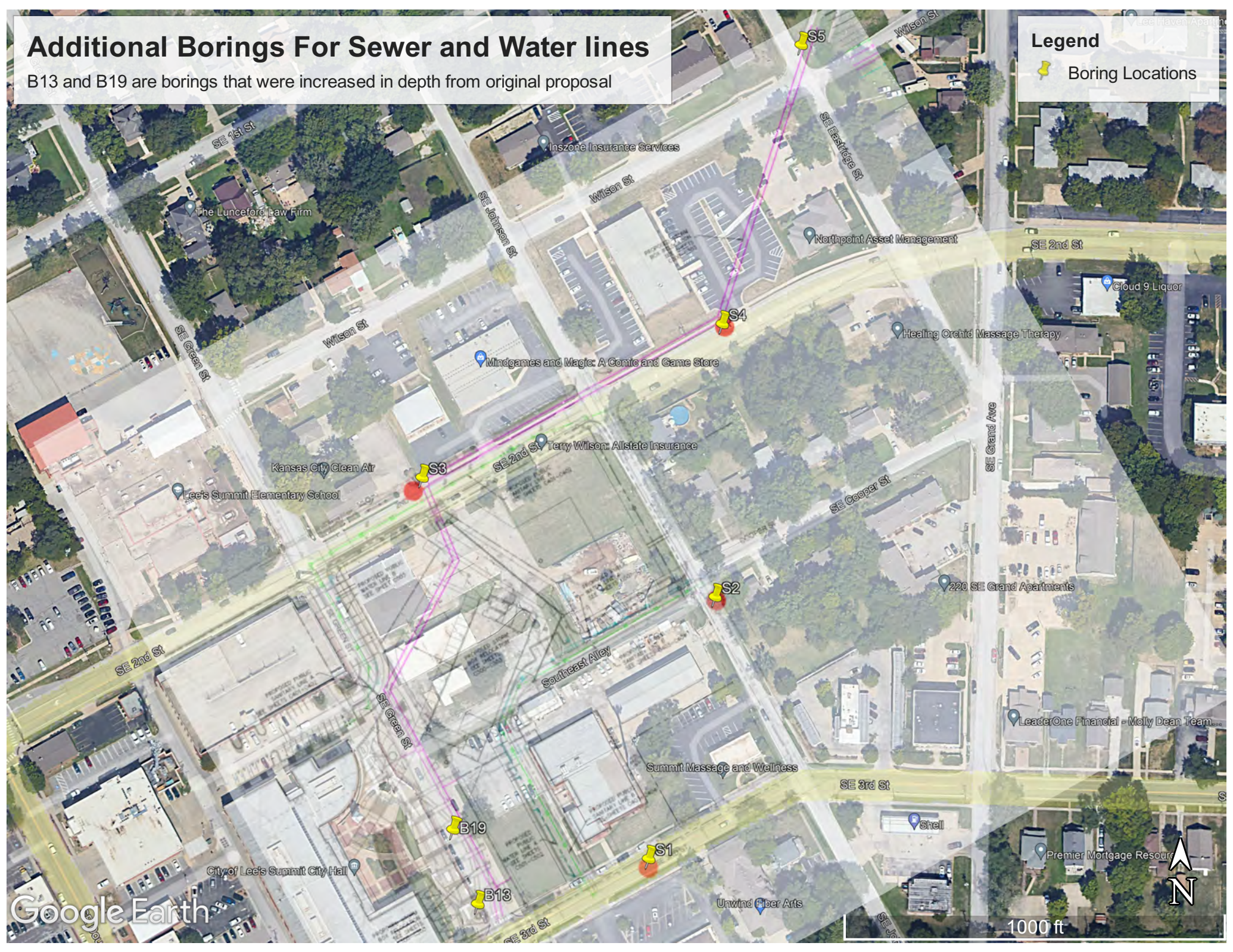


Additional Borings For Sewer and Water lines

B13 and B19 are borings that were increased in depth from original proposal

Legend

 Boring Locations



Appendix Section B

LABORATORY TEST RESULTS

Summary of Laboratory Testing

SLT 22205

Alpha-Omega Geotech, Inc.
1701 State Avenue
Kansas City, KS 66102
Office: (913) 371-0000 Fax: (913) 371-6710
Website: www.aogeotech.com



PROJECT NAME: DOWNTOWN LEE'S SUMMIT REDEVELOPMENT
PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.

PROJECT NUMBER: 230378 E
DATE: 7/6/2023

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits			USCS/ Visual Class.	% Passing No. 200	Unconfined Compression (psf)	%e	% Swell	Remarks
						LL	PL	PI						
B1	SS-1	1.0-2.5	Dark brown, speckled reddish brown FAT/LEAN CLAY						CH-CL					N=5
B1	ST-2	3.0-5.0	Brown, speckled reddish brown FAT CLAY	23.8	99.7	54	21	33	CH		1626	2.6		PP=1.25
B1	ST-3	5.0-7.0	Brown, mottled dark brown, and reddish brown FAT CLAY						CH					PP=1.75
B1	SS-4	8.5-10.0	Light brown sandy silt (Weathered Siltstone/ Weathered SHALE) (Very hard, Very slow drilling)						SH					N=50/5
B1	SS-5	13.5-15.0	Light gray LEAN CLAY (weathered SHALE) (SHALE)						SH					N=50/3
B2	SS-1	1.0-2.5	Dark brown, speckled reddish brown FAT CLAY with trace of gravel (Possible FILL)						CH					N=16
B2	SS-2	3.0-5.0	Brown, speckled light brown FAT CLAY (Possible FILL)						CH					N=14
B2	ST-3	5.0-7.0	Brown, spotted gray, reddish brown and dark brown FAT CLAY (Possible FILL)	24.9	100.2	69	23	46	CH		3169	14.9		PP=1.25
B2	SS-4	8.5-10.0	Brown, mottled light gray and light reddish brown FAT CLAY						CH					N=8

Summary of Laboratory Testing

SLT 22205

Alpha-Omega Geotech, Inc.
1701 State Avenue
Kansas City, KS 66102
Office: (913) 371-0000 Fax: (913) 371-6710
Website: www.aogeotech.com



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PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.

PROJECT NUMBER: 230378 E
DATE: 7/6/2023

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits			USCS/ Visual Class.	% Passing No. 200	Unconfined Compression (psf)	%e	% Swell	Remarks
						LL	PL	PI						
B2	SS-5	13.5-14.0	Light brown silt with sand (Weathered SANDSTONE)						SS					N=50/6
B4	SS-1	1.0-2.5	Brown, spotted light brown LEAN/FAT CLAY (Possible FILL)						CL-CH					
B4	ST-2	3.0-5.0	Brown, spotted light brown LEAN/FAT CLAY (Possible FILL) NO RECOVERY						CL-CH					PP= 0
B4	ST-3	5.0-7.0	Brown, spotted reddish brown LEAN CLAY with trace of gravel (Possible FILL)						CL					PP=3.50
B4	ST-4	8.0-10.0	Brown, spotted gray, reddish brown and tan FAT CLAY with trace of Weathered LIMESTONE /SANDSTONE						CH					PP=2.50
B5	SS-1	1.0-2.5	Dark brown, spotted reddish brown LEAN/FAT CLAY with trace of gravel and sand (Possible FILL)						CL-CH					N=14
B5	SS-2	3.5-5.0	Brown, speckled reddish brown FAT CLAY (Possible FILL)						CH					N=6
B5	SS-3	8.5-10.0	Brown LEAN CLAY with trace of gravel (Possible FILL)						CL					N=8

Summary of Laboratory Testing

SLT 22205

Alpha-Omega Geotech, Inc.
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Kansas City, KS 66102
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PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.

PROJECT NUMBER: 230378 E
DATE: 7/6/2023

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits			USCS/ Visual Class.	% Passing No. 200	Unconfined Compression (psf)	%e	% Swell	Remarks
						LL	PL	PI						
B6	SS-1	1.0-2.5	Brown, spotted dark brown, speckled reddish brown FAT CLAY (Possible FILL)						CH					N=9
B6	SS-2	3.5-5.0	Brown, mottled gray, spotted reddish brown FAT CLAY (Possible FILL)						CH					N=10
B6	SS-3	8.5-10.0	Brown, mottled gray and reddish brown LEAN/FAT CLAY (Weathered SHALE) (Possible FILL)						CL-CH					N=25
B7	SS-1	1.0-2.5	Brown, spotted gray and reddish brown FAT CLAY with trace of gravel (Possible FILL)						CH					N=10
B7	SS-2	3.5-5.0	Light brown, mottled reddish brown, spotted light gray LEAN/FAT CLAY (Possible FILL)						CL-CH					N=6
B7	SS-3	8.5-9.2	Light brown, spotted reddish brown LEAN CLAY (Weathered SHALE) (Very hard, very slow drilling)						SH					N=50/2
B8	SS-1	1.0-2.5	Dark brown, speckled reddish brown FAT CLAY with trace of organics (finger roots)						CH					N=9
B8	SS-2	3.5-5.0	Brown, mottled reddish brown, spotted gray FAT CLAY						CH					N=12

Summary of Laboratory Testing

SLT 22205

Alpha-Omega Geotech, Inc.
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Kansas City, KS 66102
Office: (913) 371-0000 Fax: (913) 371-6710
Website: www.aogeotech.com



PROJECT NAME: DOWNTOWN LEE'S SUMMIT REDEVELOPMENT
PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.

PROJECT NUMBER: 230378 E
DATE: 7/6/2023

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits			USCS/ Visual Class.	% Passing No. 200	Unconfined Compression (psf)	%e	% Swell	Remarks
						LL	PL	PI						
B8	SS-3	8.5-10.0	Light brown silty LEAN CLAY (Weathered SHALE) (Very hard, very slow drilling)						CL					N=50/4
B9	SS-1	1.0-2.5	Brown, spotted dark brown, speckled reddish brown FAT CLAY (Possible FILL)						CH					N=10
B9	SS-2	3.5-5.0	Brown, spotted gray and reddish brown FAT CLAY (Possible FILL)						CH					N=7
B9	SS-3	8.5-9.9	Brown silty sand/sandy silt (Very hard, very slow drilling)						SM					N=50/5
B10	SS-1	1.0-2.5	Brown LEAN/FAT CLAY with trace of gravel and sand						CL-CH					N=8
B10	ST-2	3.0-5.0	Brown FAT CLAY with trace of organics (finger roots)	22.9	96.7	50	22	28	CH		3245	3.5		PP=1.75
B10	ST-3	5.0-7.0	Brown FAT CLAY with trace of gravel						CH					PP=2.50
B10	SS-4	8.5-10.0	Brown, spotted reddish brown LEAN/FAT CLAY						CL-CH					N=6
B10	SS-5	13.5-15.0	Light brown silty low plasticity clay (Weathered SHALE) (Very hard, very slow drilling)						SH					N=50/2

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PROJECT NUMBER: 230378 E
DATE: 7/6/2023

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits			USCS/ Visual Class.	% Passing No. 200	Unconfined Compression (psf)	%e	% Swell	Remarks
						LL	PL	PI						
B11	SS-1	1.0-2.5	Dark brown LEAN CLAY						CL					N=4
B11	SS-2	3.0-5.0	Brown, speckled reddish brown LEAN/FAT CLAY						CL-CH					N=8
B11	ST-3	5.0-7.0	Brown, marbled dark brown, spotted reddish brown FAT CLAY	25.0	100.4	55	21	34	CH		4493	9.7		PP=2.25
B11	SS-4	8.5-10.0	Brown, mottled gray, spotted reddish brown FAT CLAY						CH					N=7
B11	SS-5	13.5-15.0	Gray SHALE (Very hard, very slow drilling)						SH					N=50/3
B12	SS-1	1.0-2.5	Dark brown, spotted reddish brown LEAN/FAT CLAY with trace of gravel						CL-CH					N=7
B12	ST-2	3.0-5.0	Brown FAT CLAY	24.9	97.5	53	22	31	CH		3469	8.9		PP=1.50
B12	SS-3	5.0-6.5	Brown, mottled gray LEAN/FAT CLAY						CL-CH					N=11
B12	SS-4	8.5-10.0	Gray, mottled brown, spotted reddish brown LEAN/FAT CLAY						CL-CH					N=8
B12	SS-5	13.5-15.0	Light gray SHALE						SH					N=50/4

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PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.

PROJECT NUMBER: 230378 E
DATE: 7/6/2023

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits			USCS/ Visual Class.	% Passing No. 200	Unconfined Compression (psf)	%e	% Swell	Remarks
						LL	PL	PI						
B13	SS-1	1.0-2.5	Brown, spotted reddish brown and dark brown FAT CLAY (Possible FILL)						CH					N=10
B13	ST-2	3.0-5.0	Brown LEAN CLAY (Possible FILL)						CL					PP=1.75
B13	ST-3	5.0-7.0	Brown, spotted dark brown, speckled reddish brown FAT CLAY (Possible FILL)						CH					PP=2.25
B13	SS-4	8.5-10.0	Brown, spotted reddish brown FAT CLAY (Possible FILL)						CH					N=6
B13	SS-5	13.5-14.3	Gray, spotted brown LEAN/FAT CLAY (Weathered SHALE) (Very hard, very slow drilling)						SH					N=50/3
B14	SS-1	1.0-2.5	Brown, mottled light brown, spotted light gray LEAN/FAT CLAY (Possible FILL)						CL-CH					N=9
B14	ST-2	3.0-5.0	Brown, spotted reddish brown and gray FAT CLAY (Possible FILL)	26.2	93.9	62	26	36	CH					PP=2.00
B14	ST-3	5.0-7.0	Brown, spotted dark brown, speckled reddish brown FAT CLAY (Possible FILL)						CH					PP=2.00

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PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.

PROJECT NUMBER: 230378 E
DATE: 7/6/2023

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits			USCS/ Visual Class.	% Passing No. 200	Unconfined Compression (psf)	%e	% Swell	Remarks
						LL	PL	PI						
B14	SS-4	8.5-10.0	Light brown, spotted light gray and light reddish brown LEAN CLAY (Weathered SHALE) (Possible FILL)						CL					N=11
B15	SS-1	1.0-2.5	Brown, mottled gray, spotted redish brown FAT CLAY (Possible FILL)						CH					N=6
B15	ST-2	3.0-5.0	Brown, spotted dark brown, speckled reddish brown FAT CLAY (Possible FILL)						CH					PP=1.50
B15	ST-3	5.0-7.0	Brown, spotted gray LEAN/FAT CLAY (Possible FILL)						CL-CH					PP=1.50
B15	SS-4	8.5-10.0	Light brown silty sand/sandy silt (Weathered SHALE) (Possible FILL) (Very hard, very slow drilling)						SH					N=50/6
B16	SS-1	1.0-2.5	Brown, spotted gray, speckled reddish brown FAT CLAY (Possible FILL)						CH					N=11
B16	ST-2	3.0-5.0	Brown, spotted dark brown and reddish brown FAT CLAY (Possible FILL)	27.4	95.8	70	24	46	CH					PP=1.25
B16	ST-3	5.0-7.0	Brown, spotted dark brown, speckled reddish brown FAT CLAY (Possible FILL)						CH					PP=2.00

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PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.

PROJECT NUMBER: 230378 E
DATE: 7/6/2023

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits			USCS/ Visual Class.	% Passing No. 200	Unconfined Compression (psf)	%e	% Swell	Remarks
						LL	PL	PI						
B16	SS-4	8.5-10.0	Brown, spotted dark brown LEAN CLAY with trace of sand (Weathered SHALE) (Possible FILL) (Very hard, very slow drilling)						SH					N=50/2
B17	SS-1	1.0-2.5	Brown, mottled gray, spotted reddish brown FAT CLAY (Possible FILL)						CH					N=9
B17	ST-2	3.0-5.0	Light brown, spotted gray and brown, speckled reddish brown FAT CLAY (Possible FILL)						CH					PP=2.50
B17	SS-3	5.0-5.8	Light brown, spotted reddish brown silty sand/sandy silt (Weathered SHALE) (Possible FILL) (Very hard, very slow drilling)						SH					N=50/3
B17	SS-4	8.5-9.3	Brown, spotted reddish brown silty sand/sandy silt (Weathered SHALE) (Very hard, very slow drilling)						SH					N=50/3
B18	SS-1	1.0-2.5	Brown FAT CLAY (Possible FILL)						CH					N=6
B18	ST-2	3.0-5.0	Light brown, mottled reddish brown and light gray FAT CLAY (Possible FILL)						CH					PP=1.75

Summary of Laboratory Testing

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PROJECT NAME: DOWNTOWN LEE'S SUMMIT REDEVELOPMENT
PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.

PROJECT NUMBER: 230378 E
DATE: 7/6/2023

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits			USCS/ Visual Class.	% Passing No. 200	Unconfined Compression (psf)	%e	% Swell	Remarks
						LL	PL	PI						
B18	SS-3	5.0-6.0	Light brown, mottled reddish brown silty sand/sandy silt (Very hard, very slow drilling) (Possible FILL)						SM					N=50/6
B18	SS-4	8.5-9.0	Brown, spotted dark brown silty sand/sandy silt (Very hard, very slow drilling)						SM					N=50/6
B19	SS-1	1.0-2.5	Brown FAT CLAY (Possible FILL)						CH					N=7
B19	ST-2	3.0-5.0	Brown, spotted light brown, gray and light reddish brown LEAN CLAY with trace of Weathered SHALE (Possible FILL)	22.9	102.4	48	24	24	SH					PP=2.00
B19	ST-3	5.0-7.0	Brown LEAN/FAT CLAY with trace of gravel (Possible FILL)						CL-CH					PP=3.00
B19	SS-4	8.5-9.9	Brown, spotted gray LEAN/FAT CLAY with trace of Weathered SHALE (Possible FILL)						CL-CH					N=50/5
B19	SS-5	13.5-13.8	Light brown, spotted brown LEAN/FAT CLAY (Very hard, very slow drilling)						CL-CH					N=50/3

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PROJECT NUMBER: 230378 E
DATE: 7/6/2023

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits			USCS/ Visual Class.	% Passing No. 200	Unconfined Compression (psf)	%e	% Swell	Remarks
						LL	PL	PI						
S2	SS-1	1.0-2.5	Dark brown LEAN CLAY with reddish brown brick fragments/debris (Possible FILL)						CL					N=5
S2	SS-2	3.5-5.0	Dark brown, mottled reddish brown and gray LEAN/FAT CLAY (Possible FILL)						CL-CH					N=7
S2	SS-3	8.5-9.0	Brown silt with weathered silt fragments						SH					N=50/6
S2	SS-4	13.5-13.7	Weathered SHALE (Very Hard, Very Slow Drilling) (NO RECOVERY)						SH					N=50/2
S3	SS-1	1.0-2.5	Dark brown, spotted reddish brown FAT CLAY (Possible FILL)						CH					N=8
S3	SS-2	3.5-5.0	Brown, spotted dark brown FAT CLAY with trace of gravel (Possible FILL)						CH					N=60
S3	SS-3	8.5-8.9	Brown silty LEAN CLAY (Weathered SHALE) (Very hard, very slow drilling)						SH					N=50/5
S3	SS-4	13.5-13.9	Gray LEAN CLAY (Weathered SHALE) (Very hard, very slow drilling)						SH					N=50/5
S4	SS-1	1.0-2.5	Dark brown, spotted reddish brown LEAN/FAT CLAY (Possible FILL)						CL-CH					N=7

Summary of Laboratory Testing

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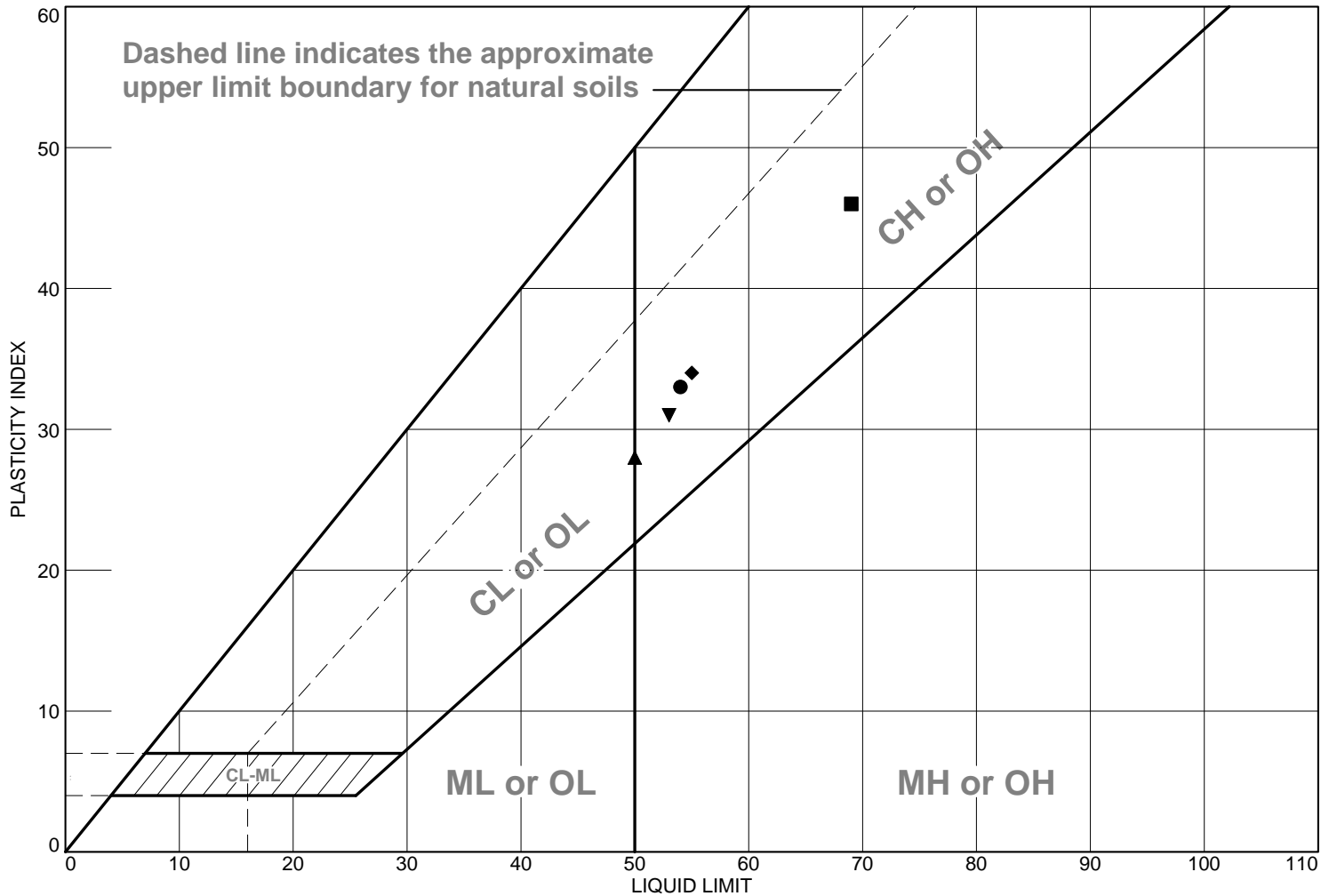


PROJECT NAME: DOWNTOWN LEE'S SUMMIT REDEVELOPMENT
PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.

PROJECT NUMBER: 230378 E
DATE: 7/6/2023

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits			USCS/ Visual Class.	% Passing No. 200	Unconfined Compression (psf)	%e	% Swell	Remarks
						LL	PL	PI						
S4	SS-2	3.5-5.0	Brown, mottled dark brown, spotted gray LEAN CLAY with weathered SHALE fragments (Possible FILL)						CL					N=60
S4	SS-3	8.5-10.0	Brown, mottled reddish brown and gray silt with sand (Weathered SHALE) (Very hard, very slow drilling) (Possible FILL)						SH					N=50/6
S5	SS-1	1.0-2.5	Dark brown LEAN/FAT CLAY (Possible FILL)						CL-CH					N=4
S5	SS-2	3.5-5.0	Brown, mottled gray, spotted reddish brown FAT CLAY (Possible FILL)						CH					N=8
S5	SS-3	8.5-8.9	Brown, spotted gray LEAN CLAY (Weathered SHALE) (Possible FILL)						CL					N=11
S5	SS-4	13.5-13.9	Gray LEAN CLAY (Weathered SHALE) (Very hard, very slow drilling)						CL					N=60

LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318)



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown, speckled reddish brown FAT CLAY	54	21	33			CH
■	Brown, spotted gray, reddish brown and dark brown FAT CLAY (Possible FILL)	69	23	46			CH
▲	Brown LEAN / FAT CLAY with trace of organics (finger roots)	50	22	28			CL-CH
◆	Brown, marbled dark brown, spotted reddish brown FAT CLAY	55	21	34			CH
▼	Brown FAT CLAY	53	22	31			CH

Project No. 230378 E **Client:** GLMV ARCHITECHTURE

Project: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT

● **Source of Sample:** B1 **Depth:** 3.0 **Sample Number:** ST-2
 ■ **Source of Sample:** B2 **Depth:** 5.0 **Sample Number:** ST-3
 ▲ **Source of Sample:** B10 **Depth:** 3.0 **Sample Number:** ST-2
 ◆ **Source of Sample:** B11 **Depth:** 5.0 **Sample Number:** ST-3
 ▼ **Source of Sample:** B12 **Depth:** 3.0 **Sample Number:** ST-2

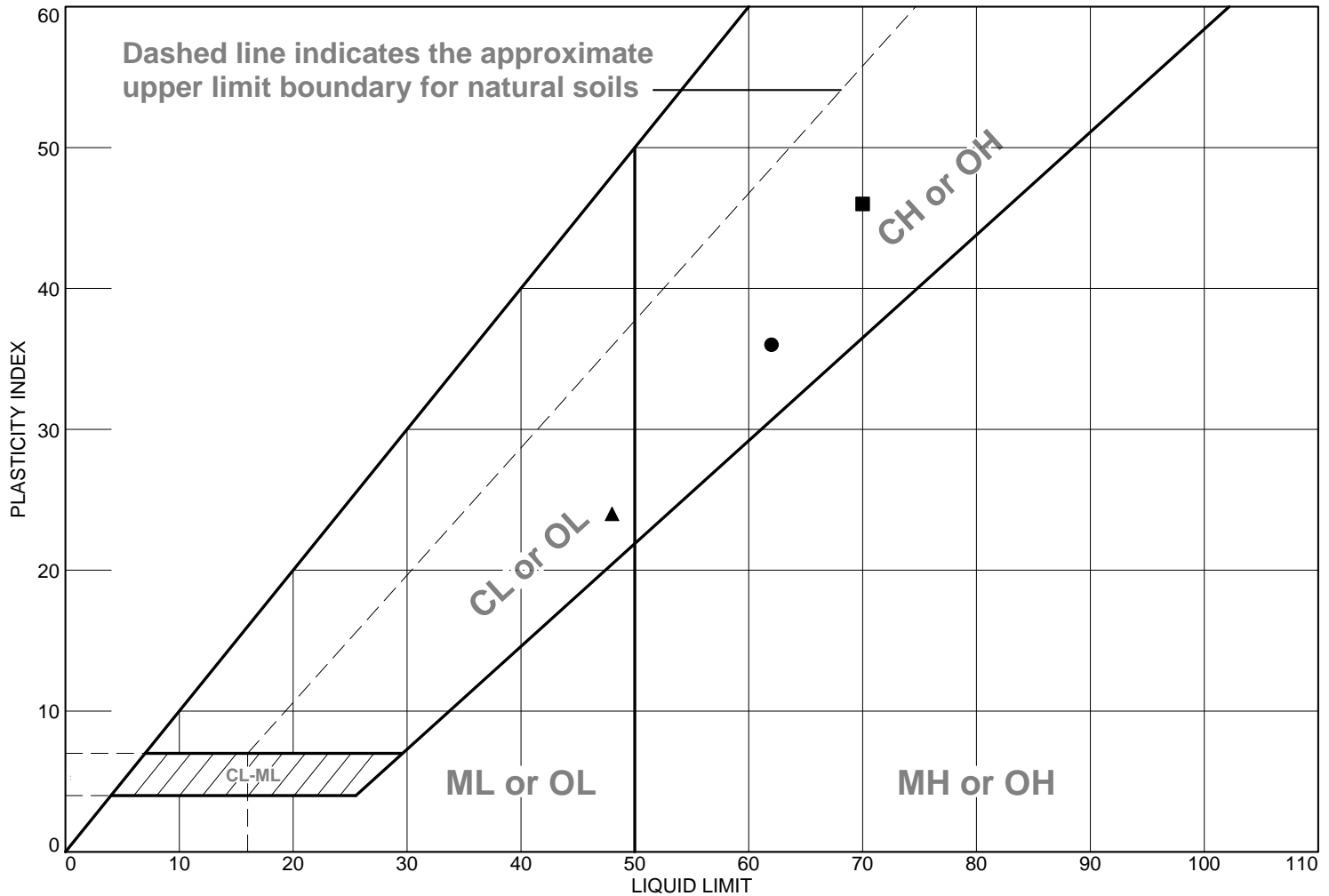


Remarks:

Figure

Tested By: D.B. **Checked By:** T.B.

LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318)



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Brown, spotted reddish brown and gray FAT CLAY (Possible FILL)	62	26	36			CH
■	Brown, spotted dark brown and reddish brown FAT CLAY (Possible FILL)	70	24	46			CH
▲	Brown, spotted light brown, gray and light reddish brown LEAN CLAY with trace of weathered shale (Possible FILL)	48	24	24			CL

Project No. 230378 E **Client:** GLMV ARCHITECHTURE

Project: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT

● **Source of Sample:** B14 **Depth:** 3.0 **Sample Number:** ST-2

■ **Source of Sample:** B16 **Depth:** 3.0 **Sample Number:** ST-2

▲ **Source of Sample:** B19 **Depth:** 3.0 **Sample Number:** ST-2

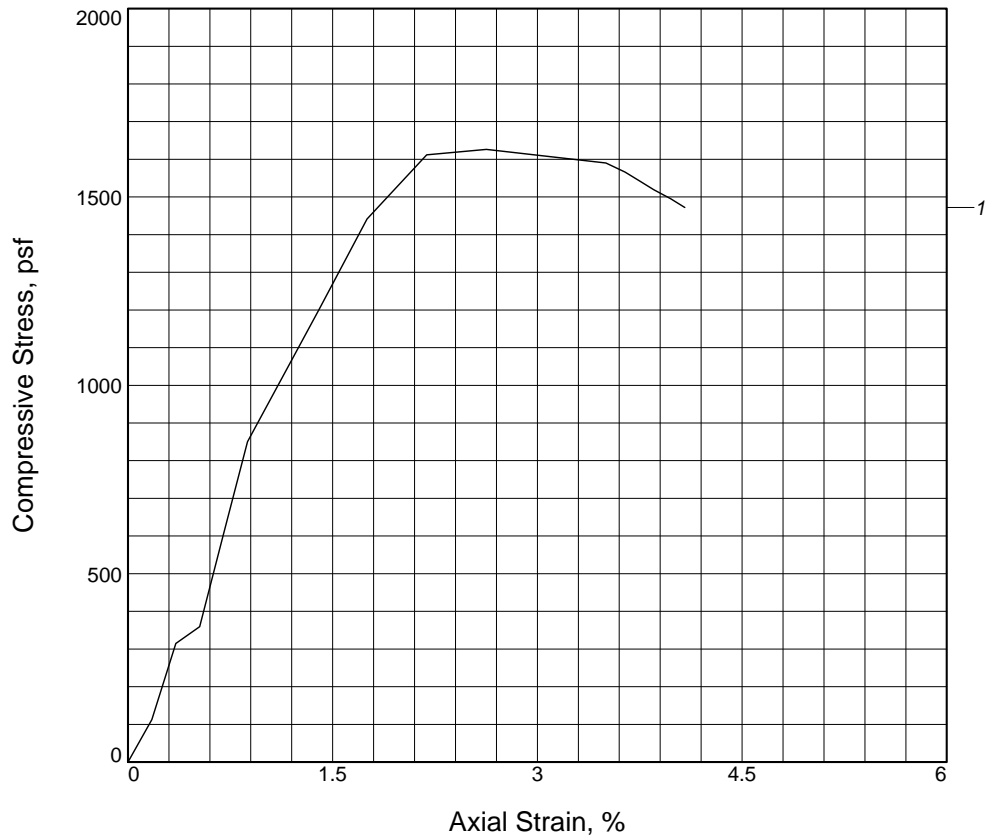
Remarks:



Figure

Tested By: D.B. **Checked By:** T.B.


UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	1626			
Undrained shear strength, psf	813			
Failure strain, %	2.6			
Strain rate, in./min.	0.086			
Water content, %	23.8			
Wet density, pcf	123.4			
Dry density, pcf	99.7			
Saturation, %	92.9			
Void ratio	0.6902			
Specimen diameter, in.	2.850			
Specimen height, in.	5.710			
Height/diameter ratio	2.00			

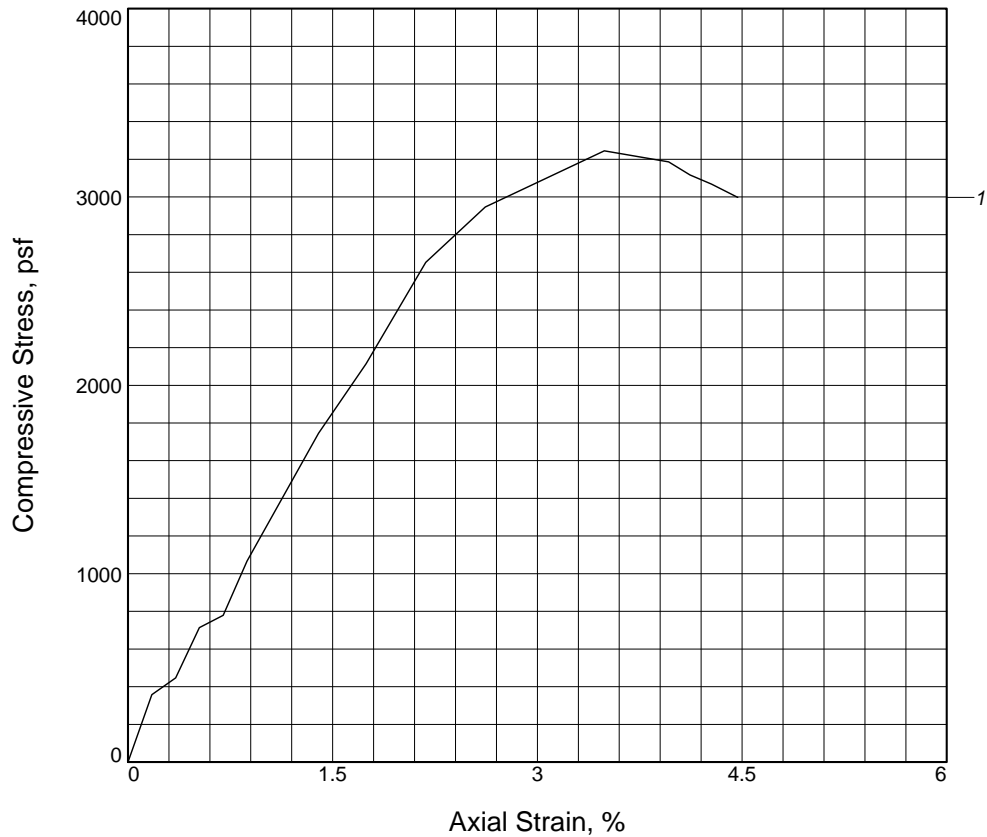
Description: Brown, speckled reddish brown FAT CLAY

LL = 54	PL = 21	PI = 33	Assumed GS= 2.70	Type: Undisturbed
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Project No.: 230378 E Date Sampled: 06/07/2023 Remarks:	Client: GLMV ARCHITECHTURE Project: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT Source of Sample: B1 Depth: 3.0 Sample Number: ST-2
Figure 1 of 1	

Tested By: D.B. Checked By: T.B.


UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	3245			
Undrained shear strength, psf	1622			
Failure strain, %	3.5			
Strain rate, in./min.	0.086			
Water content, %	22.9			
Wet density, pcf	118.9			
Dry density, pcf	96.7			
Saturation, %	83.3			
Void ratio	0.7429			
Specimen diameter, in.	2.860			
Specimen height, in.	5.730			
Height/diameter ratio	2.00			

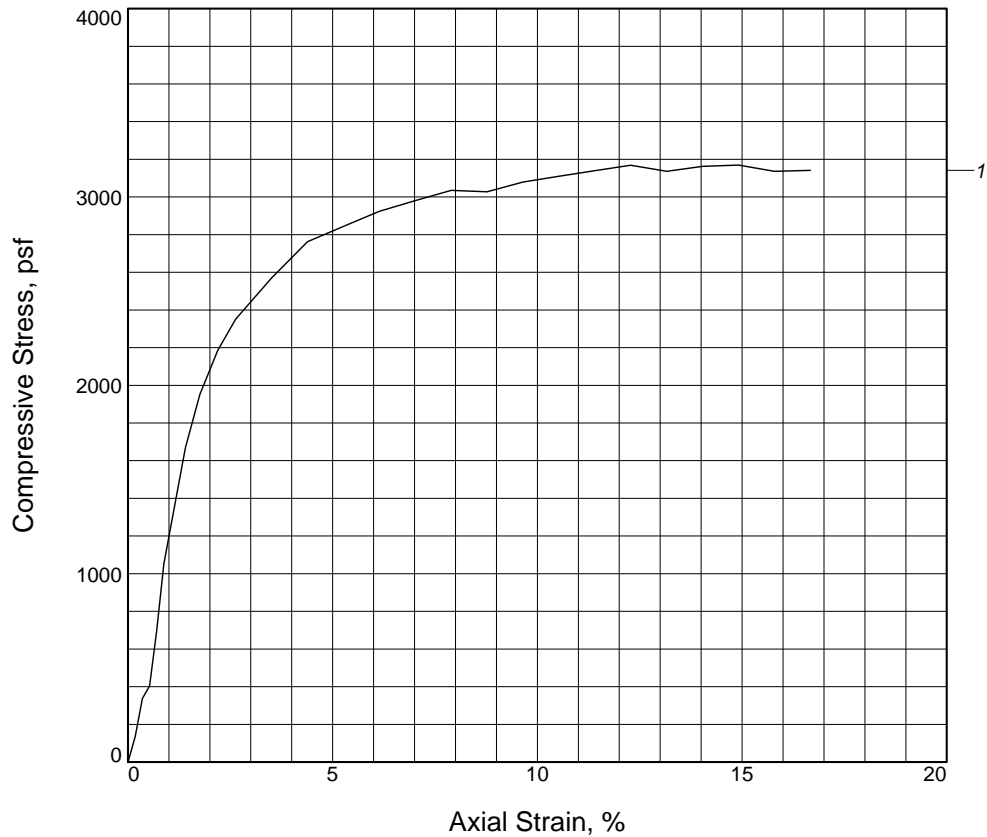
Description: Brown LEAN / FAT CLAY with trace of organics (finger roots)

LL = 50	PL = 22	PI = 28	Assumed GS= 2.70	Type: Undisturbed
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Project No.: 230378 E Date Sampled: 06/07/2023 Remarks:	Client: GLMV ARCHITECHTURE Project: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT Source of Sample: B10 Depth: 3.0 Sample Number: ST-2
Figure 1 of 1	

Tested By: D.B. Checked By: T.B.


UNCONFINED COMPRESSION TEST



Sample No.	1		
Unconfined strength, psf	3169		
Undrained shear strength, psf	1585		
Failure strain, %	14.9		
Strain rate, in./min.	0.086		
Water content, %	24.9		
Wet density, pcf	125.1		
Dry density, pcf	100.2		
Saturation, %	98.4		
Void ratio	0.6824		
Specimen diameter, in.	2.850		
Specimen height, in.	5.700		
Height/diameter ratio	2.00		

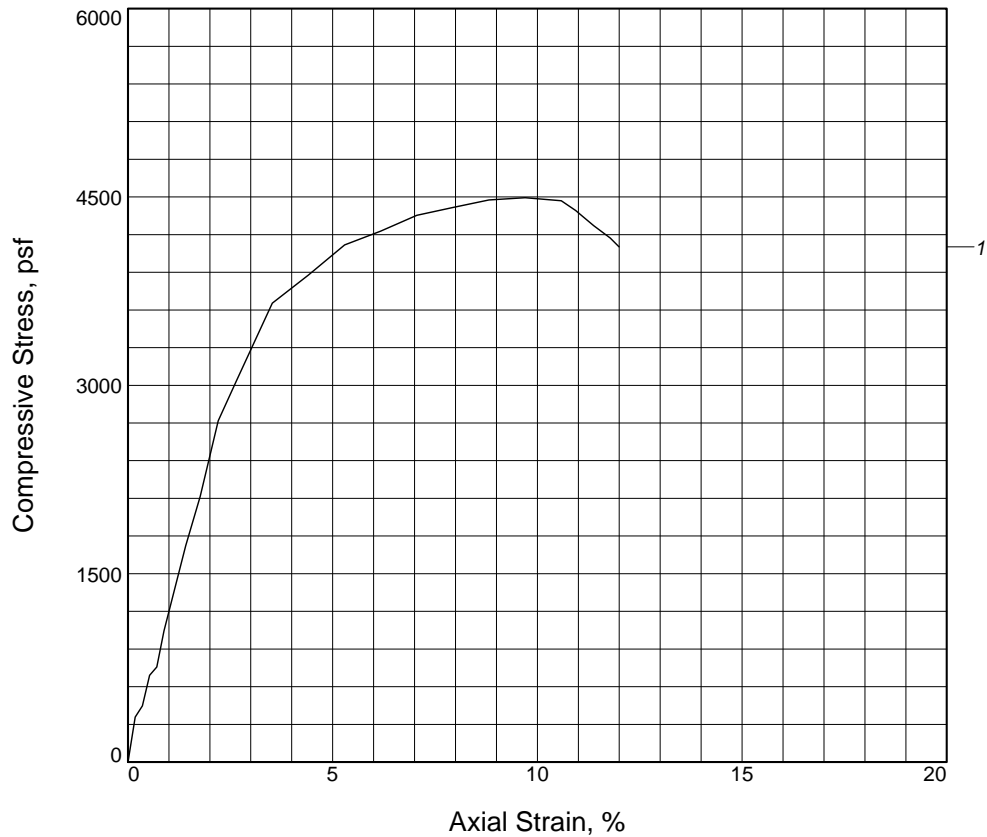
Description: Brown, spotted gray, reddish brown and dark brown FAT CLAY (Possible FILL)

LL = 69	PL = 23	PI = 46	Assumed GS= 2.70	Type: Undisturbed
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Project No.: 230378 E Date Sampled: 06/07/2023 Remarks:	Client: GLMV ARCHITECHTURE Project: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT Source of Sample: B2 Depth: 5.0 Sample Number: ST-3
Figure 1 of 1	

Tested By: D.B. Checked By: T.B.


UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	4493			
Undrained shear strength, psf	2247			
Failure strain, %	9.7			
Strain rate, in./min.	0.086			
Water content, %	25.0			
Wet density, pcf	125.5			
Dry density, pcf	100.4			
Saturation, %	99.5			
Void ratio	0.6795			
Specimen diameter, in.	2.860			
Specimen height, in.	5.670			
Height/diameter ratio	1.98			

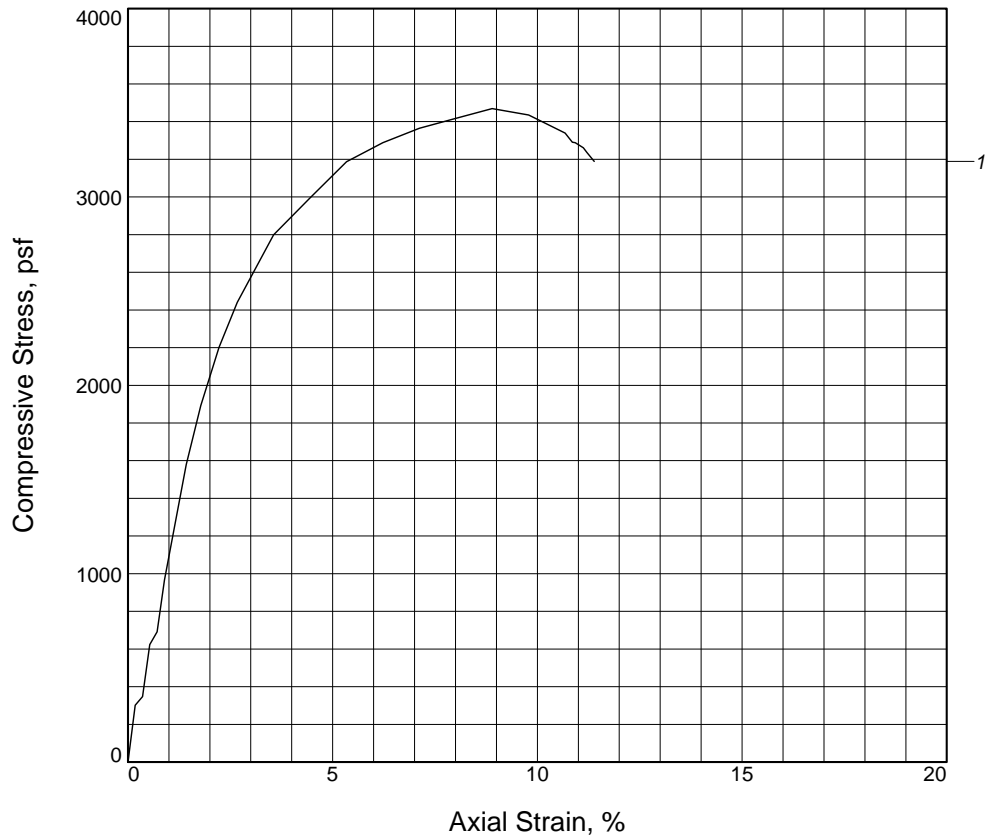
Description: Brown, marbled dark brown, spotted reddish brown FAT CLAY

LL = 55	PL = 21	PI = 34	Assumed GS= 2.70	Type: Undisturbed
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Project No.: 230378 E Date Sampled: 06/07/2023 Remarks:	Client: GLMV ARCHITECHTURE Project: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT Source of Sample: B11 Depth: 5.0 Sample Number: ST-3
Figure 1 of 1	

Tested By: D.B. Checked By: T.B.

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	3469			
Undrained shear strength, psf	1735			
Failure strain, %	8.9			
Strain rate, in./min.	0.086			
Water content, %	24.9			
Wet density, pcf	121.8			
Dry density, pcf	97.5			
Saturation, %	92.3			
Void ratio	0.7283			
Specimen diameter, in.	2.810			
Specimen height, in.	5.620			
Height/diameter ratio	2.00			

Description: Brown FAT CLAY

LL = 53	PL = 22	PI = 31	Assumed GS = 2.70	Type: Undisturbed
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Project No.: 230378 E

Date Sampled: 06/07/2023

Remarks:

Client: GLMV ARCHITECHTURE

Project: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT

Source of Sample: B12 **Depth:** 3.0

Sample Number: ST-2

Figure 1 of 1



Tested By: D.B. **Checked By:** T.B.

Appendix Section C

BORING LOGS

Note: The logs of subsurface conditions shown in this section apply only at the specific boring location and depths at the date indicated and might not be indicative of all subsurface conditions that may be encountered. This information is not warranted to be representative of subsurface conditions at other locations, depths and times. The passage of time or construction operations at or adjacent to this site may result in changes to the soil conditions at these boring locations and depths. As a result, the character of subsurface materials shall be each bidder's responsibility.



LOG OF BORING No. B1

PROJECT: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT PROJECT NO.: 230378 E
 CLIENT: GLMV ARCHITECTURE
 PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
 LOCATION: SEE SITE SKETCH ELEVATION: N/D
 DRILLER: J.M. LOGGED BY: N.N.
 DRILLING METHOD: POWER AUGER DATE: 5-26-23
 DEPTH TO - WATER> INITIAL: ☹ NONE AFTER 24 HOURS: ☹ CAVING> C NONE

Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0		ASPHALT								
0.5		BASE COURSE gravel								CH-CL
1.0		Dark brown, speckled reddish brown FAT/ LEAN CLAY	23.8	99.7	54	33		1626	1.25	CL-CH
2.5		Dark brown, speckled reddish brown FAT/ LEAN CLAY								CH
3.0		Brown, speckled reddish brown FAT CLAY								CH
5.0		Brown, mottled dark brown, and reddish brown FAT CLAY								SH
7.0		Brown, mottled dark brown, and reddish brown FAT CLAY								SH
8.5		Light brown sandy silt (Weathered Siltstone/ Weathered SHALE) (Very hard, Very slow drilling)								SH
10.0		Light brown sandy silt (Weathered Siltstone/ Weathered SHALE) (Very hard, Very slow drilling)								
13.5		Light gray LEAN CLAY (SHALE)(Very hard, Very slow drilling)								
15.0		End of boring at about 15.0 feet								



LOG OF BORING No. B2









PROJECT: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT PROJECT NO.: 230378 E
 CLIENT: GLMV ARCHITECHTURE
 PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
 LOCATION: SEE SITE SKETCH ELEVATION: N/D
 DRILLER: J.M. LOGGED BY: N.N.
 DRILLING METHOD: POWER AUGER DATE: 5-25-23
 DEPTH TO - WATER> INITIAL: ☹ NONE AFTER 24 HOURS: ☹ CAVING> C NONE

Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0		GRAVEL								
3		Dark brown, speckled reddish brown FAT CLAY								CH
6		with trace of gravel (Possible FILL)								CH
10		Dark brown, speckled reddish brown FAT CLAY								CH
3		with trace of gravel (Possible FILL)								CH
4										
10		Brown, speckled light brown FAT CLAY (Possible FILL)	24.9	100.2	69	46		3169	1.25	CH
5										CH
3		Brown, spotted gray, reddish brown and dark brown FAT CLAY								CH
3										CH
5		Brown, spotted gray, reddish brown and dark brown FAT CLAY								CH
10										CH
3		Brown, mottled light gray and light reddish brown FAT CLAY								SS
3										SS
5		Brown, mottled light gray and light reddish brown FAT CLAY								SS
10										
50/6		Weathered SANDSTONE (Very hard, Very slow drilling)								
15		Light brown silt with sand (Weathered SANDSTONE)(Very hard, Very slow drilling)								
12.5										
13.5										
14.0		End of boring at about 14.0 feet								
20										
25										
30										
35										



LOG OF BORING No. B4

PROJECT: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT PROJECT NO.: 230378 E
 CLIENT: GLMV ARCHITECTURE
 PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
 LOCATION: SEE SITE SKETCH ELEVATION: N/D
 DRILLER: J.M. LOGGED BY: E.G.
 DRILLING METHOD: POWER AUGER DATE: 6-17-23
 DEPTH TO - WATER> INITIAL: ☹ NONE AFTER 24 HOURS: ☹ CAVING> C NONE

Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0		ASPHALT								CL-CH
		Brown, spotted light brown LEAN/FAT CLAY (Possible FILL)	0.15							CL-CH
		Brown, spotted light brown LEAN/FAT CLAY (Possible FILL)	1.0							CL-CH
5		Brown, spotted light brown LEAN/FAT CLAY (Possible FILL)	2.5						3.50	CL
		Brown, spotted light brown LEAN/FAT CLAY (Possible FILL)	3.0							CL
		Brown, spotted light brown LEAN/FAT CLAY (Possible FILL) NO RECOVERY	5.0						2.50	CH
10		Brown, spotted reddish brown LEAN CLAY with trace of gravel	7.0							CH
		Brown, spotted reddish brown LEAN CLAY with trace of gravel	8.0							
15		Brown, spotted gray, reddish brown and tan FAT CLAY with trace of Weathered LIMESTONE/SANDSTONE	10.0							
		Brown, spotted gray, reddish brown and tan FAT CLAY with trace of Weathered LIMESTONE/SANDSTONE	13.0							
20		Weathered LIMESTONE/SANDSTONE (NO RECOVERY)	13.1							
		End of boring at about 13.0 feet								
25										
30										
35										



LOG OF BORING No. B5

PROJECT: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT **PROJECT NO.:** 230378 E
CLIENT: GLMV ARCHITECHTURE
PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
LOCATION: SEE SITE SKETCH **ELEVATION:** N/D
DRILLER: J.M. **LOGGED BY:** N.N.
DRILLING METHOD: POWER AUGER **DATE:** 5-25-23
DEPTH TO - WATER> INITIAL: ☹ NONE **AFTER 24 HOURS:** ☹ **CAVING> C.** NONE

Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0		CONCRETE								CONC
0.08		Dark brown, spotted reddish brown LEAN FAT CLAY with trace of gravel and sand (FILL)								CL-CH
1.0		Dark brown, spotted reddish brown LEAN/FAT CLAY with trace of gravel and sand (FILL)								CL-CH
2.5		Dark brown, spotted reddish brown LEAN/ FAT CLAY with trace of gravel and sand (FILL)								CL-CH
3.5		Brown, speckled reddish brown FAT CLAY (FILL)								CL
5.0		Brown, speckled reddish brown FAT CLAY w BRICK fragments from 6.6-8.5 (FILL)								
8.5		Brown LEAN CLAY with trace of gravel (Possible FILL)								
10.0		End of boring at about 10.0 feet								
15										
20										
25										
30										
35										



LOG OF BORING
No. B6

PROJECT: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT **PROJECT NO.:** 230378 E
CLIENT: GLMV ARCHITECHTURE
PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
LOCATION: SEE SITE SKETCH **ELEVATION:** N/D
DRILLER: J.M. **LOGGED BY:** N.N.
DRILLING METHOD: POWER AUGER **DATE:** 5-25-23
DEPTH TO - WATER> INITIAL: ☹ NONE **AFTER 24 HOURS:** ☹ **CAVING>** C. NONE

Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0	*****	ASPHALT								
0.17	3	BASE COARSE gravel								CH
0.83	4									CH
	5	Brown, spotted dark brown, speckled reddish brown FAT CLAY (Possible FILL)								CH
1.0	3									CH
	4	Brown, spotted dark brown, speckled reddish brown FAT CLAY (Possible FILL)								CH
2.5	6									
	11	Brown, spotted dark brown, speckled reddish brown FAT CLAY (Possible FILL)								
3.5	14									
		Brown, mottled gray, spotted reddish brown FAT CLAY (Possible FILL)								SH
5.0										
		Brown, mottled gray, spotted reddish brown FAT CLAY (Possible FILL)								
8.5										
		Brown, mottled gray and reddish brown LEAN/ FAT CLAY (Weathered SHALE) (Very hard, Very slow drilling)								
10.0		End of boring at about 10.0 feet								
15										
20										
25										
30										
35										



LOG OF BORING No. B7

PROJECT: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT PROJECT NO.: 230378 E
 CLIENT: GLMV ARCHITECHTURE
 PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
 LOCATION: SEE SITE SKETCH ELEVATION: N/D
 DRILLER: J.M. LOGGED BY: N.N.
 DRILLING METHOD: POWER AUGER DATE: 5-25-23
 DEPTH TO - WATER> INITIAL: 9.7' AFTER 24 HOURS: 9.7' CAVING> C. NONE

Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0		ASPHALT								
0.25		BASE COARSE gravel								CH
0.92		Brown, spotted gray and reddish brown FAT CLAY with trace of gravel (Possible FILL)								CH
1.0		Brown, spotted gray and reddish brown FAT CLAY with trace of gravel (Possible FILL)								CL-CH
2.5		Brown, spotted gray and reddish brown FAT CLAY with trace of gravel (Possible FILL)								CL-CH
3.5		Light brown, mottled reddish brown, spotted light gray LEAN/FAT CLAY								SH
5.0		Light brown, mottled reddish brown, spotted light gray LEAN/FAT CLAY								
8.5		Light brown, spotted reddish brown LEAN CLAY (Weathered SHALE) (Very hard, very slow drilling)								
9.7		End of boring at about 9.7 feet								



LOG OF BORING No. B8










PROJECT: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT PROJECT NO.: 230378 E
 CLIENT: GLMV ARCHITECHTURE
 PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
 LOCATION: SEE SITE SKETCH ELEVATION: N/D
 DRILLER: J.M. LOGGED BY: N.N.
 DRILLING METHOD: POWER AUGER DATE: 5-26-23
 DEPTH TO - WATER> INITIAL: ☹ NONE AFTER 24 HOURS: ☹ CAVING> C. NONE

Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0		Dark brown, speckled reddish brown FAT CLAY (Root Zone)								CH
4										CH
5		Dark brown, speckled reddish brown FAT CLAY with trace of organics (finger roots)								CH
7		Dark brown, speckled reddish brown FAT CLAY with trace of organics (finger roots)								CH
10		Dark brown, speckled reddish brown FAT CLAY with trace of organics (finger roots)								SH
11		Brown, mottled reddish brwon, spotted gray FAT CLAY								SH
12		Brown, mottled reddish brwon, spotted gray FAT CLAY								
13		Olive brown SHALE (Very hard, Very slow drilling)								
14		Light brown silty LEAN CLAY (Weathered SHALE) (Very hard, very slow drilling)								
15		End of boring at about 9.5 feet								
20										
25										
30										
35										



LOG OF BORING No. B9

PROJECT: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT PROJECT NO.: 230378 E
 CLIENT: GLMV ARCHITECHTURE
 PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
 LOCATION: SEE SITE SKETCH ELEVATION: N/D
 DRILLER: J.M. LOGGED BY: E.G.
 DRILLING METHOD: POWER AUGER DATE: 6-14-23
 DEPTH TO - WATER> INITIAL: ☹ NONE AFTER 24 HOURS: ☹ CAVING> C NONE

Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0		CONCRETE								CONC
0.79		BASE COARSE gravel								CH
1.0		Brown, spotted dark brown, speckled reddish brown FAT CLAY (Possible FILL)								CH
2.5		Brown, spotted dark brown, speckled reddish brown FAT CLAY (Possible FILL)								CH
3.5		Brown, spotted dark brown, speckled reddish brown FAT CLAY (Possible FILL)								CH
5.0		Brown, spotted gray and reddish brown FAT CLAY (Possible FILL)								SH
7.0		Brown, spotted gray and reddish brown FAT CLAY (Possible FILL)								SS
8.5		Brown, weathered sandy SHALE (Very hard, Very slow drilling)								
9.9		Brown silty sand/sandy silt (weathered SANDSTONE)(Very hard, very slow drilling)								
		End of boring at about 9.9 feet								
10										
15										
20										
25										
30										
35										



LOG OF BORING No. B10

PROJECT: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT PROJECT NO.: 230378 E
 CLIENT: GLMV ARCHITECTURE
 PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
 LOCATION: SEE SITE SKETCH ELEVATION: N/D
 DRILLER: J.M. LOGGED BY: N.N.
 DRILLING METHOD: POWER AUGER DATE: 5-26-23
 DEPTH TO - WATER> INITIAL: ☹ NONE AFTER 24 HOURS: ☹ CAVING> C NONE

Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0		GRAVEL								
1.0		Brown LEAN/FAT CLAY with trace of gravel and sand (Possible FILL)								CL-CH
2.5		Brown LEAN/FAT CLAY with trace of gravel and sand (Possible FILL)	22.9	96.7	50	28		3245	1.75	CL-CH
3.0		Brown FAT CLAY with trace of organics (finger roots)(Possible FILL)							2.50	CL-CH
5.0		Brown FAT CLAY with trace of gravel (Possible FILL)								CH
7.0		Brown FAT CLAY with trace of gravel (Possible FILL)								CL-CH
8.5		Brown, spotted reddish brown LEAN/FAT CLAY								CL-CH
10.0		Brown, spotted reddish brown LEAN/FAT CLAY								
13.5		Light brown silty low plasticity clay (Weathered SHALE) (Very hard, very slow drilling)								SH
13.9		End of boring at about 13.9 feet								



LOG OF BORING No. B11

PROJECT: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT PROJECT NO.: 230378 E
 CLIENT: GLMV ARCHITECHTURE
 PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
 LOCATION: SEE SITE SKETCH ELEVATION: N/D
 DRILLER: J.M. LOGGED BY: N.N.
 DRILLING METHOD: POWER AUGER DATE: 5-26-23
 DEPTH TO - WATER> INITIAL: ☹ NONE AFTER 24 HOURS: ☹ CAVING> C NONE

Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0		GRAVEL								
0.75	4 2 2	Dark brown LEAN CLAY								CL
1.0		Dark brown LEAN CLAY								CL
2.5	3 3 5	Dark brown LEAN CLAY								CL
3.0		Dark brown LEAN CLAY								CL-CH
5.0		Brown, speckled reddish brown LEAN/FAT CLAY	25.0	100.4	55	34		4493	2.25	CH
5.0		Brown, marbled dark brown, spotted reddish brown FAT CLAY								CH
7.0	3 3 4	Brown, marbled dark brown, spotted reddish brown FAT CLAY								CH
8.5		Brown, mottled gray, spotted reddish brown FAT CLAY								CH
10.0		Brown, mottled gray, spotted reddish brown FAT CLAY								CH
10.0	50/3	Brown, mottled gray, spotted reddish brown FAT CLAY								SH
13.5		Weathered Gray SHALE (Very hard, very slow drilling)								
13.8		End of boring at about 13.8 feet								
20										
25										
30										
35										



**LOG OF BORING
No. B12**

PROJECT: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT **PROJECT NO.:** 230378 E
CLIENT: GLMV ARCHITECHTURE
PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
LOCATION: SEE SITE SKETCH **ELEVATION:** N/D
DRILLER: J.M. **LOGGED BY:** N.N.
DRILLING METHOD: POWER AUGER **DATE:** 5-26-23
DEPTH TO - WATER> INITIAL: ☹ NONE **AFTER 24 HOURS:** ☹ **CAVING>** C. NONE

Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0		GRAVEL								
1.0		Dark brown, spotted reddish brown LEAN/ FAT CLAY with trace of gravel (Possible FILL)								CL-CH
2.5		Dark brown, spotted reddish brown LEAN/ FAT CLAY with trace of gravel (Possible FILL)	24.9	97.5	53	31		3469	1.50	CL-CH
3.0		Brown FAT CLAY								CL-CH
5.0		Brown, mottled gray LEAN/FAT CLAY								CL-CH
6.5		Brown, mottled gray LEAN/FAT CLAY								CL-CH
8.5		Gray, mottled brown, spotted reddish brown LEAN/FAT CLAY								CL-CH
10.0		Gray, mottled brown, spotted reddish brown LEAN/FAT CLAY								CL-CH
13.5		Weathered light gray SHALE (Very Hard, Very Slow Drilling)								SH
13.9		End of boring at about 13.9 feet								



LOG OF BORING No. B13

PROJECT: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT PROJECT NO.: 230378 E
 CLIENT: GLMV ARCHITECHTURE
 PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
 LOCATION: SEE SITE SKETCH ELEVATION: N/D
 DRILLER: J.M. LOGGED BY: E.G.
 DRILLING METHOD: POWER AUGER DATE: 6-16-23
 DEPTH TO - WATER> INITIAL: ☹ NONE AFTER 24 HOURS: ☹ CAVING> C NONE

Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0		CONCRETE								CONC
0.27		BASE COARSE gravel								LS
0.8		Weathered LIMESTONE (FILL)								CH
1.0		Brown, spotted reddish brown and dark brown FAT CLAY (FILL)							1.75	CH
2.5		Brown, spotted reddish brown and dark brown FAT CLAY (FILL)							2.25	CH
3.0		Brown LEAN CLAY w trace BRICK fragments (FILL)								CH
5.0		Brown, spotted dark brown, speckled reddish brown FAT CLAY (Possible FILL)								CH
7.0		Brown, spotted dark brown, speckled reddish brown FAT CLAY (Possible FILL)								SH
8.5		Brown, spotted reddish brown FAT CLAY (Possible FILL)								SH
10.0		Brown, spotted reddish brown FAT CLAY (Possible FILL)								
11.0		Olive brown, weathered sandy SHALE (Very hard, Very slow drilling)								
13.5		Gray, spotted brown LEAN/FAT CLAY (Weathered SHALE) (Very hard, very slow drilling)								
14.3		End of boring at about 14.3 feet								



**LOG OF BORING
No. B14**











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CLIENT: GLMV ARCHITECHTURE
PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
LOCATION: SEE SITE SKETCH **ELEVATION:** N/D
DRILLER: J.M. **LOGGED BY:** E.G.
DRILLING METHOD: POWER AUGER **DATE:** 6-16-23
DEPTH TO - WATER> INITIAL: ☹ NONE **AFTER 24 HOURS:** ☹ **CAVING>** C. NONE

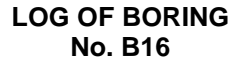
Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0		CONCRETE								CONC
		BASE COARSE gravel								CL-CH
		Brown, mottled light brown, spotted light gray LEAN/FAT CLAY (Possible FILL)								CL-CH
		Brown, mottled light brown, spotted light gray LEAN/FAT CLAY (Possible FILL)	26.2	93.9	62	36		NT	2.00	CL-CH
		Brown, mottled light brown, spotted light gray LEAN/FAT CLAY (Possible FILL)							2.00	CH
		Brown, mottled light brown, spotted light gray LEAN/FAT CLAY (Possible FILL)								SH
		Brown, spotted reddish brown and gray FAT CLAY (Possible FILL)								CL
		Brown, spotted dark brown, speckled reddish brown FAT CLAY (Possible FILL)								
		Weathered sandy SHALE								
		Light brown, spotted light gray and light reddish brown LEAN CLAY (Weathered SHALE) (Possible FILL)								
		End of boring at about 10.0 feet								
10										
15										
20										
25										
30										
35										



LOG OF BORING No. B15

PROJECT: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT PROJECT NO.: 230378 E
 CLIENT: GLMV ARCHITECHTURE
 PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
 LOCATION: SEE SITE SKETCH ELEVATION: N/D
 DRILLER: J.M. LOGGED BY: E.G.
 DRILLING METHOD: POWER AUGER DATE: 6-16-23
 DEPTH TO - WATER> INITIAL: ☹ NONE AFTER 24 HOURS: ☹ CAVING> C NONE

Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0		CONCRETE								CONC
0.42		BASE COARSE gravel								CH
0.58		Brown, mottled gray, spotted redish brown FAT CLAY (Possible FILL)								CH
1.0		Brown, mottled gray, spotted redish brown FAT CLAY (Possible FILL)							1.50	CH
2.5		Brown, mottled gray, spotted redish brown FAT CLAY (Possible FILL)							1.50	CL-CH
3.0		Brown, mottled gray, spotted redish brown FAT CLAY (Possible FILL)								CL-CH
3.50/6		Brown, spotted dark brown, speckled reddish brown FAT CLAY (Possible FILL)								SH
5.0		Brown, spotted gray LEAN/FAT CLAY (Possible FILL)								
7.0		Brown, spotted gray LEAN/FAT CLAY (Possible FILL)								
8.5		Light brown silty sand/sandy silt (Weathered SHALE) (Possible FILL) (Very hard, very slow drilling)								
9.5		End of boring at about 9.5 feet								
10										
15										
20										
25										
30										
35										



DEPTH TO - WATER> INITIAL: NONE **AFTER 24 HOURS:** **CAVING>** C NONE

Page 1 of 1



LOG OF BORING No. B17









PROJECT: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT PROJECT NO.: 230378 E
 CLIENT: GLMV ARCHITECHTURE
 PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
 LOCATION: SEE SITE SKETCH ELEVATION: N/D
 DRILLER: J.M. LOGGED BY: E.G.
 DRILLING METHOD: POWER AUGER DATE: 6-16-23
 DEPTH TO - WATER> INITIAL: ☹ NONE AFTER 24 HOURS: ☹ CAVING> C NONE

Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0		CONCRETE								CONC
3		Brown, mottled gray, spotted reddish brown FAT	0.25							CH
4		CLAY (Possible FILL)								CH
5		Brown, mottled gray, spotted reddish brown FAT	1.0					2.50		CH
		CLAY (Possible FILL)								
5		Brown, mottled gray, spotted reddish brown FAT	2.5							SH
		CLAY (Possible FILL)								SH
		Light brown, spotted gray and brown, speckled	3.0							
		reddish brown FAT CLAY (Possible FILL)								
		Light brown, spotted reddish brown silty sand/	5.0							SH
10		sandy silt (Weathered SHALE) (Very hard, very								
		slow drilling)	5.8							
		Light brown, spotted reddish brown silty sand/								
		sandy silt (Weathered SHALE) (Very hard, very	8.5							
15		slow drilling)								
		Brown, spotted reddish brown silty sand/sandy silt	9.3							
		(Weathered SHALE) (Very hard, very slow								
		drilling)								
		End of boring at about 9.3 feet								
20										
25										
30										
35										



LOG OF BORING No. B18

PROJECT: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT PROJECT NO.: 230378 E
 CLIENT: GLMV ARCHITECHTURE
 PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
 LOCATION: SEE SITE SKETCH ELEVATION: N/D
 DRILLER: J.M. LOGGED BY: E.G.
 DRILLING METHOD: POWER AUGER DATE: 6-14-23
 DEPTH TO - WATER> INITIAL: ☹ NONE AFTER 24 HOURS: ☹ CAVING> C NONE

Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0		CONCRETE								CONC
		BASE COARSE gravel								CH
		Brown FAT CLAY (Possible FILL)								CH
		Brown FAT CLAY (Possible FILL)							1.75	CH
5		Light brown, mottled reddish brown and light gray FAT CLAY (Possible FILL)								ML
		Light brown, mottled reddish brown silty sand/ sandy silt (Very hard, very slow drilling)								ML
		Light brown, mottled reddish brown silty sand/ sandy silt (Very hard, very slow drilling)								ML
10		Brown, spotted dark brown silty sand/sandy silt (Very hard, very slow drilling)								
		End of boring at about 9.0 feet								
15										
20										
25										
30										
35										



LOG OF BORING No. B19

PROJECT: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT PROJECT NO.: 230378 E
 CLIENT: GLMV ARCHITECHTURE
 PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
 LOCATION: SEE SITE SKETCH ELEVATION: N/D
 DRILLER: J.M. LOGGED BY: E.G.
 DRILLING METHOD: POWER AUGER DATE: 6-14-23
 DEPTH TO - WATER> INITIAL: ☹ NONE AFTER 24 HOURS: ☹ CAVING> C NONE

Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0		CONCRETE								CONC
		BASE COARSE gravel	0.58							CH
										CH
		Brown FAT CLAY (FILL)	0.92							CH
			1.0	22.9	102.4	48	24	NT	2.00	CL
		Brown FAT CLAY (FILL)								
		BRICK (FILL)								
5		Brown FAT CLAY (Possible FILL)	2.5						3.00	CL-CH
			3.0							
		Brown, spotted light brown, gray and light reddish brown LEAN CLAY with trace of Weathered SHALE (Possible FILL)								CL-CH
			5.0							SH
10		Brown LEAN/FAT CLAY with trace of gravel (Possible FILL)								SH
			7.0							
		Brown LEAN/FAT CLAY with trace of gravel (Possible FILL)								
			8.5							CL-CH
15		Brown, spotted gray LEAN/FAT CLAY with trace of Weathered SHALE (Very hard, Very slow drilling)								
			8.9							
		Weathered olive brown sandy SHALE (Very hard, Very slow drilling)								
			9.9							
20		Brown, spotted gray LEAN/FAT CLAY with trace of Weathered SHALE (Very hard, Very slow drilling)								
			13.5							
		Light brown, spotted brown LEAN/FAT CLAY (Very hard, very slow drilling)								
			13.8							
		End of boring at about 13.8 feet								
25										
30										
35										



LOG OF BORING No. S2

PROJECT: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT PROJECT NO.: 230378 E
 CLIENT: GLMV ARCHITECTURE
 PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
 LOCATION: SEE SITE SKETCH ELEVATION: N/D
 DRILLER: J.M. LOGGED BY: E.G.
 DRILLING METHOD: POWER AUGER DATE: 6-20-23
 DEPTH TO - WATER> INITIAL: ☹ NONE AFTER 24 HOURS: ☹ CAVING> C NONE

Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0		ASPHALT								
0.92		Dark brown LEAN CLAY with reddish brown brick fragments/ debris (FILL)								CL
1.0		Dark brown LEAN CLAY with reddish brown brick fragments/debris (FILL)								CL
2.5		Dark brown LEAN CLAY with reddish brown brick fragments/debris (FILL)								CL-CH
3.5		Dark brown LEAN CLAY with reddish brown brick fragments/debris (FILL)								CL-CH
5.0		Dark brown, mottled reddish brown and gray LEAN/FAT CLAY with iron deposits (Possible FILL)								SH
7.8		Dark brown, mottled reddish brown and gray LEAN/FAT CLAY (Possible FILL)								ML
8.5		Olive brown weathered SHALE (Possible FILL)								ML
9.0		Brown silt with weathered silt fragments (weathered siltstone)(Very Hard, Very Slow drilling)								SH
13.5		Brown silt with weathered silt fragments (weathered siltstone)(Very Hard, Very Slow drilling)								
13.7		Weathered SHALE (Very Hard, Very Slow Drilling) (NO RECOVERY)								
		End of boring at about 13.7 feet								



LOG OF BORING No. S3

PROJECT: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT PROJECT NO.: 230378 E
 CLIENT: GLMV ARCHITECTURE
 PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
 LOCATION: SEE SITE SKETCH ELEVATION: N/D
 DRILLER: J.M. LOGGED BY: E.G.
 DRILLING METHOD: POWER AUGER DATE: 6-20-23
 DEPTH TO - WATER> INITIAL: ☐ NONE AFTER 24 HOURS: ☐ CAVING> C. NONE

Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0		Dark brown, spotted reddish brown FAT CLAY (Root Zone) (Possible FILL)								CH
0.17	3 3 5	Dark brown, spotted reddish brown FAT CLAY (Possible FILL)								CH
1.0	2 3 3	Dark brown, spotted reddish brown FAT CLAY (Possible FILL)								CH
2.5		Dark brown, spotted reddish brown FAT CLAY (Possible FILL)								CH
3.5		Dark brown, spotted reddish brown FAT CLAY (Possible FILL)								SH
5.0	50/5	Brown, spotted dark brown FAT CLAY with trace of gravel (Possible FILL)								SH
7.2		Brown, spotted dark brown FAT CLAY with trace of gravel (Possible FILL)								SH
8.5		Olive brown sandy SHALE (Possible FILL) (Very hard, Very slow drilling)								SH
8.9		Brown silty LEAN CLAY (Weathered SHALE) (Very hard, very slow drilling)								
9.3		Brown silty LEAN CLAY (Weathered SHALE) (Very hard, very slow drilling)								
13.5		Weathered LIMESTONE (Very hard, very slow drilling)								
13.9		Gray LEAN CLAY (Weathered SHALE) (Very hard, very slow drilling)								
		End of boring at about 13.9 feet								
25										
30										
35										



LOG OF BORING **No. S4**

PROJECT: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT **PROJECT NO.:** 230378 E
CLIENT: GLMV ARCHITECHTURE
PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
LOCATION: SEE SITE SKETCH **ELEVATION:** N/D
DRILLER: J.M. **LOGGED BY:** E.G.
DRILLING METHOD: POWER AUGER **DATE:** 6-20-23
DEPTH TO - WATER> INITIAL: ☹ NONE **AFTER 24 HOURS:** ☹ **CAVING>** C. NONE

Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0		ASPHALT								
		Dark brown, spotted reddish brown LEAN/FAT (Possible FILL)	0.92							CL-CH
										CL-CH
		Dark brown, spotted reddish brown LEAN/FAT CLAY (Possible FILL)	1.0							CL-CH
										CL-CH
5		Dark brown, spotted reddish brown LEAN/FAT (Possible FILL)	2.5							CL
										CL
		Brown, mottled dark brown, spotted gray LEAN CLAY with weathered SHALE fragments (Possible FILL)	3.5							
										SH
10		Brown, mottled dark brown, spotted gray LEAN CLAY with weathered SHALE fragments (Possible FILL)	5.0							SH
										LS
		Brown, mottled reddish brown and gray silt with sand (Weathered SHALE) (Very hard, very slow drilling)	8.5							
15										
		Brown, mottled reddish brown and gray silt with sand (Weathered SHALE) (Very hard, very slow drilling)	10.0							
		Weathered LIMESTONE (Very hard, Very slow drilling)	10.6							
20										
		Auger refusal on Weathered LIMESTONE at about 11.3 feet. End of boring at about 11.3 feet.	11.3							
25										
30										
35										



LOG OF BORING No. S5

PROJECT: DOWNTOWN LEE'S SUMMIT, MO REDEVELOPMENT **PROJECT NO.:** 230378 E
CLIENT: GLMV ARCHITECHTURE
PROJECT LOCATION: BLOCKS OF GREEN/2ND ST. & JOHNSON/3RD ST.
LOCATION: SEE SITE SKETCH **ELEVATION:** N/D
DRILLER: J.M. **LOGGED BY:** E.G.
DRILLING METHOD: POWER AUGER **DATE:** 6-20-23
DEPTH TO - WATER> INITIAL: ☹ NONE **AFTER 24 HOURS:** ☹ **CAVING>** C. NONE

Elevation	Soil Symbols Sampler Symbols and Field Test Data	Description	w%	DDen pcf	LL	PI	200 %	Uncomp. psf	PPen. tsf	USCS/ Visual Class.
Depth (ft.)										
0		ASPHALT								
		Dark brown LEAN/FAT CLAY (Possible FILL)	0.83							CL-CH
		Dark brown LEAN/FAT CLAY (Possible FILL)	1.0							CL-CH
		Dark brown LEAN/FAT CLAY (Possible FILL)	2.5							CL-CH
		Brown, mottled gray, spotted reddish brown FAT CLAY (Possible FILL)	3.5							CH
		Brown, mottled gray, spotted reddish brown FAT CLAY (Possible FILL)	5.0							CH
		Brown, spotted gray LEAN CLAY (Weathered SHALE) (Possible FILL)	8.5							CL
		Brown, spotted gray LEAN CLAY (Weathered SHALE)	10.0							CL
		Gray LEAN CLAY (Weathered SHALE) (Very hard, very slow drilling)	13.5							SH
		End of boring at about 15.0 feet	15.0							

KEY TO SYMBOLS

Symbol Description

Symbol Description

Strata symbols



ASPHALT



Gravel



LEAN/FAT CLAY



FAT CLAY



Weathered SHALE



Weathered sandstone



No Recovery



LEAN CLAY



Concrete



BASE



SANDSTONE



Weathered LIMESTONE



Silt



Weathered

Misc. Symbols



Water table during
drilling

Notes:




1. Borings were drilled on May 25-26th, 2023 using solid auger, split spoon sampler and shelly tube sampler techniques.
 2. Ground water was encountered while drilling at the reported depths.
 3. Borings were staked by Alpha-Omega, Inc.
 4. These logs are subject to the limitations, conclusions, and recommendations in this report.
 5. Results of tests conducted on samples recovered are reported on the logs.
- Abbreviations are:

DDen =	natural dry density (pcf)	LL =	Liquid
limit			
w% =	natural moisture content (%)	PI =	Plasticity
index			
UComp =	Unconfined compression (psf)	PPen =	Pocket
Penetrometer			
-200 =	percent passing #200 sieve (%)	RQD =	Rock
Quality			
DCP =	Dynamic Cone Penetrometer		

KEY TO SYMBOLS

Symbol Description

Soil Samplers

-  Standard penetration test
-  Undisturbed thin wall
Shelby tube
-  Bulk sample taken
from 6 in. auger

SECTION 011000 - 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

- B. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Owner-furnished/Contractor-installed (OFCI) products.
4. Contractor's use of site and premises.
5. Coordination with occupants.
6. Work restrictions.
7. Specification and Drawing conventions.
8. Miscellaneous provisions.

- B. Related Requirements: Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.3 DEFINITIONS

- A. Work Package: A group of specifications, drawings, and schedules prepared by the design team to describe a portion of the Project Work for pricing, permitting, and construction.

1.4 PROJECT INFORMATION

- A. Project Identification: Lee's Summit – Market Plaza

1. Project Location: 221 SE Green Street, Lee's Summit, MO 64063

- B. Owner: City of Lee's Summit, Missouri

1. Owner's Representative: Sharon Bloom
Phone: 816-969-1615
Email: Sharon.Bloom@cityofls.net
2. Owner's Representative: Nikia Chapman-Freiberger
Phone: 816-969-1800
Email: Nikia.Chapman-Freiberger@cityofls.net

- C. Master Developer: Lane 4 Property Group, Mark Allen
Phone: 913-424-2807
Email: mallen@lane4group.com
- D. Architect: GLMV Architecture, Inc.
 - 1. Architect's Representative: Chaz Prunte, Project Manager
Phone: 816-217-8652
Email: chaz.pruente@glmv.com.
 - 2. Architect's Consultants: Architect has retained the following design professionals, who have prepared designated portions of the Contract Documents:
 - a. Collins | Webb Architecture:
 - 1) Interior Designer: Jacinta Stecklein, IIDA, NCIDQ, WELL AP
Phone: 816-249-2270
Email: jstecklein@collinsandwebb.com
 - b. Olsson Studio:
 - 1) Team Leader, Korey Schulz
Phone: 816-442-6083
Email: kschulz@olsson.com
 - c. Leigh + O'Kane Engineers:
 - 1) Principal, Adam O'Kane
Phone: 816-444-3144
Email: aokane@leok.com
 - d. Henderson Engineers, Inc.:
 - 1) Marcus Perry
Phone: 816-663-8717
Email: Marcus.Perry@hendersonengineers.com
- E. Construction Manager: McCown Gordon Construction.
 - 1. Construction Manager Representative: Shawn Cross
Phone: 816-673-5702
Email: chuxol@mccowngordon.com.
 - 2. Construction Manager for this Project is Project's constructor. The terms "Construction Manager" and "Contractor" are synonymous.
- F. Web-Based Project Software: Project software will be used for the purposes of managing communication and documents during the construction stage.
 - 1. See Section 013100 "Project Management and Coordination" for requirements for using web-based Project software.

1.5 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:
 - 1. The known scope of the Project is a new 1-story farmers market building of approximately 18,000 gross square feet, with a canopy covering an outdoor lawn/performance area of approximately 16,000 square feet, and other Work indicated in the Contract Documents.
- B. Type of Contract: Project will be constructed under a CMR contract with multiple GMPs.

1.6 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.
 - a. Upon delivery, inspect, with Contractor present, delivered items.
 - 1. If Owner-furnished products are damaged, defective, or missing, arrange for replacement.
 - a. Obtain manufacturer's inspections, service, and warranties.
 - b. 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.

1.8 CONTRACTOR'S USE OF SITE AND PREMISES

- A. Unrestricted Use of Site: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.

1.9 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 - 2. 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.
 - 3. 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.
 - 4. Specification requirements are to be performed by the Contractor unless specifically stated otherwise.
- B. Division 00 Contracting Requirements: General provisions of the Contract, including General and Supplementary Conditions, apply to all Sections of the Specifications.
- C. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- D. 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.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION 011000

SECTION 012000 - PRICE AND PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SCHEDULE OF VALUES

- A. Use Schedule of Values Form: AIA G703, edition stipulated in the Agreement.
- B. Use Schedule of Values Form: ConsensusDOCS 293, edition stipulated in the Agreement.
- C. Use Schedule of Values Form: DBIA 500-D1, edition stipulated in the Agreement.
- D. Use Schedule of Values Form: EJCDC C-620, edition stipulated in the Agreement.

1.2 APPLICATIONS FOR PROGRESS PAYMENTS

- A. Payment Period: Submit at intervals stipulated in the Agreement.
- B. Execute certification by signature of authorized officer.
- C. Submit 1 electronic and 3 hard copies of each Application for Payment.

1.3 MODIFICATION PROCEDURES

- A. For other required changes, Architect will issue a document signed by Owner instructing Contractor to proceed with the change, for subsequent inclusion in a Change Order.
- B. Allowance for the combined overhead and profit included in the total cost to the Owner shall be based on the following schedule:
 - 1. For the Contractor, for Work performed by the Contractor's own forces, 12 percent of the cost.
 - 2. For the Contractor, for Work performed by the Contractor's Subcontractor, 5 percent of the amount due to the Subcontractor.
 - 3. For each Subcontractor or Sub-subcontractor involved, for Work performed by that Subcontractor's or Sub-subcontractor's own forces, 12 percent of the cost.
 - 4. For each Subcontractor, for Work performed by the Subcontractor's Sub-subcontractors, 5 percent of the amount due the Sub-subcontractor.
- C. The percentages allowed for overhead and profit shall be deemed to include, and no further addition for:
 - 1. Field and office supervision and administration, including the field superintendent, foreman, field designer/drafter, and Project Coordinator.
 - 2. General insurance, except that listed as labor burden.

3. Labor inefficiency.
4. Lost time.
5. Use of replacement tools.
6. Consumables.
7. Shop burden.
8. Equipment rental (other than specifically required additional hoisting equipment, required excavating equipment or similar equipment necessary solely as a result of the change).
9. Engineering and estimating costs.
10. Field design/drafting.
11. As-built or Record Drawings.
12. Updating site Drawings and Specifications.
13. Cost of safety measures (including those imposed by OSHA).
14. Shipping, drayage and demurrage.
15. Parking charges.
16. Clean up and debris removal.
17. Testing.
18. Warranties.
19. Permits, unless a new permit is required.

- D. Execution of Change Orders: Architect will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.
- E. After execution of Change Order, promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Sum.

1.4 APPLICATION FOR FINAL PAYMENT

- A. Prepare Application for Final Payment as specified for progress payments, identifying total adjusted Contract Sum, previous payments, and sum remaining due.

END OF SECTION 012000

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 DEFINITIONS

- A. Substitutions: Changes from Contract Documents requirements proposed by Contractor to materials, products, assemblies, and equipment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. No substitutions will be permitted for the procurement of interior finishes and vendors provided in Drawing Finish Legends and Schedules.
- B. A Substitution Request for products, assemblies, materials, and equipment constitutes a representation that the submitter:
 - 1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.
 - 2. Agrees to provide the same warranty for the substitution as for the specified product.
 - 3. Agrees to provide same or equivalent maintenance service and source of replacement parts, as applicable.
 - 4. Agrees to coordinate installation and make changes to other Work that may be required for the Work to be complete, with no additional cost to Owner.
 - 5. Waives claims for additional costs or time extension that may subsequently become apparent.
 - 6. Agrees to reimburse Owner and Architect for review or redesign services associated with re-approval by authorities.
 - 7. Provides statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
 - 8. Provides coordination 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.
 - 9. Provides detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - 10. Provides product data, including drawings and descriptions of products and fabrication and installation procedures.
 - 11. Provides samples, where applicable or requested.

12. Provides certificates and qualification data, where applicable or requested.
 13. Provides list of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
 14. Provides material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 15. Provides research reports evidencing compliance with building code in effect for Project, International Building Code (IBC).
 16. Provides detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delins in delivery.
 17. Provides cost information, including a proposal of change, if any, to Contract Sum.
 18. Provides 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.
 19. 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.
- C. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Burden of proof is on proposer.
- D. Content: Include information necessary for tracking the status of each Substitution Request, and information necessary to provide an actionable response.
1. Forms indicated and included in the Project Manual are adequate for this purpose and must be used.
- E. Limit each request to a single proposed substitution item.
1. Submit an electronic document, combining the request form with supporting data into a single document.

3.2 SUBSTITUTION PROCEDURES DURING PROCUREMENT

- A. Submittal time restrictions: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
- B. Submittal Form (before award of Contract): Submit substitution requests by completing the form attached to this Section. See this form for additional information and instructions. Use only this form; other forms of submission are unacceptable.

3.3 SUBSTITUTION PROCEDURES DURING CONSTRUCTION

- C. Submittal Form (after award of Contract): Submit substitution requests by completing the form attached to this Section. See this Section for additional information and instructions. Use only this form; other forms of submission are unacceptable.
- D. Architect will consider requests for substitutions only within 15 days after date of Agreement.
- E. Submit request for Substitution for Cause within 14 days of discovery of need for substitution, but not later than 14 days prior to time required for review and approval by Architect, in order to stay on approved project schedule.
- F. Submit request for Substitution for Convenience within 14 days of discovery of its potential advantage to the project, but not later than 14 days prior to time required for review and approval by Architect, in order to stay on approved project schedule.
 - 1. In addition to meeting general documentation requirements, document how the requested substitution benefits the Owner through cost savings, time savings, greater energy conservation, or in other specific ways.
 - 2. Requested substitution is directly related to an "available product," "available manufacturer," or "or equal" clause or similar language in the Contract Documents.
 - 3. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 - 4. Requested substitution does not require extensive revisions to the Contract Documents.
 - 5. Substitution request is fully documented and properly submitted.
 - 6. Requested substitution has received necessary approvals of Authorities Having Jurisdiction.
 - 7. Requested substitution is compatible with other portions of Work.
 - 8. Requested substitution has been coordinated with other portions of the Work.
 - 9. Requested substitution provides specified warranty.
 - 10. If requested substitution involves more than 1 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.
 - 11. Document means of coordination of substitution item with other portions of the Work, including Work by affected subcontractors.
 - 12. Bear the costs engendered by proposed substitution of Owner's compensation to the Architect for any required redesign, time spent processing, and time spent evaluating the request.
- G. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within 7 days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
 - 1. Cost savings shall be returned to the Owner in a Change Order form.
 - 2. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes of the Work.

3. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

H. Substitutions will not be considered under 1 or more of the following circumstances:

1. When they are indicated or implied on shop drawing or product data submittals without having received prior approval.
2. Without a separate written request.
3. When acceptance will require revisions to Contract Documents.

3.4 RESOLUTION

- A. Architect may request additional information and documentation prior to rendering a decision. Provide this data in an expeditious manner.

3.5 CLOSEOUT ACTIVITIES

- A. See Section 017800 "Closeout Submittals" for closeout submittals.

3.6 ATTACHMENTS

- A. A facsimile of the Substitution Request Form required to be used on the Project is included after this Section.

END OF SECTION 012500

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City of Lee's Summit
Lee's Summit - Market Plaza
Lee's Summit, Missouri

SECTION 012500 – SUBSTITUTION REQUEST FORM

**SUBSTITUTION
REQUEST**

(After the Bidding/Negotiating Phase)

Project: _____ Substitution Request Number: _____

From: _____
To: _____ Date: _____

A/E Project Number: _____
Re: _____ Contract For: _____

Specification Title: _____ Description: _____
Section: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Address: _____ Phone: _____

Trade Name: _____ Model No.: _____

Installer: _____ Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified product: _____

☐ Point-by-point comparative data attached — REQUIRED BY A/E

Reason for not providing specified item: _____

Similar Installation:

Project: _____ Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain _____

Savings to Owner for accepting substitution: _____ (\$ _____).

Proposed substitution changes Contract Time: ☐ No ☐ Yes [Add] [Deduct] _____ days.

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

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SECTION 013000 - ADMINISTRATIVE REQUIREMENTS

PART 1 – GENERAL (NOT USED)

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 ELECTRONIC DOCUMENT SUBMITTAL SERVICE

- A. All documents transmitted for purposes of administration of the contract are to be in electronic (PDF, MS Word, or MS Excel) format, as appropriate to the document, and transmitted via an Internet-based submittal service that receives, logs and stores documents, provides electronic stamping and signatures, and notifies addressees via email. Service shall be PROCORE or equivalent with same functionality.
 - 1. Besides submittals for review, information, and closeout, this procedure applies to Requests for Interpretation (RFIs), progress documentation, contract modification documents (e.g., supplementary instructions, change proposals, change orders), applications for payment, field reports and meeting minutes, Contractor's correction punch list, and any other document any participant wishes to make part of the Project record.
 - 2. Contractor and Architect are required to use this service.
 - 3. It is Contractor's responsibility to submit documents in allowable format.
 - 4. Subcontractors, suppliers, and Architect's consultants are to be permitted to use the service at no extra charge.
 - 5. Users of the service need an email address, internet access, and PDF review software that includes ability to mark up and apply electronic stamps (such as Adobe Acrobat, www.adobe.com, or Bluebeam PDF Revu, www.bluebeam.com), unless such software capability is provided by the service provider.
- B. Cost: The cost of the service is to be paid by Contractor; include the cost of the service in the Contract Sum.

3.2 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the work at maximum bi-monthly intervals.
- B. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.
- C. Attendance Required:
 - 1. Contractor.

2. Owner.
 3. Architect.
 4. Contractor's superintendent.
 5. Major subcontractors.
- D. Record minutes and distribute copies within 5 days after meeting to participants, with 1 copy to Architect, Owner, participants, and those affected by decisions made.

3.3 CONSTRUCTION PROGRESS SCHEDULE - SEE SECTION 013216

- A. Within 10 days after date of the Agreement, submit preliminary schedule defining planned operations for the first 60 days of work, with a general outline for remainder of work.
- B. If preliminary schedule requires revision after review, submit revised schedule within 10 days.
- C. Within 20 days after review of preliminary schedule, submit draft of proposed complete schedule for review.
1. Include written certification that major contractors have reviewed and accepted proposed schedule.
 2. Include all known Owner FFE requirements.
- E. Within 10 days after joint review, submit complete schedule.
- F. Submit updated schedule with each Application for Payment.

3.4 DAILY CONSTRUCTION REPORTS

- A. Prepare a daily construction report recording the following information concerning events at Project site and Project progress:
1. Date.
 2. Meetings and significant decisions.
 3. Testing and/or inspections performed.
 4. Signature of Contractor's authorized representative.

3.5 PROGRESS PHOTOGRAPHS

- A. Maintain 1 set of all photographs at Project site for reference; same copies as submitted, identified as such.

3.6 REQUESTS FOR INTERPRETATION (RFI)

- A. Definition: A request seeking 1 of the following:
 - 1. An interpretation, amplification, or clarification of some requirement of Contract Documents arising from inability to determine from them the exact material, process, or system to be installed; or when the elements of construction are required to occupy the same space (interference); or when an item of work is described differently at more than 1 place in Contract Documents.
 - 2. A resolution to an issue which has arisen due to field conditions and affects design intent.
- B. Whenever possible, request clarifications at the next appropriate Project progress meeting, with response entered into meeting minutes, rendering unnecessary the issuance of a formal RFI.
- C. Preparation: Prepare an RFI immediately upon discovery of a need for interpretation of Contract Documents. Failure to submit a RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the work.
 - 1. Prepare a separate RFI for each specific item.
 - 2. Prepare in a format and with content acceptable to Owner.
 - 3. Prepare using an electronic version of the form appended to this Section.
 - 4. Prepare using software provided by the Electronic Document Submittal Service.
 - 5. Combine RFI and its attachments into a single electronic file. PDF format is preferred.
- D. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.
 - 1. Unacceptable Uses for RFIs: Do not use RFIs to request the following:
 - a. Approval of submittals (use procedures specified elsewhere in this Section).
 - b. Approval of substitutions (see Section 016000 "Product Requirements").
 - c. Changes that entail change in Contract Time and Contract Sum (comply with provisions of the Conditions of the Contract).
- E. Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.
 - 1. Official Project name and number, and any additional required identifiers established in Contract Documents.
 - 2. Owner's, Architect's, and Contractor's names.
 - 3. Discrete and consecutive RFI number, and descriptive subject/title.
 - 4. Issue date, and requested reply date.
 - 5. Reference to particular Contract Document(s) requiring additional information/interpretation. Identify pertinent Drawing and detail number and/or Specification Section number, title, and paragraph(s).
 - 6. Annotations: Field dimensions and/or description of conditions which have engendered the request.

7. Contractor's Suggested Resolution: A written and/or a graphic solution, to scale, is required in cases where clarification of coordination issues is involved, for example, routing, clearances, and/or specific locations of work shown diagrammatically in Contract Documents. If applicable, state the likely impact of the suggested resolution on Contract Time or the Contract Sum.
- F. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.
- G. RFI Log: Prepare and maintain a tabular log of RFIs for the duration of the Project.
1. Indicate current status of every RFI. Update log promptly and on a regular basis.
 2. Note dates of when each request is made, and when a response is received.
 3. Highlight items requiring priority or expedited response.
- H. Review Time: Architect will respond and return RFIs to Contractor within 7 working days of receipt. For the purpose of establishing the start of the mandated response period, RFIs received after 12:00 noon will be considered as having been received on the following regular working day.
1. Response period may be shortened or lengthened for specific items, subject to mutual agreement, and recorded in a timely manner in progress meeting minutes.
- I. Responses: Content of answered RFIs will not constitute in any manner a directive or authorization to perform extra work or delay the Project. If in Contractor's belief it is likely to lead to a change to Contract Sum or Contract Time, promptly issue a notice to this effect, and follow up with an appropriate Change Order request to Owner.
1. Response may include a request for additional information, in which case the original RFI will be deemed as having been answered, and an amended 1 is to be issued forthwith. Identify the amended RFI with an R suffix to the original number.
 2. Do not extend applicability of a response to specific item to encompass other similar conditions, unless specifically so noted in the response.
 3. Upon receipt of a response, promptly review and distribute it to all affected parties, and update the RFI Log.
 4. Notify Architect within 7 calendar days if an additional or corrected response is required by submitting an amended version of the original RFI, identified as specified above.

3.7 SUBMITTAL SCHEDULE

- A. Submit to Architect for review a schedule for submittals in tabular format.
1. Coordinate with Contractor's construction schedule and schedule of values.
 2. Arrange information to include scheduled date for initial submittal, Specification number and title, submittal category (for review or for information), description of item of work covered, and role and name of subcontractor.
 3. Account for time required for preparation, review, manufacturing, fabrication and delivery when establishing submittal delivery and review deadline dates.

3.8 SUBMITTALS FOR REVIEW

- A. When the following are specified in individual Sections, submit them for review:
 - 1. Product data.
 - 2. Shop drawings.
 - 3. Samples for selection.
 - 4. Samples for verification.
- B. Submit to Architect for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.
- C. Samples will be reviewed for aesthetic, color, or finish selection.
- D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 017800 "Closeout Submittals."

3.9 SUBMITTALS FOR INFORMATION

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

3.10 SUBMITTALS FOR PROJECT CLOSEOUT

- A. Submit Correction Punch List for Substantial Completion.
- B. Submit Final Correction Punch List for Substantial Completion.
- C. When the following are specified in individual Sections, submit them at Project closeout in compliance with requirements of Section 017800 "Closeout Submittals":
 - 1. Project Record Documents.
 - 2. Operation and maintenance data.
 - 3. Warranties.
 - 4. Bonds.
 - 5. Other types as indicated.
- D. Submit for Owner's benefit during and after Project completion.

3.11 NUMBER OF COPIES OF SUBMITTALS

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

3.12 SUBMITTAL PROCEDURES

- A. General Requirements:
 - 1. Use a single transmittal for related items.
 - 2. Identify: Project; Contractor; subcontractor or supplier; pertinent drawing and detail number; and Specification Section number and article/paragraph, as appropriate on each copy.
 - 3. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the work and Contract Documents.
 - 4. Deliver each submittal on date noted in submittal schedule, unless an earlier date has been agreed to by all affected parties and is of the benefit to the Project.
 - a. Deliver submittals to Construction Manager at business address.
 - b. Upload submittals in electronic form to Electronic Document Submittal Service website.
 - 5. Schedule submittals to expedite the Project, and coordinate submission of related items.
 - a. For each submittal for review, allow 15 working days excluding delivery time to and from the Contractor.
- B. Processing Time: Allow time for submittal review, including time for resubmittals, as follows.

3.13 SUBMITTAL REVIEW

- A. Submittals for Review: Architect will review each submittal, and approve, or take other appropriate action.
- B. Submittals for Information: Architect will acknowledge receipt and review. See below for actions to be taken.

- C. Architect's actions will be reflected by marking each returned submittal using virtual stamp on electronic submittals.
 - 1. Notations may be made directly on submitted items and/or listed on appended Submittal Review cover sheet.
- D. Architect's and consultants' actions on items submitted for review:
 - 1. Authorizing purchasing, fabrication, delivery, and installation:
 - a. "Approved", or language with same legal meaning.
 - b. "Approved as Noted, Resubmission not required", or language with same legal meaning.
 - c. "Approved as Noted, Resubmit for Record", or language with same legal meaning.
 - 2. Not Authorizing fabrication, delivery, and installation:
- E. Architect's and consultants' actions on items submitted for information:
 - 1. Items for which no action was taken:
 - a. "Received" - to notify the Contractor that the submittal has been received for record only.
 - 2. Items for which action was taken:
 - a. "Reviewed" - no further action is required from Contractor.

END OF SECTION 013000

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SECTION 013001 - ELECTRONIC DOCUMENT RELEASE

PART 1 – GENERAL (NOT USED)

PART 2 - PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 ELECTRONIC DOCUMENT SUBMITTAL SERVICE

- A. All documents transmitted for purposes of administration of the Contract are to be in electronic (PDF, MS Word, or MS Excel) format, as appropriate to the document, and transmitted via an Internet-based submittal service that receives, logs and stores documents, provides electronic stamping and signatures, and notifies addressees via email. Service shall be PROCORE or equivalent with same functionality.
 - 1. Besides submittals for review, information, and closeout, this procedure applies to Requests for Interpretation (RFIs), progress documentation, contract modification documents (e.g., supplementary instructions, change proposals, change orders), applications for payment, field reports and meeting minutes, Contractor's correction punch list, and any other document any participant wishes to make part of the Project Record.
 - 2. Contractor and Architect are required to use this service.
 - 3. It is Contractor's responsibility to submit documents in allowable format.
 - 4. Subcontractors, suppliers, and Architect's consultants are to be permitted to use the service at no extra charge.
 - 5. Users of the service need an email address, internet access, and PDF review software that includes ability to mark up and apply electronic stamps (such as Adobe Acrobat, www.adobe.com, or Bluebeam PDF Revu, www.bluebeam.com), unless such software capability is provided by the service provider.
- B. Cost: The cost of the service is to be paid by Contractor; include the cost of the service in the Contract Sum.

3.2 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the work at maximum bi-monthly intervals.
- B. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.
- C. Attendance Required:
 - 1. Contractor.
 - 2. Owner.
 - 3. Architect.

4. Contractor's superintendent.
5. Major subcontractors.

- D. Record minutes and distribute copies within 5 days after meeting to participants, with 1 copy each to Architect, Owner, participants, and those affected by decisions made.

3.3 CONSTRUCTION PROGRESS SCHEDULE - SEE SECTION 013216

- A. Within 10 days after date of the Agreement, submit preliminary schedule defining planned operations for the first 60 days of work, with a general outline for remainder of work.
- B. If preliminary schedule requires revision after review, submit revised schedule within 10 days.
- C. Within 20 days after review of preliminary schedule, submit draft of proposed Complete Schedule for review.
 1. Include written certification that major contractors have reviewed and accepted proposed schedule.
 2. Include all known Owner FFE requirements.
- E. Within 10 days after joint review, submit complete schedule.
- F. Submit an updated schedule with each Application for Payment.

3.4 DAILY CONSTRUCTION REPORTS

- A. Prepare a daily construction report recording the following information concerning events at Project site and Project progress:
 1. Date.
 2. Meetings and significant decisions.
 3. Testing and/or inspections performed.
 4. Signature of Contractor's authorized representative.

3.5 PROGRESS PHOTOGRAPHS

- A. Maintain 1 set of all photographs at Project site for reference; same copies as submitted, identified as such.

3.6 REQUESTS FOR INTERPRETATION (RFI)

- A. Definition: A request seeking 1 of the following:
 1. An interpretation, amplification, or clarification of some requirement of Contract Documents arising from inability to determine from them the exact material, process, or system to be installed; or when the elements of construction are required to occupy the same space (interference); or when an item of work is described differently at more than 1 place in Contract Documents.

2. A resolution to an issue which has arisen due to field conditions and affects design intent.
- B. Whenever possible, request clarifications at the next appropriate Project progress meeting, with response entered into meeting minutes, rendering unnecessary the issuance of a formal RFI.
- C. Preparation: Prepare an RFI immediately upon discovery of a need for interpretation of Contract Documents. Failure to submit an RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the work.
 1. Prepare a separate RFI for each specific item.
 2. Prepare in a format and with content acceptable to Owner.
 3. Prepare using an electronic version of the form appended to this Section.
 4. Prepare using software provided by the Electronic Document Submittal Service.
 5. Combine RFI and its attachments into a single electronic file. PDF format is preferred.
- D. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.
 1. Unacceptable Uses for RFIs: Do not use RFIs to request the following:
 - a. Approval of submittals (use procedures specified elsewhere in this Section).
 - b. Approval of substitutions (see Section 016000 "Product Requirements").
 - c. Changes that entail change in Contract Time and Contract Sum (comply with provisions of the Conditions of the Contract).
- E. Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.
 1. Official Project name and number, and any additional required identifiers established in Contract Documents.
 2. Owner's, Architect's, and Contractor's names.
 3. Discrete and consecutive RFI number, and descriptive subject/title.
 4. Issue date and requested reply date.
 5. Reference to particular Contract Documents requiring additional information/interpretation. Identify pertinent Drawing and detail number and/or Specification Section number, title, and paragraphs.
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 7. Contractor's Suggested Resolution: A written and/or a graphic solution, to scale, is required in cases where clarification of coordination issues is involved, for example, routing, clearances, and/or specific locations of work shown diagrammatically in Contract Documents. If applicable, state the likely impact of the suggested resolution on Contract Time or the Contract Sum.
- G. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.
- H. RFI Log: Prepare and maintain a tabular log of RFIs for the duration of the Project.
 1. Indicate current status of every RFI. Update log promptly and on a regular basis.
 2. Note dates of when each request is made, and when a response is received.

3. Highlight items requiring priority or expedited response.
- I. Review Time: Architect will respond and return RFIs to Contractor within 7 working days of receipt. For the purpose of establishing the start of the mandated response period, RFIs received after 12:00 noon will be considered as having been received on the following regular working day.
 1. Response period may be shortened or lengthened for specific items, subject to mutual agreement, and recorded in a timely manner in progress meeting minutes.
- J. Responses: Content of answered RFIs will not constitute in any manner a directive or authorization to perform extra work or delay the Project. If in Contractor's belief it is likely to lead to a change to Contract Sum or Contract Time, promptly issue a notice to this effect, and follow up with an appropriate Change Order request to Owner.
 1. Response may include a request for additional information, in which case the original RFI will be deemed as having been answered, and an amended RFI 1 is to be issued forthwith. Identify the amended RFI with an R suffix to the original number.
 2. Do not extend applicability of a response to specific item to encompass other similar conditions, unless specifically so noted in the response.
 3. Upon receipt of a response, promptly review and distribute it to all affected parties, and update the RFI Log.
 4. Notify Architect within 7 calendar days if an additional or corrected response is required by submitting an amended version of the original RFI, identified as specified above.

3.7 SUBMITTAL SCHEDULE

- A. Submit to Architect for review a schedule for submittals in tabular format.
 1. Coordinate with Contractor's construction schedule and schedule of values.
 2. Arrange information to include scheduled date for initial submittal, Specification number and title, submittal category (for review or for information), description of item of work covered, and role and name of subcontractor.
 3. Account for time required for preparation, review, manufacturing, fabrication, and delivery when establishing submittal delivery and review deadline dates.

3.8 SUBMITTALS FOR REVIEW

- A. When the following are specified in individual Sections, submit them for review:
 1. Product data.
 2. Shop drawings.
 3. Samples for selection.
 4. Samples for verification.
- B. Submit to Architect for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.

- C. Samples will be reviewed for aesthetic, color, or finish selection.
- D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 017800 "Closeout Submittals."

3.9 SUBMITTALS FOR INFORMATION

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

3.10 SUBMITTALS FOR PROJECT CLOSEOUT

- A. Submit Correction Punch List for Substantial Completion.
- B. Submit Final Correction Punch List for Substantial Completion.
- C. When the following are specified in individual sections, submit them at Project Closeout in compliance with requirements of Section 017800 "Closeout Submittals":
 - 1. Project Record Documents.
 - 2. Operation and maintenance data.
 - 3. Warranties.
 - 4. Bonds.
 - 5. Other types as indicated.
- D. Submit for Owner's benefit during and after Project completion.

3.11 NUMBER OF COPIES OF SUBMITTALS

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

3.12 SUBMITTAL PROCEDURES

A. General Requirements:

1. Use a single transmittal for related items.
2. Identify: Project, Contractor, subcontractor or supplier, pertinent drawing and detail number; and Specification Section number and article/paragraph, as appropriate on each copy.
3. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the work and Contract Documents.
4. Deliver each submittal on date noted in submittal schedule unless an earlier date has been agreed to by all affected parties and is of the benefit to the Project.
 - a. Deliver submittals to Construction Manager at business address.
 - b. Upload submittals in electronic form to Electronic Document Submittal Service website.
5. Schedule submittals to expedite the Project, and coordinate submission of related items.
 - a. For each submittal for review, allow 15 working days excluding delivery time to and from the Contractor.

B. Processing Time: Allow time for submittal review, including time for resubmittals, as follows.

3.13 SUBMITTAL REVIEW

- A. Submittals for Review: Architect will review each submittal, and approve, or take other appropriate action.
- B. Submittals for Information: Architect will acknowledge receipt and review. See below for actions to be taken.
- C. Architect's actions will be reflected by marking each returned submittal using virtual stamp on electronic submittals.
 1. Notations may be made directly on submitted items and/or listed on appended Submittal Review cover sheet.
- D. Architect's and consultants' actions on items submitted for review:
 1. Authorizing purchasing, fabrication, delivery, and installation:
 - a. "Approved," or language with same legal meaning.
 - b. "Approved as Noted, Resubmission not required," or language with same legal meaning.
 - c. "Approved as Noted, Resubmit for Record," or language with same legal meaning.
 2. Not Authorizing fabrication, delivery, and installation.

E. Architect's and consultants' actions on items submitted for information:

1. Items for which no action was taken:
 - a. "Received" - to notify the Contractor that the submittal has been received for record only.
2. Items for which action was taken:
 - a. "Reviewed" - no further action is required from Contractor.

END OF SECTION 013001

City of Lee's Summit
Lee's Summit - Market Plaza

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SECTION 013100 - 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. RFIs.
 - 4. Digital project management procedures.
 - 5. Web-based project management software package.
 - 6. Project meetings.

1.3 DEFINITIONS

- A. BIM: Building Information Modeling.
- B. RFI: Request for Information. Request from Owner, construction manager, 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.
- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses, cellular telephone numbers, and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

4. Post copies of list in Project meeting room, in temporary field office, in web-based Project software directory, and in prominent location in each built facility. Keep list current at all times.

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 1 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.
- B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
 1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities 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 1 entity.
 1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on 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.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire protection, fire alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to represent the Work adequately.
2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within plenums to accommodate layout of light fixtures and other components indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms, showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Slab Edge and Embedded Items: Indicate slab edge locations; sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads; and similar items.
6. Mechanical and Plumbing Work: Show the following:
 - a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
 - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts, and electrical distribution equipment.
 - c. Fire-rated enclosures around ductwork.
7. Electrical Work: Show the following:
 - a. Runs of vertical and horizontal conduit 1-1/4 inches in diameter and larger.
 - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire alarm locations.

- c. Panelboard, switchboard, switchgear, transformer, busway, generator, and motor-control center locations.
 - d. Location of pull boxes and junction boxes, dimensioned from column center lines.
- 8. Review: Architect will review coordination drawings to confirm that, in general, the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Architect determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Architect will so inform Contractor, who shall make suitable modifications and resubmit.
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
 - 1. File Submittal Format: Submit or post coordination drawing files using PDF format.

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. Architect will return without response those RFIs submitted to Architect by other entities controlled by Contractor.
 - 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. Owner name.
 - 3. Owner's Project number.
 - 4. Name of Architect.
 - 5. Architect's Project number.
 - 6. Date.
 - 7. Name of Contractor.
 - 8. RFI number, numbered sequentially.
 - 9. RFI subject.
 - 10. Specification Section number and title and related paragraphs, as appropriate.
 - 11. Drawing number and detail references, as appropriate.
 - 12. Field dimensions and conditions, as appropriate.
 - 13. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 - 14. Contractor's signature.

15. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms: AIA Document G716 or software-generated form with substantially the same content as indicated above, acceptable to Architect.
 1. Attachments shall be electronic files in PDF format.
- D. Architect's Action: Architect will review each RFI, determine action required, and respond. Allow 7 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 012600 "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 5 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 weekly. Include the following:
 1. Project name.
 2. Name and address of Contractor.
 3. Name and address of Architect.
 4. RFI number, including RFIs that were returned without action or withdrawn.
 5. RFI description.
 6. Date the RFI was submitted.
 7. Date Architect's response was received.
 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 within 7 days if Contractor disagrees with response.

1.8 DIGITAL PROJECT MANAGEMENT PROCEDURES

- A. Architect's Data Files Not Available: Architect will not provide Architect's BIM model or CAD drawing digital data files for Contractor's use during construction.
- 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 PROJECT MEETINGS

- A. General: Construction Manager will 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 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, Construction Manager, and Architect, within 3 days of the meeting.
- B. Preconstruction Conference: Construction Manager will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect, but no later than 15 days after execution of the Agreement.
 - 1. Attendees: Authorized representatives of Owner; Owner's Commissioning Authority; Construction Manager, 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. Work restrictions.
 - q. Working hours.
 - r. Owner's occupancy requirements.
 - s. Responsibility for temporary facilities and controls.
 - t. Procedures for moisture and mold control.
 - u. Procedures for disruptions and shutdowns.
 - v. Construction waste management and recycling.
 - w. Parking availability.
 - x. Office, work, and storage areas.
 - y. Equipment deliveries and priorities.
 - z. First aid.
 - aa. Security.
 - bb. 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, Construction Manager, and Owner's Commissioning Authority 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. Review of mock-ups.
 - h. Possible conflicts.
 - i. Compatibility requirements.
 - j. Time schedules.
 - k. Weather limitations.
 - l. Manufacturer's written instructions.

- m. Warranty requirements.
 - n. Compatibility of materials.
 - o. Acceptability of substrates.
 - p. Temporary facilities and controls.
 - q. Space and access limitations.
 - r. Regulations of authorities having jurisdiction.
 - s. Testing and inspecting requirements.
 - t. Installation procedures.
 - u. Coordination with other work.
 - v. Required performance results.
 - w. Protection of adjacent work.
 - x. 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: Construction Manager will 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, Owner's Commissioning Authority, Construction Manager, 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. Progress Meetings: Construction Manager will conduct progress meetings at biweekly intervals.
 - 1. Coordinate dates of meetings with preparation of payment requests.
 - 2. Attendees: In addition to representatives of Owner, Owner's Commissioning Authority, Construction Manager, 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.
 - 3. 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) Sequence of operations.
 - 2) Status of submittals.
 - 3) Deliveries.
 - 4) Off-site fabrication.
 - 5) Access.
 - 6) Site use.
 - 7) Temporary facilities and controls.
 - 8) Progress cleaning.
 - 9) Quality and work standards.
 - 10) Status of correction of deficient items.
 - 11) Field observations.
 - 12) Status of RFIs.
 - 13) Status of Proposal Requests.
 - 14) Pending changes.
 - 15) Status of Change Orders.
 - 16) Pending claims and disputes.
 - 17) Documentation of information for payment requests.

4. 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 013100

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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 other 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. Startup construction schedule.
 - 2. Contractor's Construction Schedule.
 - 3. Construction schedule updating reports.
 - 4. Daily construction reports.
 - 5. Material location reports.
 - 6. Site condition reports.
 - 7. Unusual event reports.

1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.
 - 1. Critical 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.

1.4 INFORMATIONAL SUBMITTALS

- A. Format for Submittals: Submit required submittals in PDF file format.
- B. Startup construction schedule.
 - 1. Submittal of cost-loaded startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.
- C. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

- D. Construction Schedule Updating Reports: Submit with Applications for Payment.
- E. Daily Construction Reports: Submit at monthly intervals.
- F. Material Location Reports: Submit at monthly intervals.
- G. Site Condition Reports: Submit at time of discovery of differing conditions.
- H. Unusual Event Reports: Submit at time of unusual event.

1.5 QUALITY ASSURANCE

- A. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to the preliminary Construction Schedule and Contractor's Construction Schedule, including, but not limited to, the following:
 - 1. Review software limitations and content and format for reports.
 - 2. Verify availability of qualified personnel needed to develop and update schedule.
 - 3. Discuss constraints, including phasing, work stages, area separations, and interim milestones.
 - 4. Review delivery dates for Owner-furnished products.
 - 5. Review schedule for work of Owner's separate contracts.
 - 6. Review submittal requirements and procedures.
 - 7. Review time required for review of submittals and resubmittals.
 - 8. Review requirements for tests and inspections by independent testing and inspecting agencies.
 - 9. Review time required for Project closeout and Owner startup procedures, including commissioning activities.
 - 10. Review and finalize list of construction activities to be included in schedule.
 - 11. Review procedures for updating schedule.

1.6 COORDINATION

- A. Coordinate Contractor's Construction Schedule with the schedule of values, 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.

1.7 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Time Frame: Extend schedule from date established for commencement of the Work to date of Final Completion.
 - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
- B. Activities: Treat each floor 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. Temporary Facilities: Indicate start and completion dates for the following as applicable:
 - a. Securing of approvals and permits required for performance of the Work.
 - b. Temporary facilities.
 - c. Construction of mock-ups, prototypes, and samples.
 - d. Owner interfaces and furnishing of items.
 - e. Interfaces with separate contracts.
 - f. Regulatory agency approvals.
 - g. Punch list.
 - 3. Procurement Activities: Include procurement process activities for the following long lead-time 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.
 - 4. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.
 - 5. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
 - 6. Commissioning Time: Include no fewer than 15 days for commissioning.
 - 7. Substantial Completion: Indicate completion in advance of date established for Substantial Completion and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
 - 8. 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. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
 - 3. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.

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, including, but not limited to, the following:
 - a. Subcontract awards.
 - b. Submittals.
 - c. Purchases.
 - d. Mock-ups.
 - e. Fabrication.
 - f. Sample testing.
 - g. Deliveries.
 - h. Installation.
 - i. Tests and inspections.
 - j. Adjusting.
 - k. Curing.
 - l. Commissioning.
 6. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
 - a. Structural completion.
 - b. Temporary enclosure and space conditioning.
 - c. Permanent space enclosure.
 - d. Completion of mechanical installation.
 - e. Completion of electrical installation.
 - f. Substantial Completion.
- D. Milestones: Include milestones indicated in the Contract Documents in the 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 the Contract Time.

- F. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule 1 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.
- G. 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. Indicate changes to working hours, working days, crew sizes, equipment required to achieve compliance, and date by which recovery will be accomplished.
- H. Distribution: Distribute copies of approved schedule to Architect, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
 - 1. Post copies in Project meeting rooms and temporary field offices.
 - 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

1.8 STARTUP CONSTRUCTION SCHEDULE

- A. Gantt-Chart Schedule: Submit startup, horizontal, Gantt-chart-type construction schedule within 7 days of date established for commencement of the Work.
- B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 90 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

1.9 GANTT-CHART SCHEDULE REQUIREMENTS

- A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's Construction Schedule within 30 days of the date established for commencement of the Work.
 - 1. Base schedule on the startup Construction Schedule and additional information received since the start of Project.

- 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 3 months or longer to complete, indicate an estimated completion percentage in 10 percent increments within time bar.

1.10 CPM SCHEDULE REQUIREMENTS

- A. Contract Modifications: For each proposed contract modification 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.
- B. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. 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).
- C. C. Schedule Updating: Concurrent with making revisions to Schedule, prepare tabulated reports showing the following:
 - 1. Identification of activities that have changed.
 - 2. Changes in early and late start dates.
 - 3. Changes in early and late finish dates.
 - 4. Changes in activity durations in workdays.
 - 5. Changes in the critical path.
 - 6. Changes in total float or slack time.
 - 7. Changes in the Contract Time.
- D. Value Summaries: Prepare 2 cumulative value lists, sorted by finish dates.
 - 1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.
 - 2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
 - 3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
 - 4. Prepare list for ease of comparison with payment requests, coordinate timing with progress meetings.

- a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
- b. Submit value summary printouts 1 week before each regularly scheduled progress meeting.

1.11 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
 1. List of subcontractors at Project site.
 2. List of separate contractors at Project site.
 3. Approximate count of personnel at Project site.
 4. Equipment at Project site.
 5. Material deliveries.
 6. High and low temperatures and general weather conditions, including presence of rain or snow.
 7. Testing and inspection.
 8. Accidents.
 9. Meetings and significant decisions.
 10. Unusual events.
 11. Stoppages, delays, shortages, and losses.
 12. Meter readings and similar recordings.
 13. Emergency procedures.
 14. Orders and requests of authorities having jurisdiction.
 15. Change Orders received and implemented.
 16. Construction Change Directives received and implemented.
 17. Services connected and disconnected.
 18. Equipment or system tests and startups.
 19. Partial completions and occupancies.
 20. Substantial Completions authorized.
- B. Material Location Reports: At weekly intervals, prepare and submit a comprehensive list of materials delivered to and stored at the Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:
 1. Material stored prior to previous report and remaining in storage.
 2. Material stored prior to previous report and since removed from storage and installed.
 3. Material stored following previous report and remaining in storage.
- C. 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.

- D. Unusual Event Reports: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, responses by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these events are known or predictable.
1. Submit unusual event reports directly to Owner within 1 day of an occurrence. Distribute copies of report to parties affected by the occurrence.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013200

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SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - 2. Concealed Work photographs.
 - 3. Periodic construction photographs.
 - 4. Final Completion construction photographs.

1.3 INFORMATIONAL SUBMITTALS

- A. Key Plan: Submit Key Plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.
- B. Digital Photographs: Submit image files within 3 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. Name and contact information for photographer.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Date photograph was taken.
 - f. Description of location, vantage point, and direction.
 - g. Unique sequential identifier keyed to accompanying Key Plan.

1.4 FORMATS AND MEDIA

- A. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3,200 by 2,400 pixels. 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. Metadata: Record accurate date and time from camera.
- D. File Names: Name media files with date and Project area and sequential numbering suffix.

1.5 CONSTRUCTION PHOTOGRAPHS

- A. Photographer: Engage a qualified photographer to take construction photographs.
- B. 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.
- 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. Under-slab services.
 - 3. Piping.
 - 4. Electrical conduit.
 - 5. Waterproofing and weather-resistant barriers.
- D. Periodic Construction Photographs: Take 20 photographs weekly coinciding with the cutoff date associated with each Application for Payment. Select vantage points to show the status of construction and progress since last photographs were taken.
- E. Final Completion Construction Photographs: Take 50 photographs after date of Substantial Completion for submission as Project Record Documents.
- F. Additional Photographs: Architect may request photographs in addition to periodic photographs specified.
 - 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. Special events planned at Project site.
 - b. Immediate follow-up when on-site events result in construction damage or losses.
 - c. Photographs are to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
 - d. Substantial Completion of a major phase or component of the Work.
 - e. Extra record photographs at time of final acceptance.
 - f. Owner's request for special publicity photographs.

City of Lee's Summit
Lee's Summit - Market Plaza

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

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SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submittal schedule requirements.
2. Administrative and procedural requirements for submittals.

1.2 DEFINITIONS

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

1.3 SUBMITTAL SCHEDULE

- A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.
1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
 2. Initial Submittal Schedule: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 3. Final Submittal Schedule: Submit concurrently with the first complete submittal of Contractor's construction schedule.

- a. Submit revised submittal schedule as required to reflect changes in current status and timing for submittals.
4. Format: Arrange the following information in a tabular format:
 - a. Scheduled date for first submittal.
 - b. Specification Section number and title.
 - c. Submittal Category: Action; informational.
 - d. Name of subcontractor.
 - e. Description of the Work covered.
 - f. Scheduled date for Architect's final release or approval.

1.4 SUBMITTAL FORMATS

A. Submittal Information: Include the following information in each submittal:

1. Project name.
2. Date.
3. Name of Architect.
4. Name of Construction Manager.
5. Name of Contractor.
6. Name of firm or entity that prepared submittal.
7. Names of subcontractor, manufacturer, and supplier.
8. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier and alphanumeric suffix for resubmittals.
9. Category and type of submittal.
10. Submittal purpose and description.
11. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
12. Drawing number and detail references, as appropriate.
13. Indication of full or partial submittal.
14. Location(s) where product is to be installed, as appropriate.
15. Other necessary identification.
16. Remarks.
17. Signature of transmitter.

B. Options: Identify options requiring selection by Architect.

- C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
- D. Electronic Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.
- E. Submittals Utilizing Web-Based Project Software: Prepare submittals as PDF files or other format indicated by Project management software.

1.5 SUBMITTAL PROCEDURES

- A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 - 1. Email: Prepare submittals as PDF package and transmit to Architect by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Architect.
 - a. Architect will return annotated file. Annotate and retain 1 copy of file as a digital Project Record Document file.
 - 2. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project management software website. Enter required data in web-based software site to fully identify submittal.
- B. 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. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 - 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 - 4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections, so processing will not be delayed because of the 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.

- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow 15 days for review of each resubmittal.
 4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.
 5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Architect and to Architect's consultants, allow 15 days for review of each submittal. Submittal will be returned to Architect before being returned to Contractor.
- D. Resubmittals: Make resubmittals in the same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
 2. Note date and content of revision in label or title block, and clearly indicate extent of revision.
 3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.
- E. 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.
- F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

1.6 SUBMITTAL REQUIREMENTS

- A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams that show factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before Shop Drawings, and before or concurrently with samples.
- B. 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. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 2. Paper Sheet Size: Except for templates, patterns, and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.
 - a. 3 opaque copies of each submittal. Architect will retain 2 copies; remainder will be returned.
- C. Samples: Submit samples for review of type, color, pattern, and texture for a check of these characteristics with other materials.
1. Transmit samples that contain multiple, related components, such as accessories together in 1 submittal package.
 2. Identification: Permanently attach label on unexposed side of samples that includes the following:
 - a. Project name and submittal number.
 - b. Generic description of sample.
 - c. Product name and name of manufacturer.
 - d. Sample source.
 - e. Number and title of applicable Specification Section.
 - f. Specification paragraph number and generic name of each item.
 3. Email Transmittal: Provide PDF transmittal. Include digital image file illustrating sample characteristics and identification information for record.
 4. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.

5. Paper Transmittal: Include paper transmittal, including complete submittal information indicated.
 - a. 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.
 - b. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such samples must be in an undamaged condition at time of use.
 - c. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
 - b. 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.
 - d. Number of Samples: Submit 1 full set 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.
 - e. Samples for Verification: Submit full-size units or samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 - f. Number of Samples: Submit 3 sets of samples. Architect will retain 2 sample sets; remainder will be returned. Mark up and retain 1 returned sample set as a Project Record sample.
 - 1) Submit a single sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a sample, submit at least 3 sets of paired units that show approximate limits of variations.
- D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 2. Manufacturer and product name, and model number if applicable.
 3. Number and name of room or space.
 4. Location within room or space.
- E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.

- F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.
- G. Certificates:
1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
 2. Installer Certificates: Submit written statements on manufacturer's letterhead, certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
 3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
 4. Material Certificates: Submit written statements on manufacturer's letterhead, certifying that material complies with requirements in the Contract Documents.
 5. Product Certificates: Submit written statements on manufacturer's letterhead, certifying that product complies with requirements in the Contract Documents.
 6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of AWS B2.1/B2.1M on AWS forms. Include names of firms and personnel certified.
- H. Test and Research Reports:
1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for substrate preparation and primers required.
 2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
 3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
 4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
 5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
 6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - a. Name of evaluation organization.
 - b. Date of evaluation.
 - c. Time period when report is in effect.

- d. Product and manufacturers' names.
- e. Description of product.
- f. Test procedures and results.
- g. Limitations of use.

1.7 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 insufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file and 3 paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

1.8 CONTRACTOR'S REVIEW

- A. Action Submittals and Informational Submittals: 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. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp. Include 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.
 - 1. Architect will not review submittals received from Contractor that do not have Contractor's review and approval.

1.9 ARCHITECT'S AND CONSTRUCTION MANAGER'S REVIEW

- A. Action Submittals: Architect and Construction Manager will review each submittal, indicate corrections or revisions required, and return.
 - 1. PDF Submittals: Architect and Construction Manager will indicate, via markup on each submittal, the appropriate action.
 - 2. Submittals by Web-Based Project Management Software: Architect and Construction Manager will indicate, on Project management software website, the appropriate action.

- B. Informational Submittals: Architect and Construction Manager will review each submittal and will not return it or will return it if it does not comply with requirements. Architect and Construction Manager will forward each submittal to appropriate party.
- C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect and Construction Manager.
- D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- E. Architect and Construction Manager will return without review submittals received from sources other than Contractor.
- F. Submittals not required by the Contract Documents will be returned by Architect without action.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

SECTION 014000 – QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Test Reports: After each test/inspection, promptly submit 2 copies of the reports to Architect and to Contractor.
- B. Manufacturer's Instructions: When specified in individual Specification Sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, for the Owner's information. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.
- C. Manufacturer's Field Reports: Submit reports for Architect's benefit as Contract Administrator or for Owner.
 - 1. Submit for information for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents.

1.2 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Submit copy of report of laboratory facilities inspection made by NIST Construction Materials Reference Laboratory during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.
- B. Designer Qualifications: Where professional engineering design services and design data submittals are specifically required of Contractor and/or Vendors by Contract Documents, provide services of a Professional Engineer experienced in design of this type of Work and licensed in State of Missouri.

1.3 REFERENCES AND STANDARDS

- A. For products and workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Comply with reference standard of date of issue current on date of Contract Documents, except where a specific date is established by applicable code.
- C. Should specified reference standards conflict with Contract Documents, request clarification from Architect before proceeding.

- D. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of Architect shall be altered from Contract Documents by mention or inference otherwise in any reference document.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 CONTROL OF INSTALLATION

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

3.2 MOCK-UPS

- A. Before installing portions of the Work where mock-ups are required, construct mock-ups in location and size indicated for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work. The purpose of mock-up is to demonstrate the proposed range of aesthetic effects and workmanship.
- B. Accepted mock-ups establish the standard of quality the Architect will use to judge the Work.
- C. Integrated Exterior Mock-ups: Construct integrated exterior mock-up as indicated on drawings. Coordinate installation of exterior envelope materials and products as required in individual Specification Sections. Provide adequate supporting structure for mock-up materials as necessary.
- D. Tests shall be performed under provisions identified in this Section and identified in the respective product Specification Sections.

- E. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.
- F. Architect will use accepted mock-ups as a comparison standard for the remaining Work.
- G. Where mock-up has been accepted by Architect and is specified in product Specification Sections to be removed, protect mock-up throughout construction, remove mock-up and clear area when directed to do so by Architect.

3.3 DEFECT ASSESSMENT

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

END OF SECTION 014000

SECTION 014533 - CODE-REQUIRED SPECIAL INSPECTIONS

PART 1 - GENERAL

1.1 DEFINITIONS

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

1.2 SUBMITTALS

- A. Special Inspection Agency Qualifications: Prior to the start of Work, the special inspection agency is required to:
 - 1. Submit agency name, address, and telephone number, names of full-time registered Engineer and responsible officer.
 - 2. Submit copy of report of laboratory facilities inspection made by NIST Construction Materials Reference Laboratory during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.
 - 3. Submit certification that special inspection agency is acceptable to AHJ.
- B. Testing Agency Qualifications: Prior to the start of work, the Testing Agency is required to:
 - 1. Submit agency name, address, telephone number, and names of full-time registered Engineer and responsible officer.
 - 2. Submit copy of report of laboratory facilities inspection made by NIST Construction Materials Reference Laboratory during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.
 - 3. Submit certification that testing agency is acceptable to AHJ.

- C. Special Inspection Reports: After each special inspection, the Special Inspector is required to promptly submit at least electronic copies of report; 1 to Architect and 1 to the AHJ.
- D. Test Reports: After each test or inspection, promptly submit at least electronic copies of the report; 1 to Architect and 1 to AHJ.
- E. Certificates: When specified in individual special inspection requirements, Special Inspector shall submit certification by the manufacturer, fabricator, and installation subcontractor to Architect and AHJ, in quantities specified for product data.
 - 1. Indicate material or product complies with or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
 - 2. Certificates may be recent or previous test results on material or product but must be acceptable to Architect and AHJ.
- F. Manufacturer's Field Reports: Submit reports to Architect and AHJ.
 - 1. Submit report in duplicate within 30 days of observation to Architect for information.
 - 2. Submit for information for the limited purpose of assessing compliance with information given and the design concept expressed in Contract Documents.

1.3 SPECIAL INSPECTION AGENCY

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

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 SCHEDULE OF SPECIAL INSPECTIONS, GENERAL

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

3.2 SPECIAL INSPECTION AGENCY DUTIES AND RESPONSIBILITIES

A. Special Inspection Agency shall:

1. Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
2. Perform specified sampling and testing of products in accordance with specified reference standards.
3. Ascertain compliance of materials and products with requirements of Contract Documents.
4. Promptly notify Architect and Contractor of observed irregularities or non-compliance of work or products.
5. Perform additional tests and inspections required by Architect.
6. Submit reports of all tests or inspections specified.

END OF SECTION 014533

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 TEMPORARY UTILITIES

- A. See Section 015100 "Temporary Utilities."

1.2 TEMPORARY SANITARY FACILITIES

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

1.3 BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas, to prevent access to areas that could be hazardous to Workers or the public, to allow for Owner's use of site, and to protect existing facilities and adjacent properties from damage from construction operations and demolition.

1.4 FENCING

- A. Construction: Contractor's option.

1.5 SECURITY

- A. Provide security and facilities to protect Work, existing facilities, and Owner's operations from unauthorized entry, vandalism, or theft.

1.6 VEHICULAR ACCESS AND PARKING

- A. Coordinate access and haul routes with governing authorities and Owner.
- B. Provide and maintain access to fire hydrants, free of obstructions.

1.7 WASTE REMOVAL

- A. See Section 017419 "Construction Waste Management and Disposal," for additional requirements.

- B. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.
- C. Provide containers with lids. Remove trash from site periodically.

1.8 PROJECT IDENTIFICATION

- A. Provide Project identification sign of design and construction indicated on Drawings.
- B. Erect on site at location indicated.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 015000

SECTION 015100 - TEMPORARY UTILITIES

PART 1 - GENERAL

1.1 TEMPORARY ELECTRICITY

- A. Cost: By Contractor.
- B. Provide power service required from utility source.

1.2 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

- A. Provide and maintain 0.25-watt/square foot high-intensity discharge (HID) lighting to interior work areas after dark for security purposes.

1.3 TEMPORARY HEATING

- A. Cost of Energy: By Contractor.
- B. Maintain minimum ambient temperature of 50 degrees F in areas where construction is in progress, unless indicated otherwise in Specifications.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION 015100

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUBMITTALS

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

1.2 QUALITY ASSURANCE

- A. Environmental Product Declaration (EPD): Publicly available, critically reviewed life cycle analysis having at least a cradle-to-gate scope.
 - 1. Good: Product-specific; compliant with ISO 14044.
 - 2. Better: Industry-wide, generic; compliant with ISO 21930, or with ISO 14044, ISO 14040, ISO 14025, and EN 15804; Type III third-party certification with external verification, in which the manufacturer is recognized as the program operator.
 - 3. Best: Commercial-product-specific; compliant with ISO 21930, or with ISO 14044, ISO 14040, ISO 14025, and EN 15804; Type III third-party certification with external verification, in which the manufacturer is recognized as the program operator.
 - 4. Where demonstration of impact reduction below industry average is required, submit both industry-wide and commercial-product-specific declarations; or submit at least 5 declarations for products of the same type by other manufacturers in the same industry.
- B. GreenScreen Chemical Hazard Analysis: Ingredients of 100 parts-per-million or greater evaluated using GreenScreen (METH).
 - 1. Good: GreenScreen (LIST) evaluation to identify Benchmark 1 hazards; a Health Product Declaration includes this information.
 - 2. Better: GreenScreen Full Assessment.
 - 3. Best: GreenScreen Full Assessment by GreenScreen Licensed Profiler.
 - 4. Acceptable Evidence: GreenScreen report.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS

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

2.2 NEW PRODUCTS

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

2.3 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.
- B. Products Specified by Naming 1 or More Manufacturers: Use a product of 1 of the manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products Specified by Naming 1 or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

PART 3 - EXECUTION

3.1 SUBSTITUTION LIMITATIONS

- A. See Section 012500 "Substitution Procedures."

END OF SECTION 016000

SECTION 016116 - VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS

PART 1 – GENERAL

1.1 DEFINITIONS

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

1.2 SUBMITTALS

- A. Product Data: For each VOC-restricted product used in the project, submit evidence of compliance.

1.3 QUALITY ASSURANCE

- A. Indoor Emissions Standard and Test Method: CAL (CDPH SM), using Standard Private Office exposure scenario and the allowable concentrations specified in the method, and range of total VOCs after 14 days.
1. Paints and Coatings: Test tinted products, not just tinting bases.
 2. Evidence of Compliance: Acceptable types of evidence are the following;
 - a. Current UL (GGG) certification.
 - b. Current SCS (CPD) Floorscore certification.
 - c. Current SCS (CPD) Indoor Advantage Gold certification.
 - d. Current listing in CHPS (HPPD) as a low-emitting product.
 - e. Current CRI (GLP) certification.
 - f. Test report showing compliance and stating exposure scenario used.
 3. Product data submittal showing VOC content is NOT acceptable evidence.
 4. Manufacturer's certification without test report by independent agency is NOT acceptable evidence.
- B. Composite Wood Emissions Standard: CARB (ATCM) for ultra-low emitting formaldehyde (ULEF) resins.
1. Evidence of Compliance: Acceptable types of evidence are:
 - a. Current SCS "No Added Formaldehyde (NAF)" certification; www.scs-certified.com.
 - b. Report of laboratory testing performed in accordance with requirements.
 - c. Published product data showing compliance with requirements.
 - d. Certification by manufacturer that product complies with requirements.
- C. Furnishings Emissions Standard and Test Method: BIFMA e3 Sections 7.6.1 and 7.6.2, tested in accordance with BIFMA M7.1.
1. Evidence of Compliance: Test report showing compliance and stating exposure scenario used.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. All Products: Comply with the most stringent of Federal, State, and local requirements, or these Specifications.

- B. Indoor-Emissions-Restricted Products: Comply with Indoor Emissions Standard and Test Method, except for:
1. Composite Wood, Wood Fiber, and Wood Chip Products: Comply with Composite Wood Emissions Standard or contain no added formaldehyde resins.
 2. Furnishings: Comply with Furnishings Emissions Standard and Test Method.
 3. Inherently Non-Emitting Materials.

PART 3 – EXECUTION (NOT USED)

END OF SECTION 016116

SECTION 017000 - EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Survey Work: Submit name, address, and telephone number of Surveyor before starting survey work.
- B. Demolition Plan: Submit Demolition Plan as specified by OSHA and local authorities.
- C. Cutting and Patching: Submit written request in advance of cutting or alteration that affects:
 - 1. Structural integrity of any element of Project.
 - 2. Integrity of weather exposed or moisture resistant element.
 - 3. Efficiency, maintenance, or safety of any operational element.
- D. Project Record Documents: Accurately record actual locations of capped and active utilities.

1.2 PROJECT CONDITIONS

- A. Use of explosives is not permitted.
- B. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

PART 2 - PRODUCTS

2.1 PATCHING MATERIALS

- A. New Materials: As specified in product sections; match existing products and work for patching and extending work.
- B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.

PART 3 - EXECUTION

3.1 LAYING OUT THE WORK

- A. Verify locations of survey control points prior to starting Work.
- B. Promptly notify Architect of any discrepancies discovered.

3.2 GENERAL INSTALLATION REQUIREMENTS

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

3.3 CUTTING AND PATCHING

- A. Whenever possible, execute the work by methods that avoid cutting or patching.
- B. Perform whatever cutting and patching is necessary to:
 - 1. Complete the work.
 - 2. Fit products together to integrate with other work.
 - 3. Provide openings for penetration of mechanical, electrical, and other services.
 - 4. Match work that has been cut to adjacent work.
 - 5. Repair areas adjacent to cuts to required condition.
 - 6. Repair new work damaged by subsequent work.
 - 7. Remove samples of installed work for testing when requested.
 - 8. Remove and replace defective and non-complying work.
- C. Patching: Finish patched surfaces to match the finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish the entire unit.

3.4 PROGRESS CLEANING

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

3.5 PROTECTION OF INSTALLED WORK

- A. Protect installed Work from damage by construction operations.
- B. Provide special protection where specified in individual Specification Sections.
- C. Remove protective coverings when no longer needed; reuse or recycle coverings, if possible.

3.6 FINAL CLEANING

- A. Use cleaning materials that are nonhazardous.
- B. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains, and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
- C. Remove all labels that are not permanent. Do not paint or otherwise cover fire-test labels or nameplates on mechanical and electrical equipment.
- D. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.

3.7 CLOSEOUT PROCEDURES

- A. Make submittals that are required by governing or other authorities.
- B. Notify Architect when Work is considered ready for Architect's Substantial Completion inspection.
- C. Submit written certification containing Contractor's Correction Punch List, that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Architect's Substantial Completion inspection.
- D. Notify Architect when Work is considered finally complete and ready for Architect's Substantial Completion final inspection.
- E. Complete items of work determined by Architect listed in executed Certificate of Substantial Completion.
- F. The Contractor shall reimburse the Owner for Architect's additional services and/or attorney's fees made necessary by the Contractor's failure to finally complete the Work within 45 days after the date specified in the Contract Documents for Project Substantial Completion.
- G. 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 the Project and authorized to conclude matters relating to the Work.
 - 3. Agenda: Discuss items of significance that could affect or delay Project closeout.
 - 4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

END OF SECTION 017000

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 – GENERAL

1.1 WASTE MANAGEMENT REQUIREMENTS

- A. Owner requires that this Project generate the least amount of trash and waste possible.
- B. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 WASTE MANAGEMENT PLAN IMPLEMENTATION

- A. Manager: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan.
- B. Communication: Distribute copies of the Waste Management Plan to Jobsite Foreman, each subcontractor, Owner, and Architect.
- C. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return, and trash disposal, for use by all contractors and installers.
- D. Hazardous Wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.
- E. Recycling: Separate, store, protect, and handle at the site identified recyclable waste products in order to prevent contamination of materials and to maximize recyclability of identified materials. Arrange for timely pickups from the site or deliveries to recycling facility in order to prevent contamination of recyclable materials.
- F. Reuse of Materials On-Site: Set aside, sort, and protect separated products in preparation for reuse.
- G. Salvage: Set aside, sort, and protect products to be salvaged for reuse off-site.

END OF SECTION 017419

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SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for Contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final Completion procedures.
 - 3. Warranties.
 - 4. Final cleaning.

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.
- C. 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.
- D. 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.
- E. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
- F. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Architect. Label with manufacturer's name and model number.
- G. 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 Architect's signature for receipt of submittals.
- H. Submit testing, adjusting, and balancing records.
- I. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- J. 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.
- K. Advise Owner of pending insurance changeover requirements.
- L. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
- M. Complete startup and testing of systems and equipment.

- N. Perform preventive maintenance on equipment used prior to Substantial Completion.
- O. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
- P. Advise Owner of changeover in utility services.
- Q. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
- R. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
- S. Complete final cleaning requirements.
- T. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- U. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to the date the Work will be completed and ready for final inspection and tests. On receipt of request, the Architect 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.
- V. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
- W. 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 012900 "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 shall 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 the date the Work will be completed and ready for final inspection and tests. On receipt of request, the Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
- C. 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.
- B. 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.
- C. Organize items applying to each space by major element, including categories for ceilings, individual walls, floors, equipment, and building systems.
- D. Include the following information at the top of each page:
 - 1. Project name.
 - 2. Date.
 - 3. Name of Architect.
 - 4. Name of Contractor.
 - 5. Page number.

1.10 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Architect for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.
- B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
- D. 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.

- E. Submit on digital media acceptable to Architect by uploading to web-based project software site or by email to Architect.
- F. Provide additional copies of each warranty to include in the 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.
- B. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
- C. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:
 - 1. Clean Project site of rubbish, waste material, litter, and other foreign substances.
 - 2. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - 3. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.
 - 4. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - 5. Remove snow and ice to provide safe access to buildings.
 - 6. Clean exposed exterior and interior hard-surface 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.
 - 7. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - 8. Clean flooring, removing debris, dirt, and staining; clean according to manufacturer's recommendations.
 - 9. Vacuum and mop concrete.

10. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
 11. 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.
 12. Remove labels that are not permanent.
 13. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 14. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 15. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 16. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
 17. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.
 18. Clean strainers.
 19. Leave Project clean and ready for occupancy.
- W. Pest Control: Comply with pest control requirements in Section 015000 "Temporary Facilities and Controls." Prepare written report.
- X. Construction Waste Disposal: Comply with waste-disposal requirements in Section 017419 "Construction Waste Management and Disposal."

3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations required by Section 017300 "Execution" before requesting inspection for determination of Substantial Completion.

END OF SECTION 017700

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SECTION 017800 - CLOSEOUT SUBMITTALS

PART 1 – GENERAL

1.1 SUBMITTALS

- A. Project Record Documents: Submit documents to Architect with claim for final Application for Payment.
- B. Operation and Maintenance Data: Submit 2 copies of preliminary draft or proposed formats and outlines of contents before start of Work. The Architect will review the draft and return 1 copy with comments.
- C. Warranties and Bonds: For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PROJECT RECORD DOCUMENTS

- A. Maintain on site 1 set of the following Record Documents; record actual revisions to the Work:
 - 1. Drawings.
 - 2. Addenda.
 - 3. Change Orders and other modifications to the Contract.

3.2 OPERATION AND MAINTENANCE DATA

- A. Source Data: For each product or system, list names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
- B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as Maintenance Drawings.

3.3 OPERATION AND MAINTENANCE DATA FOR MATERIALS AND FINISHES

- A. For Each Product, Applied Material, and Finish.

- B. Instructions for Care and Maintenance: Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental cleaning agents and methods, and recommended schedule for cleaning and maintenance.

3.4 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

- A. For Each Item of Equipment and Each System:
 - 1. Description of unit or system, and component parts.
 - 2. Identify function, normal operating characteristics, and limiting conditions.
 - 3. Include performance curves, with engineering data and tests.
 - 4. Complete nomenclature and model number of replaceable parts.
- B. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shutdown, and emergency instructions. Include summer, winter, and any special operating instructions.
- C. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and troubleshooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

3.5 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

- A. Assemble operation and maintenance data into durable manuals for Owner's personnel use, with data arranged in the same sequence as, and identified by, the specification sections.
- B. Where systems involve more than 1 Specification Section, provide separate tabbed divider for each system.
- C. Binders: Commercial quality, 8-1/2- by 11-inch 3-D side ring binders with durable plastic covers; 2-inch maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
- D. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.

3.6 WARRANTIES AND BONDS

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

END OF SECTION 017800

SECTION 017832 - 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. Emergency manuals.
 - 3. Systems and equipment operation manuals.
 - 4. Systems and equipment maintenance manuals.
 - 5. Product 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 Commissioning Authority 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 by email to Architect. Enable reviewer comments on draft submittals.
 - 2. Initial Manual Submittal: Submit a draft copy of each manual at least 30 days before commencing demonstration and training. Architect and Commissioning Authority will comment on whether general scope and content of manual are acceptable.

3. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect and Commissioning Authority will return copy with comments.
4. Correct or revise each manual to comply with Architect's and Commissioning Authority's comments. Submit copies of each corrected manual within 15 days of receipt of Architect's and Commissioning Authority's comments and prior to commencing demonstration and training.
5. Comply with Section 017700 "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 the 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.
6. Name and contact information for Construction Manager.
7. Name and contact information for Architect.
8. Name and contact information for Commissioning Authority.
9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
10. Cross-reference to related systems in other operation and maintenance manuals.

- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 - 1. If operation or maintenance documentation requires more than 1 volume to accommodate data, include a 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 1 system into a single binder.
- 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 EMERGENCY MANUALS

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Content: Organize manual into a separate section for each of the following:
 - 1. Type of emergency.
 - 2. Emergency instructions.
 - 3. Emergency procedures.
- C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
 - 1. Fire.
 - 2. Flood.
 - 3. Gas leak.
 - 4. Water leak.
 - 5. Power failure.

6. Water outage.
 7. System, subsystem, or equipment failure.
 8. Chemical release or spill.
- D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- E. Emergency Procedures: Include the following, as applicable:
1. Instructions on stopping.
 2. Shutdown instructions for each type of emergency.
 3. Operating instructions for conditions outside normal operating limits.
 4. Required sequences for electric or electronic systems.
 5. Special operating instructions and procedures.

1.9 SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating the 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. Operating logs.
 6. Wiring diagrams.
 7. Control diagrams.
 8. Piped system diagrams.
 9. Precautions against improper use.
 10. License requirements including inspection and renewal dates.
- 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.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

D. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

1. Piped Systems: Diagram piping as installed and identify color coding where required for identification.

1.10 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 1 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.
 3. 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.
 4. Maintenance Service Contracts: Include copies of maintenance agreements with the name and telephone number of service agent.
 5. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 6. Include procedures to follow and required notifications for warranty claims.
 7. 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.
 8. Do not use original Project Record Documents as part of maintenance manuals.

1.11 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. Inspection procedures.
 - 2. Types of cleaning agents to be used and methods of cleaning.
 - 3. List of cleaning agents and methods of cleaning detrimental to product.
 - 4. Schedule for routine cleaning and maintenance.
 - 5. Repair instructions.
- 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 017832

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SECTION 017839 - 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

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

1.3 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit copies of Record Drawings as follows:
 - a. Initial Submittal:
 - 1) Submit 1 paper copy set of marked-up Record Prints.
 - 2) Submit PDF electronic files of scanned Record Prints and 1 set of file prints.
 - 3) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal:
 - 1) Submit 1 paper copy set of marked-up Record Prints.
 - 2) Submit PDF electronic files of scanned Record Prints and 1 set of file prints.
 - 3) Print each drawing, whether or not changes and additional information were recorded.
- B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and Contract modifications.
- C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.
 - 1. Where record Product Data is required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

- D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.
- E. Reports: Submit written report weekly indicating items incorporated into Project Record Documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

1.4 RECORD DRAWINGS

- A. Record Prints: Maintain 1 set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
 - 1. Preparation: Mark Record Prints to show the actual installation, where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding 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 acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross-reference Record Prints to corresponding photographic documentation.
 - 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following Architect's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
 - 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up Record Prints.
 - 4. Mark Record Prints with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.

5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up Record Prints with Architect. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
1. Format: Annotated PDF electronic file with comment function enabled.
 2. Incorporate changes and additional information previously marked on Record Prints. Delete, redraw, and add details and notations where applicable.
 3. Refer instances of uncertainty to Architect for resolution.
- C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize Record Prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Format: Annotated PDF electronic file with comment function enabled.
 3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
 4. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Architect.
 - e. Name of Contractor.

1.5 RECORD SPECIFICATIONS

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

1.6 RECORD PRODUCT DATA

- A. Recording: Maintain 1 copy of each submittal during the construction period for Project Record Document purposes. Post changes and revisions to Project Record Documents as they occur; do not wait until end of Project.
- B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Include significant changes to the product delivered to Project site and changes in manufacturer's written instructions for installation.
 - 3. Note related Change Orders, Record Specifications, and Record Drawings where applicable.
- C. Format: Submit Record Product Data as an annotated PDF electronic file and scanned PDF electronic files of marked-up paper copy of Product Data.
 - 1. Include Record Product Data directory organized by Specification Section number and title, electronically linked to each item of Record Product Data.

1.7 MISCELLANEOUS RECORD SUBMITTALS

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

1.8 MAINTENANCE OF RECORD DOCUMENTS

- A. Maintenance of Record Documents: Store Record Documents 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.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION 017839

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SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 – GENERAL

1.1 SUBMITTALS

- A. Draft Training Plans: Owner will designate personnel to be trained; tailor training to needs and skill-level of attendees.
- B. Training Manuals: Provide training manual for each attendee; allow for minimum of 2 attendees per training session.

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.
- B. Demonstrations conducted during Functional Testing need not be repeated unless Owner personnel training is specified.
- C. Demonstration may be combined with Owner personnel training, if applicable.
- D. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.
- E. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.

3.2 TRAINING - GENERAL

- A. The Commissioning Authority will prepare the training plan based on draft plans submitted.
- B. Conduct training on-site unless otherwise indicated.
- C. Owner will provide classroom and seating at no cost to Contractor.
- D. Do not start training until Functional Testing is complete, unless otherwise specified or approved by the Commissioning Authority.
- E. Provide training in a minimum of 2-hour segments.

- F. The Commissioning Authority is responsible for determining that the training was satisfactorily completed and will provide approval forms.
- G. Training schedule will be subject to availability of Owner's personnel to be trained; reschedule 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.

END OF SECTION 017900

SECTION 024100 – DEMOLITION

PART 1 – GENERAL (NOT USED)

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.
 - 2. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 - 3. Provide, erect, and maintain temporary barriers and security devices.

3.2 EXISTING UTILITIES

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

3.3 DEBRIS AND WASTE REMOVAL

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

END OF SECTION 024100

SECTION 032000 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel reinforcement bars.
2. Welded-wire reinforcement.

B. Related Requirements:

1. Section 033816 "Unbonded Post-Tensioned Concrete" for reinforcing related to post-tensioned concrete.
2. Section 034100 "Precast Structural Concrete" for reinforcing used in precast structural concrete.
3. Section 034500 "Precast Architectural Concrete" for reinforcing used in precast architectural concrete.
4. Section 321313 "Concrete Paving" for reinforcing related to concrete pavement and walks.
5. Section 321316 "Decorative Concrete Paving" for reinforcing related to decorative concrete pavement and walks.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Each type of steel reinforcement.
2. Bar supports.

B. Shop Drawings: Comply with ACI SP-066:

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, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.
3. For structural thermal break insulated connection system, indicate general configuration, insulation dimensions, tension bars, compression pads, shear bars, and dimensions.

C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.

1. Location of construction joints is subject to approval of Architect.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For testing and inspection agency.

B. Welding certificates.

1. Reinforcement To Be Welded: Welding procedure specification in accordance with AWS D1.4/D1.4M.

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

1. Epoxy-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."
2. Dual-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."

D. Material Test Reports: For the following, from a qualified testing agency:

1. Steel Reinforcement:
 - a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.

E. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

- B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

1.5 DELIVERY, STORAGE, AND HANDLING

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

1. Store reinforcement to avoid contact with earth.
2. Do not allow epoxy-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
3. Do not allow dual-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
4. Do not allow stainless steel reinforcement to come into contact with uncoated reinforcement.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A615M, **Grade 60 Grade 75**, deformed.

- B. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

2.3 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. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and 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.

2.4 FABRICATING REINFORCEMENT

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

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.

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.
 - 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 318**.

- E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- F. Splices: Lap splices as indicated on Drawings.
 - 1. Bars indicated to be continuous, and all vertical bars to be lapped not less than 36 bar diameters at splices, or **24 inches**, whichever is greater.
 - 2. Stagger splices in accordance with **ACI 318**.
 - 3. Weld reinforcing bars in accordance with AWS D1.4/D 1.4M, where indicated on Drawings.
- G. Install welded-wire reinforcement in longest practicable lengths.
 - 1. Support welded-wire reinforcement in accordance with CRSI "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**] to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. Inspections:
 - 1. Steel-reinforcement placement.

2. Steel-reinforcement welding.
- D. 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 032000

SECTION 033000 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete standards.
2. Concrete materials.
3. Admixtures.
4. Placement procedures
5. Finishes
6. Vapor retarders.
7. Curing materials.
8. Accessories.
9. Repair materials.
10. Concrete mixture materials.
11. Concrete mixture class types.
12. Concrete mixing.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
2. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
3. Section 033300 "Architectural Concrete" for general building applications of specially finished formed concrete.
4. Section 033543 "Polished Concrete Finishing" for concrete floors scheduled to receive a polished concrete finish.
5. Section 035300 "Concrete Topping" for concrete floor toppings.
6. Section 312000 "Earth Moving" for drainage fill under slabs-on-ground.
7. Section 321313 "Concrete Paving" for concrete pavement and walks.
8. Section 321316 "Decorative Concrete Paving" for decorative concrete pavement and walks.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement or blended hydraulic cement alone or in combination with 1 or more of the following:

1. Fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. Water/Cementitious Materials (w/cm) Ratio: The ratio by weight of mixing water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for inspections and acceptance testing of concrete at Project site.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete Subcontractor.
 - e. Special concrete finish Subcontractor.
2. Review the Following:
 - a. Special inspection and testing and inspecting agency procedures for field quality control.
 - b. Construction joints, control joints, isolation joints, and joint-filler strips.
 - c. Semirigid joint fillers.
 - d. Vapor-retarder installation.
 - e. Anchor rod and anchorage device installation tolerances.
 - f. Cold- and hot-weather concreting procedures.
 - g. Concrete finishes and finishing.
 - h. Curing procedures.
 - i. Forms and form-removal limitations.
 - j. Shoring and reshoring procedures.
 - k. Methods for achieving specified floor and slab flatness and levelness.
 - l. Floor and slab flatness and levelness measurements.
 - m. Concrete repair procedures.
 - n. Concrete protection.
 - o. Initial curing of standard-cured and field curing of field-cured test cylinders (ASTM C31/C31M.)
 - p. Protection of field-cured field-test cylinders.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Silica fume.
5. Aggregates.
6. Admixtures: 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
7. Vapor retarders.
8. Curing materials.

- a. Include documentation from color pigment manufacturer, indicating that proposed methods of curing are recommended by color pigment manufacturer.
9. Joint fillers.
10. Repair materials.
- B. Design Mixtures: For each concrete mixture, include the following:
 1. Mixture identification.
 2. Minimum 28-day compressive strength.
 3. Durability exposure class.
 4. Maximum w/cm.
 5. Calculated equilibrium unit weight, for lightweight concrete.
 6. Slump limit.
 7. Air content.
 8. Nominal maximum aggregate size.
 9. Steel-fiber reinforcement content.
 10. Synthetic microfiber content.
 11. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
 12. Include manufacturer's certification that permeability-reducing admixture is compatible with mix design.
 13. Include certification that dosage rate for permeability-reducing admixture matches dosage rate used in performance compliance test.
 14. Intended placement method.
 15. Submit adjustments to design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant changes.
- C. Shop Drawings:
 1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - a. Location of construction joints is subject to approval of the Architect.
 2. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For the following:
 1. Installer: Include copies of applicable ACI certificates.
 2. Ready-mixed concrete manufacturer.
 3. Testing Agency: Include documentation indicating compliance with ASTM E329 or ASTM C1077 and copies of applicable ACI certificates for testing technicians or ACI Concrete Construction Special Inspector - MH, ASCC.

B. Material Certificates: For each of the following:

1. Cementitious materials.
2. Admixtures.
3. Curing compounds.
4. Bonding agents.
5. Adhesives.
6. Vapor retarders.
7. Semirigid joint filler.
8. Joint-filler strips.
9. Repair materials.

C. Material Test Reports: For the following:

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Silica fume.
5. Natural or other pozzolans.
6. Aggregates.
7. Admixtures:

- a. Permeability-reducing Admixture: Include independent test reports, indicating compliance with specified requirements, including dosage rate used in test.

D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances.

E. Research Reports:

1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
2. For sheet vapor retarder/termite barrier, showing compliance with ICC's Acceptance Criteria AC380.

F. Preconstruction Test Reports: For each mix design.

G. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified Installer who employs Project personnel qualified as an ACI-certified Concrete Flatwork Associate and Concrete Flatwork Finisher and a supervisor who is a certified ACI Advanced Concrete Flatwork Finisher/Technician or an ACI Concrete Flatwork Finisher with experience installing and finishing concrete.

1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.

- B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
 - 1. Manufacturer's production facilities and delivery vehicles certified in accordance with NRMCA's certification requirements or equivalent approval by a State DOT.
- C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.
 - 1. Personnel performing laboratory tests to be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Level 1. Testing agency laboratory supervisor tests to be an ACI-certified Concrete Laboratory Testing Technician, Level 2.
- D. Field Quality-Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
 - 1. Personnel conducting field tests on plastic concrete properties are to be qualified as an ACI Concrete Field-Testing Technician, Grade 1, in accordance with policies from ACI CPP 610.1 or an equivalent certification program.

1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.
 - 1. Include the following information in each test report:
 - a. Admixture dosage rates.
 - b. Slump.
 - c. Air content.
 - d. 7-day compressive strength.
 - e. 28-day compressive strength.
 - f. Evaluation of permeability-reducing admixtures.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with ASTM C94/C94M and ACI 301.

1.9 FIELD CONDITIONS

A. Cold Weather Placement: Comply with ACI 301 and ACI 306.1 as follows:

1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
2. When average high and low temperature is expected to fall below 40 degrees F for 3 successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place concrete in contact with surfaces less than 35 degrees F, other than reinforcing steel.
5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:

1. Maintain concrete temperature at time of discharge to not exceed 95 degrees F.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCRETE STANDARDS

A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 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. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, Type I, Type II, Type III, Type V, gray, white.
2. Blended Hydraulic Cement: ASTM C595/C595M, Type IS, Portland blast-furnace slag, Type IP, Portland-pozzolan, Type IL, Portland-limestone, Type IT, ternary-blended cement.
3. Performance-Based Hydraulic Cement: ASTM C1157/C1157M: Type GU, general use, Type HE, high early strength, Type MS, moderate sulfate resistance, Type HS, high sulfate resistance, Type MH, moderate heat of hydration, Type LH, low heat of hydration.
4. Pozzolans: ASTM C618, Class C, F, or N.
5. Fly Ash: ASTM C618, Class C or F.
6. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
7. Ground Glass Pozzolan: ASTM C1866/C1866M, Type GS or GE.
8. Silica Fume: ASTM C1240, amorphous silica.

C. Normal-Weight Aggregates:

1. Coarse Aggregate: ASTM C33/C33M, Class 3S, Class 3M, Class 1N.
2. Maximum Coarse Aggregate Size: 1-1/2 inches, 1-inch, 3/4-inch.
3. Fine Aggregate: ASTM C33/C33M. Free of materials with deleterious reactivity to alkali in cement.
4. Recycled Aggregate: Provide documentation of characteristics of recycled aggregate and mechanical properties and durability of proposed concrete, which incorporates recycled aggregate to conform to applicable requirements for the class of concrete.
5. Alkali-Silica Reaction: Comply with 1 of the following for each aggregate used:
 - a. Expansion Result of Aggregate: Not more than 0.04 percent at 1 year when tested in accordance with ASTM C1293.
 - b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567. Do not use this option with fly ash with an alkali content greater than 4.0 percent. Submit supporting data for each aggregate showing expansion in excess of 0.10 percent when tested in accordance with ASTM C1260.
 - c. Alkali Content in Concrete: Not to exceed 4 lb./cu. yd. for aggregate with expansion greater than or equal to 0.04 percent and less than 0.12 percent or 3 lb./cu. yd. for aggregate with expansion greater than or equal to 0.12 percent and less than 0.24 percent. Test aggregate reactivity in accordance with ASTM C1293. Calculate alkali content of concrete in accordance with ACI 301. Do not use this option with natural pozzolan or fly ash that has a calcium oxide content greater than 18 percent or an alkali content greater than 4.0 percent; or for an aggregate with expansion at 1 year greater than or equal to 0.24 percent when tested in accordance with ASTM C1293.

- D. Lightweight Aggregate: ASTM C330/C330M, 1 inch, 3/4-inch, 1/2-inch, 3/8-inch, nominal maximum aggregate size.
 - 1. Limit lightweight aggregate for internal curing to prewetted lightweight fine aggregate in accordance with ASTM C1761/C1761M.
- E. Ground Calcium Carbonate or Aggregate Mineral Filler: ASTM C1797. Unless otherwise permitted, do not use mineral filler derived from carbonate sources in concrete for members assigned to Exposure Class S1, S2, or S3.

2.3 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that 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 2 edges and 1 side for a tight fit.

2.4 ADMIXTURES

- A. Air-Entraining 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. Water-Reducing Admixture: ASTM C494/C494M, Type A.
 - 2. Retarding Admixture: ASTM C494/C494M, Type B.
 - 3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
 - 5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
 - 6. Admixtures with special properties, with documentation of claimed performance enhancement, ASTM C494/C494M, Type S.
 - 7. Set-Accelerating Corrosion-Inhibiting Admixture: ASTM C1582/C1582M.
 - a. Manufacturers: Subject to compliance with requirements, provide products by 1 of the following:
 - 1) Euclid Chemical Company (The); a subsidiary of RPM International, Inc.
 - 2) GCP Applied Technologies Inc.
 - 3) MAPEI Corporation.
 - 4) Master Builders Solutions; brand of MBCC Group.
 - 5) Sika Corporation.

8. Permeability-Reducing Admixture: ASTM C494/C494M, Type S, hydrophilic, permeability-reducing crystalline or colloidal nano-silica admixture, capable of reducing water absorption of concrete exposed to hydrostatic pressure (PRAH).
 - a. Manufacturers: Subject to compliance with requirements, provide products by 1 of the following:
 - 1) AQUAFIN, Inc.
 - 2) AVECS LLC.
 - 3) Barrier One, Inc.
 - 4) Bone Dry Products, Inc.
 - 5) ISE Logik Industries, Inc.
 - 6) Kryton International, Inc.
 - 7) Master Builders Solutions; brand of MBCC Group.
 - 8) Penetron International, LTD.
 - 9) Xypex Chemical Corporation.
 - b. Permeability: No leakage when tested in accordance with U.S. Army Corps of Engineers CRD C48 at a hydraulic pressure of 200 psi for 14 days.
9. Moisture-Vapor-Reducing Admixture: ASTM C494/C494M, Type S, hydrophilic, moisture-vapor-reducing, capable of reducing water absorption in and moisture-vapor emission from concrete (MVRA).
 - a. Manufacturers: Subject to compliance with requirements, provide products by 1 of the following:
 - 1) AQUAFIN, Inc.
 - 2) AVECS LLC.
 - 3) Barrier One, Inc.
 - 4) Concure Products Inc.
 - 5) ISE Logik Industries, Inc.
 - 6) Kryton International, Inc.
 - 7) Master Builders Solutions; brand of MBCC Group.
 - 8) Moxie International.
 - 9) Penetron International, LTD.
 - 10) Xypex Chemical Corporation.
- C. Mixing Water for Concrete Mixtures and Water Used to Make Ice: ASTM C1602/C1602M, potable. Include documentation of compliance with limits for alkalis, sulfates, chlorides, or solids content of mixing water from Table 2 in ASTM C1602/C1602M.

2.5 VAPOR RETARDERS

- A. Sheet Vapor Retarder, Class A: ASTM E1745, Class A; not less than 15 mils thick. Include manufacturer's recommended thickness and adhesive or pressure-sensitive tape.
- a. Manufacturers: Subject to compliance with requirements, provide products by 1 of the following:
 - 1) Stego industries, LLC.
 - 2) W.R. Meadows, Inc.
- B. Sheet Vapor Retarder/Termite Barrier: ASTM E1745, Class A, except with maximum water-vapor permeance of 0.03 perms; complying with ICC Acceptance Criteria AC380. Include manufacturer's recommended adhesive or pressure-sensitive tape.
- 1. Manufacturers: Subject to compliance with requirements, provide products by 1 of the following:
 - a. Polyguard Products, Inc.
 - b. Or approved equal.
 - 2. Low-Temperature Flexibility: Pass at minus 15 degrees F; ASTM D146/D146M.
 - 3. Puncture Resistance: 224 lb/f minimum; ASTM E154/E154M.
 - 4. Water Absorption: 0.1 percent weight-gain maximum after 48-hour immersion at 70 degrees F; ASTM D570.
 - 5. Hydrostatic-Head Resistance: 231 ft. minimum; ASTM D5385/D5385M.
- C. Bituminous Vapor Retarder: ASTM E1993/E1993M, 110-mil-thick, semiflexible, 7-ply sheet membrane, consisting of reinforced core and carrier sheet with fortified asphalt layers, protective weather coating, and removable plastic release liner. Furnish manufacturer's accessories, including bonding asphalt, pointing mastics, and self-adhering joint tape.
- 1. Manufacturers: Subject to compliance with requirements, provide products by 1 of the following:
 - a. W.R. Meadows, Inc.
 - b. Or Approved equal.
 - 2. Water-Vapor Permeance: 0.0011 grains/h x square feet x inches Hg when tested in accordance with ASTM E154/E154M.
 - 3. Tensile Strength: 156 lbf/inch when tested in accordance with ASTM E154/E154M.
 - 4. Puncture Resistance: 140 lbf when tested in accordance with ASTM E154/E154M.

2.6 CURING MATERIALS

- A. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.
 - 1. Color:
 - a. Ambient Temperature Below 50 degrees F: Black.
 - b. Ambient Temperature between 50 and 85 degrees F: Any color.
 - c. Ambient Temperature Above 85 degrees F (29 degrees C): White.
- B. Water: Potable water that does not cause staining of the surface.
- C. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.
 - 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. Dayton Superior Corporation.
 - b. Euclid Chemical Company (The); an RPM company.
 - c. SpecChem, LLC.
- D. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.
 - 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. Dayton Superior Corporation.
 - b. Euclid Chemical Company (The); an RPM company.
 - c. SpecChem, LLC.

2.7 ACCESSORIES

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork.
- B. Semirigid Joint Filler: 2-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80, aromatic polyurea with a Type A shore durometer hardness range of 90 to 95 in accordance with ASTM D2240.
- C. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- D. Floor Slab Protective Covering: 8-foot-wide cellulose fabric.

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. McTech Group, Inc.

2.8 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 4,100 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 5,000 psi at 28 days when tested in accordance with ASTM C109/C109M.

2.9 CONCRETE MIXTURE MATERIALS

- 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, in accordance with ACI 301.

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

- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland or hydraulic cement in concrete assigned to Exposure Class F3 as follows:

1. Fly Ash or Other Pozzolans: 25 percent by mass.
 2. Slag Cement: 50 percent by mass.
 3. Silica Fume: 10 percent by mass.

4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

1. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
2. Use permeability-reducing admixture in concrete mixtures where indicated.
3. Use water-reducing admixture in concrete, as required, for placement and workability.
4. Use water-reducing admixture in pumped concrete, and concrete with a w/cm below 0.50.

2.10 CONCRETE MIXTURE CLASS TYPES

A. Class A: Normal-weight concrete used for footings, grade beams, and tie beams.

1. Exposure Class: ACI 318 Class F2.
2. Minimum Compressive Strength: 4,000 psi at 28 days.
3. Maximum Dry Shrinkage in Accordance with ASTM C157: 0.05 percent
4. Slump Limit: 8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site.
5. Air Content:
 - a. Exposure Classes F2 and F3: 6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.
6. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cementitious materials.

B. Class B: Normal-weight concrete used for foundation walls.

1. Exposure Class: ACI 318 Class F2.
2. Minimum Compressive Strength: 4,000 psi at 28 days.
3. Maximum Dry Shrinkage in Accordance with ASTM C157: 0.05 percent
4. Slump Limit: 8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site.
5. Air Content:
 - a. Exposure Classes F2 and F3: 6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.
6. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

C. Class C: Normal-weight concrete used for interior slabs-on-ground.

1. Exposure Class: ACI 318 Class C0.
2. Minimum Compressive Strength: 4,000 psi at 28 days.
3. Maximum Dry Shrinkage in Accordance with ASTM C157: 0.05percent
4. Minimum Cementitious Materials Content: 540 lbs./cu. yd.
5. Slump Limit: 8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site.
6. Air Content: Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
7. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

D. Class J: Normal-weight concrete used for exterior retaining walls.

1. Exposure Class: To be determined by Civil engineer.
2. Minimum Compressive Strength: 4,000 psi at 28 days.
3. Maximum Dry Shrinkage in Accordance with ASTM C157: 0.05 percent
4. Minimum Cementitious Materials Content: 540 lbs./cu. yd.
5. Slump Limit: 8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at Project site.
6. Air Content: Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
7. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

2.11 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M and furnish batch ticket information.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Before placing concrete, verify that installation of concrete forms, accessories, reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:
 - 1. Daily access to the Work.
 - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 - 3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
 - 4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 INSTALLATION OF EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.
 - 1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
 - 3. Install reglets to receive waterproofing and through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3.4 INSTALLATION OF VAPOR RETARDERS

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.
 - 1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
 - 2. Face laps away from exposed direction of concrete pour.
 - 3. Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.
 - 4. Lap joints 6 inches and seal with manufacturer's recommended tape.
 - 5. 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.
 - 6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
 - 7. Protect vapor retarder during placement of reinforcement and concrete.
 - a. Repair damaged areas by patching with vapor retarder material, overlapping damaged area by 6 inches on all sides and sealing to vapor retarder.
- B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder in accordance with manufacturer's written instructions.

3.5 INSTALLATION OF CAST-IN-PLACE CONCRETE

- A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
 - 1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
 - 2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.
- B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.
- C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but do not exceed the permitted amount indicated on the concrete delivery ticket.
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not exceeding the permitted amount indicated on the concrete delivery ticket.
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- E. Deposit concrete continuously in 1 layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.
 - 1. If a section cannot be placed continuously, provide construction joints as indicated.
 - 2. Deposit concrete to avoid segregation.
 - 3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
 - 4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.
 - a. Do not use vibrators to transport concrete inside forms.
 - b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
 - c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
 - d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Do not place concrete floors and slabs in a checkerboard sequence.

2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Maintain reinforcement in position on chairs during concrete placement.
4. Screed slab surface with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.6 INSTALLATION OF JOINTS

- A. Construct joints true to line, with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.
 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. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
 4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 6. Space vertical joints in walls 20 feet maximum. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.
 7. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least 1/4 of concrete thickness as follows:
 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.

- D. 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 1 length is required, lace or clip sections together.
- E. Dowel Plates: Install dowel plates at joints where indicated on Drawings.

3.7 APPLICATION OF FINISHING FLOORS AND SLABS

- A. Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surface. Do not wet concrete surfaces.
- B. Scratch Finish:
 - 1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
 - 2. Use stiff brushes, brooms, or rakes to produce a profile depth of 1/4-inch in 1 direction.
 - 3. Apply scratch finish to surfaces to receive concrete floor toppings.
- C. Float Finish:
 - 1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
 - 2. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.
 - 3. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- D. Trowel Finish:
 - 1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
 - 2. Continue troweling passes and restraighen until surface is free of trowel marks and uniform in texture and appearance.
 - 3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - 4. Do not add water to concrete surface. Use of an approved finishing aid is acceptable.
 - 5. Do not apply troweled finish to concrete, which has a total air content greater than 3 percent.

6. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
7. Finish surfaces to the following tolerances, in accordance with ASTM E1155, for a randomly trafficked floor surface:
 - a. Slabs on Ground: Finish and measure surface so gap at any point between concrete surface and an unlevelled, freestanding, 10-ft-long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/8-inch.
 - b. Suspended Slabs: Finish and measure surface so gap at any point between concrete surface and an unlevelled, freestanding, 10-ft-long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/8-inch.
- E. Trowel and Fine-Broom Finish: First apply a trowel finish to surfaces. While concrete is still plastic, slightly scarify surface with a fine broom perpendicular to main traffic route.
 1. Coordinate required final finish with Architect before application.
 2. 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 locations indicated on Drawings.
 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with a fiber-bristle broom perpendicular to main traffic route.
 2. Coordinate required final finish with Architect before application.

3.8 APPLICATION OF FINISHING FORMED SURFACES

- A. As-Cast Surface Finishes:
 1. ACI 301 (ACI 301M) Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.
 - a. Patch voids larger than 1-1/2 inches wide or 1/2-inch deep.
 - b. Remove projections larger than 1 inch.
 - c. Tie holes do not require patching.
 - d. Surface Tolerance: ACI 117, Class D.
 - e. Apply concrete surfaces for metal lap pan deck formed surfaces and those surfaces that are buried or covered with subsequent installed surfaces.
 2. ACI 301 (ACI 301M) Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
 - a. Patch voids larger than 3/4-inch wide or 1/2-inch deep.
 - b. Remove projections larger than 1/4-inch.
 - c. Patch tie holes.
 - d. Surface Tolerance: ACI 117, Class B.
 - e. Locations: Apply to concrete surfaces exposed to public view.

3. ACI 301 (ACI 301M) Surface Finish SF-3.0:

- a. Patch voids larger than 3/4-inch wide or 1/2-inch-deep.
- b. Remove projections larger than 1/8-inch.
- c. Patch tie holes.
- d. Surface Tolerance: ACI 117 Class A.
- e. Locations: Apply to concrete surfaces to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.

B. Rubbed Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

1. Smooth-Rubbed Finish:

- a. Perform no later than 1 day after form removal.
- b. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture.
- c. If sufficient cement paste cannot be drawn from the concrete by the rubbing process, use a grout made from the same cementitious materials used in the in-place concrete.
- d. Maintain required patterns or variances as shown on Drawings or to match design reference sample and mockups.

2. Grout-Cleaned Rubbed Finish:

- a. Clean concrete surfaces after contiguous surfaces are completed and accessible.
- b. Do not clean concrete surfaces as Work progresses.
- c. Mix 1 part Portland cement to 1-1/2 parts fine sand, complying with ASTM C144 or ASTM C404, by volume, with sufficient water to produce a mixture with the consistency of thick paint. Add white Portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces.
- d. Wet concrete surfaces.
- e. 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.
- f. Maintain required patterns or variances as shown on Drawings or to match mockups.

C. Abrasive-Blast Finish: Apply the following to as-cast surface finishes where indicated on Drawings:

- 1. Perform abrasive blasting after compressive strength of concrete exceeds 2,000 psi.
- 2. Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at the same age.
- 3. Surface Continuity:
 - a. Perform abrasive-blast finishing as continuous operation, maintaining continuity of finish on each surface or area of Work.
 - b. Maintain required patterns or variances in depths of blast to match mockups.

4. Abrasive Blasting:
 - a. Abrasive-blast corners and edges of patterns carefully, using backup boards to maintain uniform corner and edge lines.
 - b. Determine type of nozzle pressure and blasting techniques required to match field sample.
 - c. Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match field sample, as follows:
 - 1) Brush Texture: Remove cement matrix to dull surface sheen and expose face of fine aggregate, with no significant reveal.
 - 2) Light Texture: Expose fine aggregate with occasional exposure of coarse aggregate and uniform color, with maximum reveal of 1/16-inch.
 - 3) Medium Texture: Generally, expose coarse aggregate with slight reveal and with a maximum reveal of 1/4-inch.
 - 4) Heavy Texture: Expose and reveal coarse aggregate to a maximum projection of 1/3 its diameter, with reveal range of 1/4- to 1/2-inch.
 - d. Maintain required patterns or variances in reveal projection to match mockups.
- D. High-Pressure Water-Jet Finish: Apply the following to as-cast surface finishes where indicated on Drawings:
 1. Perform high-pressure water jetting on concrete that has achieved a minimum compressive strength of 4,500 psi.
 2. Coordinate with formwork removal to ensure that surfaces to be high-pressure water-jet finished are treated at same age for uniform results.
 3. Surface Continuity: Perform high-pressure water-jet finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work.
 4. Maintain required patterns or variances in reveal projection to match mockups.
- E. Bushhammer Finish: Apply the following to as-cast surface finishes where indicated on Drawings:
 1. Perform bushhammer finish to concrete that has achieved a minimum compressive strength of 4,500 psi.
 2. Surface Continuity: Perform bushhammer finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work.
 3. Surface Cut:
 - a. Maintain required depth of cut and general aggregate exposure.
 - b. Use power tools with hammer attachments for large, flat surfaces, and use hand hammers for small areas, at corners and edges, and for restricted locations where power tools cannot reach.
 4. Remove impressions of formwork and form facings with exception of tie holes.
 5. Maintain required patterns or variances of cut as shown on Drawings or to match mock-ups.
 6. Maintain control of concrete chips, dust, and debris in each Work area, limiting migration of airborne materials and dust by use of tarpaulins, windbreaks, or similar devices.

3.9 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling In:

1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2. Mix, place, and cure concrete, as specified, to match color and texture with in-place construction exposed to view.
3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 4 inches high unless otherwise indicated on Drawings and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
3. Minimum Compressive Strength: 4,000 psi at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 12-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices.
 - a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - b. Cast anchor-bolt insert into bases.
 - c. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.10 APPLICATION OF CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Comply with ACI 301 for cold weather protection during curing.
2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
3. Maintain moisture loss no more than 0.2-lb./sq. ft. x h, calculated in accordance with ACI 305R, before and during finishing operations.

B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:

1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.

3. If forms remain during curing period, moist cure after loosening forms.
4. If removing forms before end of curing period, continue curing for remainder of curing period as follows:
 - a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
 - b. Continuous Sprinkling: Maintain concrete surface continuously wet.
 - c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
 - d. Water-Retention Sheetting Materials: Cover exposed concrete surfaces with sheetting material, taping, or lapping seams.
 - e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
 - 1) Recoat areas subject to heavy rainfall within 3 hours after initial application.
 - 2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:

1. Begin curing after finishing concrete.
2. Interior Concrete Floors:
 - a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:
 - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
 - a) Lap edges and ends of absorptive cover not less than 12 inches.
 - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than 7 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.
 - a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - b) Cure for not less than 7 days.
 - 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than 7 days, utilizing 1, or a combination of, the following not in cold weather:
 - a) Water.
 - b) Continuous water-fog spray.

- b. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:
 - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
 - a) Lap edges and ends of absorptive cover not less than 12 inches.
 - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than 7 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.
 - a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 - b) Cure for not less than 7 days.
 - 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than 7 days, utilizing 1, or a combination of, the following:
 - a) Water.
 - b) Continuous water-fog spray.
- c. Floors to Receive Polished Finish: Contractor has option of the following:
 - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
 - a) Lap edges and ends of absorptive cover not less than 12 inches.
 - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than 7 days.
 - 2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than 7 days, utilizing 1, or a combination of, the following:
 - a) Water.
 - b) Continuous water-fog spray.
- d. Floors To Receive Chemical Stain:
 - 1) As soon as concrete has sufficient set to permit application without marring concrete surface, install curing paper over entire area of floor.
 - 2) Install curing paper square to building lines, without wrinkles, and in a single length without end joints.

- 3) Butt sides of curing paper tight; do not overlap sides of curing paper.
- 4) Leave curing paper in place for duration of curing period, but not less than 28 days.

e. Floors to Receive Urethane Flooring:

- 1) As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
- 2) Rewet absorptive cover and cover immediately with polyethylene moisture-retaining cover with edges lapped 6 inches and sealed in place.
- 3) Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.
- 4) Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.

f. Floors to Receive Curing Compound:

- 1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
- 2) Recoat areas subjected to heavy rainfall within 3 hours after initial application.
- 3) Maintain continuity of coating, and repair damage during curing period.
- 4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

g. Floors to Receive Curing and Sealing Compound:

- 1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
- 2) Recoat areas subjected to heavy rainfall within 3 hours after initial application.
- 3) Repeat the process 24 hours later and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

3.11 TOLERANCES

- A. Comply with ACI 117.

3.12 APPLICATION OF LIQUID FLOOR TREATMENTS

- A. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller in accordance with manufacturer's written instructions.

3.13 INSTALLATION OF JOINT FILLING

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

3.14 INSTALLATION OF CONCRETE SURFACE REPAIRS

- A. Defective Concrete:
 - 1. Repair and patch defective areas when approved by Architect.
 - 2. Remove and replace concrete that cannot be repaired and patched to meet specification requirements.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part Portland cement to 2-1/2-parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles exceeding surface finish limits, honeycombs, rock pockets, fins and other projections on the surface exceeding surface finish limits, and stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2-inch in any dimension to solid concrete.
 - a. Limit cut depth to 3/4-inch.
 - b. Make edges of cuts perpendicular to concrete surface.
 - c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
 - d. Fill and compact with patching mortar before bonding agent has dried.
 - e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 - 2. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement, so that, when dry, patching mortar matches surrounding color.
 - a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
 - b. Compact mortar in place and match surrounding surface.

3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance, as determined by Architect.

D. Repairing Unformed Surfaces:

1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
 - a. Correct low and high areas.
 - b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01-inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width.
3. After concrete has cured for at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by adding patching mortar.
 - a. Finish repaired areas to blend into adjacent concrete.
5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.
 - a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 - b. Feather edges to match adjacent floor elevations.
6. Correct other low areas scheduled to remain exposed with repair topping.
 - a. Cut out low areas to ensure a minimum repair topping depth of 1/4-inch to match adjacent floor elevations.
 - b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
7. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.
 - a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
 - b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
 - c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
 - d. Place, compact, and finish to blend with adjacent finished concrete.
 - e. Cure in same manner as adjacent concrete.

8. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.
 - a. Groove tops of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
 - b. Dampen cleaned concrete surfaces and apply bonding agent.
 - c. Place patching mortar before bonding agent has dried.
 - d. Compact patching mortar and finish to match adjacent concrete.
 - e. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.15 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform field-tests and inspections and prepare testing and inspection reports.
- B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
 1. Testing agency to be responsible for providing curing facility for initial curing of strength test specimens on-site and verifying that test specimens are cured in accordance with standard curing requirements in ASTM C31/C31M.
 2. Testing agency to immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
 3. Testing agency to report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
 - a. Test reports to include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
 - 1) Project name.
 - 2) Name of testing agency.
 - 3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
 - 4) Name of concrete manufacturer.
 - 5) Date and time of inspection, sampling, and field testing.
 - 6) Date and time of concrete placement.
 - 7) Location in Work of concrete represented by samples.
 - 8) Date and time sample was obtained.
 - 9) Truck and batch ticket numbers.
 - 10) Design compressive strength at 28 days.
 - 11) Concrete mixture designation, proportions, and materials.
 - 12) Field-test results of fresh concrete, including slump or slump flow, air content, temperature, and density.

- 13) Information on storage and curing of samples at the Project site, including curing method and maximum and minimum temperatures during initial curing period.
 - 14) Type of fracture and compressive break strengths at 7 days and 28 days.
- C. Batch Tickets: For each load delivered, submit 3 copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.
- D. Inspections:
1. Headed bolts and studs.
 2. Verification of use of required design mixture.
 3. Concrete placement, including conveying and depositing.
 4. Curing procedures and maintenance of curing temperature.
 5. Verification of concrete strength before removal of shores and forms from beams and slabs.
 6. Batch Plant Inspections: On a random basis, as determined by Architect.
- E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M to be performed in accordance with the following requirements:
1. Testing Frequency: Obtain 1 composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus 1 set for each additional 150 cu. yd. or fraction thereof.
 - a. When frequency of testing provides fewer than 5 compressive-strength tests for each concrete mixture, testing is to be conducted from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
 2. Slump: ASTM C143/C143M:
 - a. One test at point of delivery for each composite sample, but not less than 1 test for each day's pour of each concrete mixture.
 - b. Perform additional tests as needed.
 3. Slump Flow: ASTM C1611/C1611M:
 - a. One test at point of delivery for each composite sample when strength test specimens are cast, but not less than 1 test for each day's pour of each concrete mixture.
 - b. Perform additional tests as needed.
 4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete:
 - a. One test for each composite sample when strength test specimens are cast, but not less than 1 test for each day's pour of each concrete mixture.

5. Concrete Temperature: ASTM C1064/C1064M:
 - a. One test hourly when air temperature is 40 degrees F and below or 80 degrees F and above, and 1 test for each composite sample when strength test specimens are cast.
6. Compression Test Specimens: ASTM C31/C31M:
 - a. Cast and laboratory cure five 4-inch by 8-inch cylindrical specimens for each composite sample.
7. Compressive-Strength Tests: ASTM C39/C39M.
 - a. Test 1 laboratory cured specimens at 7 days and 1 set of 2 specimens at 28 days.
 - b. A compressive-strength test to be the average compressive strength from a set of 2 specimens obtained from same composite sample and tested at age indicated.
8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor to evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
9. Strength of each concrete mixture will be satisfactory if every average of any 3 consecutive compressive-strength tests of standard cured cylinders equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5,000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5,000 psi.
10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole-basis for approval or rejection of concrete.
11. Additional Tests:
 - a. Testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
 - b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
 - 1) Acceptance criteria for concrete strength to be in accordance with ACI 301, Section 1.7.6.3.
12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

3.16 PROTECTION

A. Protect Concrete Surfaces as Follows:

1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.
8. Protect concrete surfaces scheduled to receive surface hardener or polished concrete finish using floor slab protective covering.

END OF SECTION 033000

DOCUMENT 033511 - CONCRETE FLOOR FINISHES

PART 1 – GENERAL

1.1 SUBMITTALS

- A. 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.

1.2 FIELD CONDITIONS

- A. Maintain light-level equivalent to a minimum 200W light source at 8 feet above the floor surface and over each 20-foot-square area of floor being finished.
- B. Do not finish floors until interior heating system is operational.

PART 2 – PRODUCTS

2.1 CONCRETE FLOOR FINISH APPLICATIONS

- A. Liquid Densifier and Hardener: Refer to Cast-in-Place Concrete mix design.
- B. Polished Finish:
 - 1. Use at following locations: Refer to Drawings.

2.2 DENSIFIERS AND HARDENERS

- A. Liquid Densifier and Hardener: Penetrating chemical compound that reacts with concrete, filling the pores, hardening, and dustproofing.
 - 1. Composition: Lithium silicate.

2.3 COATINGS

- A. Concrete Stain or Dye: Translucent, penetrating compound for interior or exterior use; must be finished with a topical sealer.
 - 1. VOC: 100 g/L or less.
 - 2. Primary Color: Match Architect's sample, in a formulation to match approved mock-up.

- B. High-Gloss Clear Coating: Transparent, nonyellowing, acrylic polymer-based coating.
 - 1. Composition: Solvent-based.
 - 2. Nonvolatile Content: 15 percent, minimum, when measured by volume.

2.4 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.

PART 3 – EXECUTION

3.1 GENERAL

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

3.2 COATING APPLICATION

- A. Verify that surface is free of previous coatings, sealers, curing compounds, water repellents, laitance, efflorescence, fats, oils, grease, wax, soluble salts, residues from cleaning agents, and other impediments to adhesion.
- B. Verify that water-vapor-emission from concrete and relative humidity in concrete are within limits established by coating manufacturer.
- C. Protect adjacent non-coated areas from drips, overflow, and overspray; immediately remove excess material.
- D. Apply coatings in accordance with manufacturer's instructions, matching approved mock-ups for color, special effects, sealing and workmanship.

3.3 CONCRETE POLISHING

- A. Execute using materials, equipment, and procedures specified by manufacturer, using manufacturer-approved installer.
 - 1. Final Polished Sheen: As selected by Architect from mock-up; other sheens are included as comparison to illustrate required sheen; final sheen is before addition of any sealer or coating, regardless of whether that is also specified or not.

END OF SECTION 033511

SECTION 042000 - UNIT MASONRY - SITE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes unit masonry assemblies consisting of the following:

1. Concrete masonry units.
2. Face brick.

1.2 SUBMITTALS

- A. Product Data: For each masonry unit, accessory, and other manufactured product indicated.
- B. Shop Drawings: For masonry reinforcing bars; comply with ACI 315, "Details and Detailing of Concrete Reinforcement."
- C. Samples: Showing the full range of colors and textures available for exposed masonry units and colored mortars.
- D. Material Test Reports: For each type of masonry unit, mortar, and grout required.
- E. Material Certificates: For each type of masonry unit required.

1.3 QUALITY ASSURANCE

- A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on each type of unit required per test method indicated.
1. Clay Masonry Units: ASTM C 67.
 2. Concrete Masonry Units: ASTM C 140.
 3. Mortar: For properties per ASTM C 270.
 4. Grout: For compressive strength per ASTM C 1019.
- B. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by another means, as acceptable to authorities having jurisdiction.
- C. Mockups: Build sample panels for each type of exposed unit masonry assembly to verify selections made under sample Submittals and to demonstrate aesthetic effects.
1. Build mockups in sizes approximately 48 inches long by 48 inches high by full thickness.

1.4 PROJECT CONDITIONS

- A. Cold-Weather Requirements: Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements in ACI 530.1/ASCE 6/TMS 602.
- B. Hot-Weather Requirements: When ambient temperature exceeds 100 deg F, or 90 deg F with a wind velocity greater than 8 mph, do not spread mortar beds more than 48 inches ahead of masonry. Set masonry units within one minute of spreading mortar.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products specified.
 - 2. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 COLORS AND TEXTURES

- A. Exposed Brick Units: Per plans.

2.3 MASONRY UNITS

- A. Concrete Masonry Units: ASTM C 90.
 - 1. Provide shapes indicated.
 - 2. Weight Classification: Normal weight.
 - 3. Type: II, nonmoisture-controlled units.
- B. Brick, General:
 - 1. Provide units without cores or frogs and with exposed surfaces finished for ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces.
 - 2. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
- C. Face Brick: ASTM C 216, Grade SW, Type FBS.
 - 1. Unit Compressive Strength: 3000-psi minimum, average net-area compressive strength.
 - 2. Initial Rate of Absorption: Less than 20 g/30 sq. in. per minute when tested per ASTM C 67.

3. Efflorescence: When tested per ASTM C 67 and brick is rated "not effloresced."
4. Size: Manufactured to the following actual dimensions:
 - a. Norman: 3-5/8 inches wide by 2-1/4 inches high by 11-5/8 inches long.
5. Approved manufacturers
 - a. Hebron Brick
 - b. Or, approved equal

2.4 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Mortar Cement: ASTM C 1329.
 1. Products:
 - a. Blue Circle Cement; Magnolia Superbond Mortar Cement.
 - b. Lafarge Corporation; Lafarge Mortar Cement.
- D. Pigmented Mortar: Colored cement or cement-lime formulation as required to produce the color indicated.
 1. Colored Portland Cement-Lime Mix:
 - a. Products:
 - 1) Blue Circle Cement; Eaglebond.
 - 2) Glen-Gery Corporation; Color Mortar Blend.
 - 3) Holnam, Inc.; Rainbow Mortamix Custom Color Cement/Lime.
 - 4) Lafarge Corporation; Centurion Colorbond PL.
 - 5) Lehigh Portland Cement Co.; Lehigh Custom Color Portland/Lime.
 - 6) Riverton Corporation (The); Riverton Portland Cement Lime Custom Color.
- E. Aggregate for Mortar: ASTM C 144; except for joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
 1. Colored-Mortar Aggregates: Natural-colored sand or ground marble, granite, or other sound stone; of color necessary to produce required mortar color.
- F. Aggregate for Grout: ASTM C 404.
- G. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.
 1. Products:
 - a. Davis Colors; True Tone Mortar Colors.

- b. Lafarge Corporation; Centurion Pigments.
 - c. Solomon Grind-Chem Services, Inc.; SGS Mortar Colors.
- H. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494, Type C, and recommended by the manufacturer for use in masonry mortar of composition indicated.
 - 1. Products:
 - a. Euclid Chemical Co.; Accelguard 80.
 - b. Grace, W. R. & Co., Construction Products Division; Morseled.
 - c. Sonneborn, Div. of ChemRex, Inc.; Trimix-NCA.
- I. Water: Potable.

2.5 REINFORCING

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M; ASTM A 616/A 616M, including Supplement 1; or ASTM A 617/A 617M, Grade 60.
- B. Masonry Joint Reinforcement: ASTM A 951; mill galvanized, carbon-steel wire for interior walls and hot-dip galvanized, carbon-steel wire for exterior walls.
 - 1. Single-Wythe Masonry: Use either ladder or truss type with single pair of side rods and cross rods spaced not more than 16 inches o.c.
 - 2. Multiwythe Masonry: Use ladder type with perpendicular cross rods spaced not more than 16 inches o.c. and 1 side rod for each face shell of hollow masonry units more than 4 inches in width, plus 1 side rod for each wythe of masonry 4 inches or less in width.

2.6 TIES AND ANCHORS

- A. Materials, General: As follows, unless otherwise indicated:
 - 1. Galvanized Carbon-Steel Wire: ASTM A 82; with ASTM A 153, Class B-2 coating for exterior walls and Class 1 coating for interior walls.
 - 2. Galvanized Steel Sheet: ASTM A 366/A 366M cold-rolled, carbon-steel sheet hot-dip galvanized after fabrication to comply with ASTM A 153, at exterior walls; and ASTM A 653/A 653M, G60, commercial-quality, steel sheet zinc coated by hot-dip process on continuous lines before fabrication at interior walls.
- B. Bent Wire Ties: Rectangular units with closed ends and not less than 4 inches wide, made from 3/16-inch- diameter, galvanized steel wire.
- C. Anchors for Connecting to Concrete: Provide two-piece assemblies that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to wall.
 - 1. Anchor Section: Dovetail anchor section formed from 0.0528-inch- thick, galvanized steel sheet.

2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.1875-inch- diameter, galvanized steel wire.

2.7 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing and Accessories: Fabricated to complying with requirements specified in Division 7 Section "Sheet Metal Flashing and Trim."
 1. Material: copper, 10-oz./sq. ft. weight or 0.0135 inch thick for fully concealed flashing; 16-oz./sq. ft. weight or 0.0216 inch thick elsewhere.
- B. Contractor's Option for Concealed Flashing: For flashing partly exposed to the exterior, use metal flashing specified above. For flashing not exposed to the exterior, use the following, unless otherwise indicated:
 1. Copper-Laminated Flashing: Manufacturer's standard laminated flashing consisting of 5-oz./sq. ft. sheet copper bonded with asphalt between 2 layers of glass-fiber cloth.
 - a. Products:
 - 1) Advanced Building Products, Inc.; Copper Fabric Flashing.
 - 2) AFCO Products, Inc.; Copper Fabric.
 - 3) Hohmann & Barnard, Inc.; H & B C-Fab Flashing.
 - 4) Phoenix Building Products; Type FCC-Fabric Covered Copper.
 - 5) Polytite Manufacturing Corp.; Copper Fabric Flashing.
 - 6) Sandell Manufacturing Co., Inc.; Copper Fabric Flashing.
 - 7) York Manufacturing, Inc.; York Copper Fabric Flashing.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; formulated from neoprene.
- B. Preformed Control-Joint Gaskets: Designed to fit standard sash block and to maintain lateral stability in masonry wall. Made from PVC complying with ASTM D 2287, Type PVC-65406.
- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Wicking Material: Cotton or polyester rope, 1/4 to 3/8 inch in diameter, in length required to produce 2-inch exposure on exterior and 18 inches in cavity between wythes.

2.9 MASONRY CLEANERS

- A. Job-Mixed Detergent Solution: Solution of 1/2-cup dry measure tetrasodium polyphosphate and 1/2-cup dry measure laundry detergent dissolved in 1 gal. of water.

- B. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

2.10 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, unless otherwise indicated. Do not use calcium chloride in mortar or grout.
- B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification.
- C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification.
 - 1. Extended-Life Mortar for Unit Masonry: Mortar complying with ASTM C 1142 may be used instead of mortar specified above, at Contractor's option.
 - 2. Limit cementitious materials in mortar to portland cement, mortar cement, and lime.
 - 3. For masonry below grade, in contact with earth, and where indicated, use Type S.
 - 4. For exterior, above-grade, load-bearing and non-load-bearing walls, and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N or RN.
- D. Pigmented Mortar: Select and proportion pigments with other ingredients to produce color required. Limit pigments to the following percentages of cement content by weight:
 - 1. For portland cement-lime mortar, not more than 10 percent.
- E. Grout for Unit Masonry: Comply with ASTM C 476.
 - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 5 of ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
 - 2. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143.

2.11 SOURCE QUALITY CONTROL

- A. Owner will engage a qualified independent testing agency to perform source quality-control testing indicated below.
 - 1. Payment for these services will be made by Owner.
 - 2. Retesting of materials failing to meet specified requirements shall be done at Contractor's expense.
- B. Brick Tests: For each type and grade of brick indicated, units will be tested according to ASTM C 67.
- C. Concrete Masonry Unit Tests: For each type of concrete masonry unit indicated, units will be tested according to ASTM C 140.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Cut masonry units with motor-driven saws. Allow units cut with water-cooled saws to dry before placing, unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
- C. Wetting of Brick: Wet brick before laying if the initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at the time of laying.
- D. Comply with tolerances in ACI 530.1/ASCE 6/TMS 602 and the following:
 - 1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/4 inch in 20 feet, nor 1/2 inch maximum.
 - 2. For conspicuous horizontal lines, such as exposed lintels, sills, parapets, and reveals, do not vary from level by more than 1/4 inch in 20 feet, nor 1/2 inch maximum.

3.2 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Lay exposed masonry in bond pattern indicated; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Built-in Work: As construction progresses, build in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items.
- D. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

3.3 MORTAR BEDDING AND JOINTING

- A. Lay hollow masonry units as follows:
 - 1. With full mortar coverage on horizontal and vertical face shells.
 - 2. Bed webs in mortar in starting course on footings and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be filled with grout.

3. For starting course on footings where cells are not grouted, spread out full mortar bed, including areas under cells.
- B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than the joint thickness, unless otherwise indicated.

3.4 CAVITIES

- A. Keep cavities clean of mortar droppings and other materials during construction.
 1. Use wood strips temporarily placed in cavity to collect mortar droppings. As work progresses, remove strips, clean off mortar droppings, and replace in cavity.

3.5 MASONRY JOINT REINFORCEMENT

- A. Provide continuous masonry joint reinforcement as indicated. Install with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
- B. Provide continuity at corners and wall intersections by using prefabricated "L" and "T" sections.

3.6 ANCHORING MASONRY

- A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:
 1. Provide an open space not less than 1 inch in width between masonry and structural member, unless otherwise indicated.
 2. Anchor masonry to structural members with flexible anchors embedded in masonry joints and attached to structure.
- B. Anchor masonry veneers to concrete and masonry backup with masonry-veneer anchors to comply with the following requirements:
 1. Fasten each anchor section to concrete and masonry backup with two metal fasteners of type indicated.
 2. Embed tie sections in masonry joints.
 3. Space anchors not more than 16 inches o.c. vertically and 24 inches o.c. horizontally with not less than 1 anchor for each 2.67 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 36 inches, around perimeter.

3.7 FLASHING, WEEP HOLES, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

1. Extend flashing 4 inches at ends and turn flashing up not less than 2 inches to form a pan.
 2. Install metal drip edges beneath flashing at exterior face of wall. Stop flashing 1/2 inch back from outside face of wall and adhere flashing to top of metal drip edge.
 3. Install metal flashing termination beneath flashing at exterior face of wall. Stop flashing 1/2 inch back from outside face of wall and adhere flashing to top of metal flashing termination.
- B. Install weep holes in the head joints in exterior wythes of the first course of masonry immediately above embedded flashing.
1. Space weep holes 16 inches o.c.
 2. Trim wicking material used in weep holes flush with outside face of wall after mortar has set.

3.8 FIELD QUALITY CONTROL

- A. Owner will engage a qualified independent testing agency to perform field quality-control testing indicated below. Payment for these services will be made by Owner.
1. Testing Frequency: Tests and Evaluations listed in these subparagraphs will be performed during construction for each 500 sq. ft. of wall area or portion thereof.
 2. Mortar: Properties will be tested per ASTM C 780.
 3. Grout: Sampled and tested for compressive strength per ASTM C 1019.
 4. Brick Tests: For each type and grade of brick indicated, units will be tested according to ASTM C 67.
 5. Concrete Masonry Unit Tests: For each type of concrete masonry unit indicated, units will be tested according to ASTM C 140.

3.9 CLEANING

- A. Clean unit masonry by dry brushing to remove mortar fins and smears before tooling joints, as work progresses.
- B. After mortar is thoroughly set and cured, clean exposed masonry as follows:
1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
 2. Protect adjacent surfaces from contact with cleaner.
 3. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing the surfaces thoroughly with clear water.
 4. Clean brick by the bucket-and-brush hand-cleaning method described in BIA Technical Notes No. 20, using job-mixed detergent solution.
 5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
 6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2 applicable to type of stain on exposed surfaces.

3.10 MASONRY WASTE DISPOSAL

- A. Masonry Waste Disposal: Dispose of clean masonry waste, including broken masonry units, waste mortar, and excess or soil-contaminated sand, by crushing and mixing with fill material as fill is placed.
1. Do not dispose of masonry waste as fill within 18 inches of finished grade.
 2. Remove excess, clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04810

SECTION 042200 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Mortar and grout.
3. Steel reinforcing bars.
4. Masonry-joint reinforcement.
5. Embedded flashing.
6. Miscellaneous masonry accessories.

B. Products Installed but not Furnished under This Section:

1. Cast-stone trim in concrete unit masonry.

C. Related Requirements:

1. Section 031000 "Concrete Forms and Accessories" for installing dovetail slots for masonry anchors.
2. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
3. Section 071900 "Water Repellents" for water repellents applied to unit masonry assemblies.
4. Section 076200 "Sheet Metal Flashing and Trim" for exposed sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.
5. Section 089516 "Wall Vents" for wall vents (brick vents).
6. Section 323223 "Segmental Retaining Walls" for dry-laid, concrete unit retaining walls.

1.2 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. Show elevations of reinforced walls.
3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of the following:

1. Masonry units.
 - a. Include data on material properties .
 - b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
2. Integral water repellant used in CMUs.
3. Cementitious materials. Include name of manufacturer, brand name, and type.
4. Mortar admixtures.
5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
6. Grout mixes. Include description of type and proportions of ingredients.
7. Reinforcing bars.
8. Joint reinforcement.
9. Anchors, ties, and metal accessories.

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

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

C. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined in accordance with TMS 602/ACI 530.1/ASCE 6.

D. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.6 QUALITY ASSURANCE

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.8 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of **24 inches** down both sides of walls, and hold cover securely in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is **40 deg F** and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.2 PERFORMANCE REQUIREMENTS

- A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.
 - 1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) in accordance with TMS 602/ACI 530.1/ASCE 6.
 - 2. Determine net-area compressive strength of masonry by testing masonry prisms in accordance with ASTM C1314.

2.3 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6 except as modified by requirements in the Contract Documents.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.
- C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.
 - 1. Where fire-resistance-rated construction is indicated, units are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.4 CONCRETE MASONRY UNITS

- A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
 - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 - 2. Provide square-edged units for outside corners unless otherwise indicated.
- B. Integral Water Repellent: Provide units made with integral water repellent for exposed units .
 - 1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested in accordance with ASTM E514/E514M as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, show no visible water or leaks on the back of test specimen.

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Acme Brick Company.
 - 2) Euclid Chemical Company (The); a subsidiary of RPM International, Inc.
 - 3) GCP Applied Technologies Inc.
 - 4) Master Builders Solutions; brand of MBCC Group.

C. CMUs: ASTM C90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of **2800 psi**.
2. Density Classification: Normal weight.
3. Size (Width): Manufactured to dimensions **3/8 inch** less-than-nominal dimensions.
4. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.
5. Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.

2.5 MASONRY LINTELS

- A. General: Provide one of the following:
- B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.6 MORTAR AND GROUT MATERIALS

- A. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- B. Mortar Cement: ASTM C1329/C1329M.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Lafarge North America Inc.
- C. Water: Potable.

2.7 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, **Grade 60**.
- B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from **0.148-inch** steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Heckmann Building Products, Inc.
 - b. Hohmann & Barnard, Inc.
 - c. Wire-Bond.

C. Masonry-Joint Reinforcement, General: Ladder type complying with ASTM A951/A951M.

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

2.8 TIES AND ANCHORS

A. General: Ties and anchors extend at least 1-1/2 inches into masonry but with at least a 5/8-inch cover on outside face.

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

1. Mill-Galvanized, Carbon-Steel Wire: ASTM A82/A82M, with ASTM A641/A641M, Class 1 coating.
2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A82/A82M, with ASTM A153/A153M, Class B-2 coating.
3. Stainless Steel Wire: ASTM A580/A580M, Type 304 .
4. Galvanized-Steel Sheet: ASTM A653/A653M, Commercial Steel, G60 zinc coating.
5. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.
6. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304 .
7. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

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

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

2.9 EMBEDDED FLASHING MATERIALS

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

1. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.016 inch thick.

2. Fabricate continuous flashings in sections **96 inches** long minimum, but not exceeding **12 feet**. Provide splice plates at joints of formed, smooth metal flashing.
3. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with ribs at **3-inch** intervals along length of flashing to provide an integral mortar bond.
 - a. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - 1) Cheney Flashing Company.
 - 2) Hohmann & Barnard, Inc.
 - 3) Keystone Flashing Company, Inc.
4. Fabricate metal drip edges and sealant stops for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least **3 inches** into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam sheds water.
5. Solder metal items at corners.

B. Application: Unless otherwise indicated, use the following:

1. Where flashing is indicated to receive counterflashing, use metal flashing.
2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing with a drip edge or flexible flashing with a metal drip edge or elastomeric thermoplastic flashing with a drip edge.
4. Where flashing is fully concealed, use flexible flashing.

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

2.10 MISCELLANEOUS MASONRY ACCESSORIES

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

2.11 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
1. Do not use calcium chloride in mortar or grout.
 2. Use portland cement-lime or mortar cement mortar unless otherwise indicated.
 3. For exterior masonry, use portland cement-lime or mortar cement mortar.
 4. For reinforced masonry, use portland cement-lime or mortar cement mortar.
 5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

- B. Mortar for Unit Masonry: Comply with ASTM C270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
 - 1. For masonry below grade or in contact with earth, use Type S.
 - 2. For reinforced masonry, use Type N.
 - 3. For mortar parge coats, use Type S or Type N.
 - 4. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.
 - 5. For interior nonload-bearing partitions, Type O may be used instead of Type N.
- C. Grout for Unit Masonry: Comply with ASTM C476.
 - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
 - 2. Proportion grout in accordance with ASTM C476, paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
 - 3. Provide grout with a slump of 8 to 11 inches as measured in accordance with ASTM C143/C143M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
 - 2. Verify that foundations are within tolerances specified.
 - 3. Verify that reinforcing dowels are properly placed.
 - 4. Verify that substrates are free of substances that would impair mortar bond.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Build chases and recesses to accommodate items specified in this and other Sections.
- B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.
- C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped

edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

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

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than **1/4 inch in 10 feet**, or **1/2-inch** maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than **1/8 inch in 10 feet**, **1/4 inch in 20 feet**, or **1/2-inch** maximum.
3. For vertical lines and surfaces do not vary from plumb by more than **1/4 inch in 10 feet**, **3/8 inch in 20 feet**, or **1/2-inch** maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than **1/8 inch in 10 feet**, **1/4 inch in 20 feet**, or **1/2-inch** maximum.
5. For lines and surfaces, do not vary from straight by more than **1/4 inch in 10 feet**, **3/8 inch in 20 feet**, or **1/2-inch** maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than **1/4 inch in 10 feet**, or **1/2-inch** maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than **1/16 inch**.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus **1/8 inch**, with a maximum thickness limited to **1/2 inch**.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than **1/8 inch**.
3. For head and collar joints, do not vary from thickness indicated by more than plus **3/8 inch** or minus **1/4 inch**.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus **1/8 inch**.

3.4 LAYING MASONRY WALLS

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

- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond ; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4 inches. Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.
- H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
 - 1. Install compressible filler in joint between top of partition and underside of structure above.
 - 2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c. unless otherwise indicated.
 - 3. Wedge nonload-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
 - 4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078443 "Joint Firestopping."

3.5 MORTAR BEDDING AND JOINTING

- A. Lay hollow CMUs as follows:
 - 1. Bed face shells in mortar and make head joints of depth equal to bed joints.
 - 2. Bed webs in mortar in all courses of piers, columns, and pilasters.
 - 3. Bed webs in mortar in grouted masonry, including starting course on footings.
 - 4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
- B. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

- C. Set cast-stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
 - 1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
 - 2. Wet joint surfaces thoroughly before applying mortar.
 - 3. Rake out mortar joints for pointing with sealant.
- D. Rake out mortar joints at pre-faced CMUs to a uniform depth of **1/4 inch** and point with epoxy mortar to comply with epoxy-mortar manufacturer's written instructions.
- E. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- F. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.
- G. Cut joints flush where indicated to receive waterproofing unless otherwise indicated.

3.6 MASONRY-JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of **5/8 inch** on exterior side of walls, **1/2 inch** elsewhere. Lap reinforcement a minimum of **6 inches**.
 - 1. Space reinforcement not more than **16 inches** o.c.
 - 2. Space reinforcement not more than **8 inches** o.c. in foundation walls and parapet walls.
 - 3. Provide reinforcement not more than **8 inches** above and below wall openings and extending **12 inches** beyond openings in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.
- E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

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

3.8 CONTROL AND EXPANSION JOINTS

- A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry using one of the following methods:
 - 1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.
 - 2. Install preformed control-joint gaskets designed to fit standard sash block.
 - 3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar, or rake out joint for application of sealant.
 - 4. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.

3.9 LINTELS

- A. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.
- B. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.10 FLASHING

- A. General: Install embedded flashing at ledges and other obstructions to downward flow of water in wall where indicated.
- B. Install flashing as follows unless otherwise indicated:
 - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
 - 2. At lintels, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
 - 3. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
 - 4. Install metal drip edges and sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
 - 5. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal drip edge.
 - 6. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall, and adhere flexible flashing to top of metal flashing termination.

7. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.
- C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.
- D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

3.11 REINFORCED UNIT MASONRY

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
 1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 2. Limit height of vertical grout pours to not more than 60 inches .

3.12 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements is done at Contractor's expense.
- B. Inspections: Special inspections in accordance with Level B in TMS 402/ACI 530/ASCE 5.
 1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
 2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
 3. Place grout only after inspectors have verified proportions of site-prepared grout.

- C. Testing Prior to Construction: One set of tests.
- D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.
- E. Concrete Masonry Unit Test: For each type of unit provided, in accordance with ASTM C140 for compressive strength.
- F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, in accordance with ASTM C780.
- G. Mortar Test (Property Specification): For each mix provided, in accordance with ASTM C780. Test mortar for compressive strength.
- H. Grout Test (Compressive Strength): For each mix provided, in accordance with ASTM C1019.
- I. Prism Test: For each type of construction provided, in accordance with ASTM C1314 at 7 days and at 28 days.

3.13 PARGING

- A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of 3/4 inch. Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.
- B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot. Form a wash at top of parging and a cove at bottom.
- C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.14 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.15 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
 1. Crush masonry waste to less than 4 inches in each dimension.
 2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
 3. Do not dispose of masonry waste as fill within 18 inches of finished grade.
- C. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.
- D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042200

SECTION 044313.13 - ANCHORED STONE MASONRY VENEER - SITE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stone masonry anchored to concrete backup.
2. Stone masonry anchored to unit masonry backup.
3. Stone cap.

B. Products Installed but Not Furnished under This Section Include:

1. Steel lintels in unit masonry.
2. Steel shelf angles for supporting unit masonry.

C. Related Requirements:

1. Section 042000 "Unit Masonry" for concealed flashing, horizontal joint reinforcement, and veneer anchors.

1.2 ACTION SUBMITTALS

A. Product Data: For each variety of stone, stone accessory, and manufactured product.

B. Samples for Verification:

1. For each stone type indicated. Include at least four Samples in each set and show the full range of color and other visual characteristics in completed Work.
2. For each color of mortar required.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, supply sources, and other information as required to identify materials used. Include mix proportions for mortar and source of aggregates.

1. Neither receipt of list nor approval of mockups constitutes approval of deviations from the Contract Documents contained in mockups unless Landscape Architect approves such deviations in writing.

C. Material Test Reports:

1. Stone Test Reports: For each stone variety proposed for use on Project, by a qualified testing agency, indicating compliance with required physical properties, other than abrasion resistance, according to referenced ASTM standards. Base reports on testing done within previous three years.
2. Sealant Compatibility and Adhesion Test Report: From sealant manufacturer indicating that sealants will not stain or damage stone. Include interpretation of test results and recommendations for primers and substrate preparation needed for adhesion.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs experienced stonemasons and stone fitters.
- B. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for materials and execution.
 1. Build mockup of typical wall area as shown on Drawings.
 2. Build mockups for each type of stone masonry in sizes approximately 48 inches long by 48 inches high by full thickness, including face and backup wythes and accessories.
 - a. Include stone coping at top of mockup.
 - b. Include a sealant-filled joint at least 16 inches long in mockup.
 - c. Include through-wall flashing installed for a 24-inch length in corner of mockup approximately 16 inches down from top of mockup, with a 12-inch length of flashing left exposed to view (omit stone masonry above half of flashing).
 3. Protect accepted mockups from the elements with weather-resistant membrane.
 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.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

- B. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- C. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, in a dry location, or in covered weatherproof dispensing silos.
- D. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.6 FIELD CONDITIONS

- A. Protection of Stone Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed stone masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
- B. Stain Prevention: Immediately remove mortar and soil to prevent them from staining stone masonry face.
 - 1. Protect base of walls from rain-splashed mud and mortar splatter using coverings spread on the ground and over the wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at end of each day to prevent rain from splashing mortar and dirt on completed stone masonry.
- C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace stone masonry damaged by frost or freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

1.7 COORDINATION

- A. Advise installers of adjacent Work about specific requirements for placement of reinforcement, veneer anchors, flashing, and similar items to be built into stone masonry.

- B. Coordinate locations of dovetail slots installed in concrete that are to receive stone anchors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Stone: Obtain each variety of stone, from single quarry with resources to provide materials of consistent quality in appearance and physical properties.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of uniform quality for each cementitious component from single manufacturer and each aggregate from single source or producer.
- C. Varieties and Sources: Subject to compliance with requirements, provide stone of varieties and from sources complying with Section 044200 "Exterior Stone Cladding."

2.2 LIMESTONE

- A. Material Standard: Comply with ASTM C568/C568M.
 - 1. Classification: I Low Density II Medium Density II Medium Density, except as follows: absorption, 5 percent by weight maximum; density, 150 lb/cu. ft. minimum; compressive strength, 8000 psi minimum; and modulus of rupture 800 psi minimum III High Density.
- B. Description: Dolomitic Oolitic Shell limestone.
- C. Varieties and Sources: Indiana limestone quarried in Lawrence, Monroe, or Owen Counties, Indiana.
 - 1. Indiana Limestone Grade and Color: Select, buff Select, gray Standard, buff Standard, gray Rustic, buff Rustic, gray Variegated, according to grade and color classification established by ILI.
- D. Match Landscape Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.

2.3 MORTAR MATERIALS

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

1. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C114.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Holcim (US) Inc.
 - b. Lafarge North America Inc.
 - c. Lehigh Hanson; HeidelbergCement Group.
 - d. Mutual Materials Co.
- D. Mortar Cement: ASTM C1329/C1329M.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Lafarge North America Inc.
- E. Masonry Cement: ASTM C91/C91M.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cemex S.A.B. de C.V.
 - b. Holcim (US) Inc.
 - c. Lafarge North America Inc.
 - d. Lehigh Hanson; HeidelbergCement Group.
 - e. National Cement Company, Inc.
- F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in stone masonry mortar.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Davis Colors.
 - b. Lanxess Corporation.
 - c. Solomon Colors, Inc.
- G. Colored Portland Cement-Lime Mix: Packaged blend of portland cement, hydrated lime, and mortar pigments. Mix produces color indicated or, if not indicated, as selected from manufacturer's standard colors. Pigments do not exceed 10 percent of portland cement by weight.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Holcim (US) Inc.
 - b. Lafarge North America Inc.
 - c. Lehigh Hanson; HeidelbergCement Group.
 - d. Mutual Materials Co.
 - H. Colored Masonry Cement Mix: Packaged blend of masonry cement and mortar pigments. Mix produces color indicated or, if not indicated, as selected from manufacturer's standard colors. Pigments do not exceed 5 percent of masonry cement by weight.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cemex S.A.B. de C.V.
 - b. Essroc.
 - c. Holcim (US) Inc.
 - d. Lafarge North America Inc.
 - e. Lehigh Hanson; HeidelbergCement Group.
 - f. National Cement Company, Inc.
 - I. Aggregate: ASTM C144 and as follows:
 1. For pointing mortar, use aggregate graded with 100 percent passing No. 16 sieve.
 2. White Aggregates: Natural white sand or ground white stone.
 3. Colored Aggregates: Natural-colored sand or ground marble, granite, or other sound stone; of color necessary to produce required mortar color.
 - a. Match Architect's sample.
 - J. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Euclid Chemical Company (The); an RPM company.
 - b. GCP Applied Technologies Inc.
 - c. Sonneborn.
 - K. Water: Potable.
- 2.4 VENEER ANCHORS
- A. Materials:

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M; with ASTM A153/A153M, Class B-2.
 2. Stainless Steel Wire: ASTM A580/A580M, Type 304 Type 316.
 3. Hot-Dip Galvanized-Steel Sheet: ASTM A1008/A1008M, cold-rolled, carbon-steel sheet, hot-dip galvanized after fabrication to comply with ASTM A153/A153M, Class B-2.
 4. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304 Type 316.
- B. Size: Sufficient to extend at least halfway, but not less than 1-1/2 inches, through stone masonry and with at least a 5/8-inch cover on exterior face.
- C. Wire Veneer Anchors: Wire ties formed from W1.7 or 0.148-inch- diameter, hot-dip galvanized stainless steel wire.
1. Ties are bent in the form of loops with legs not less than 15 inches in length and with last 2 inches bent at 90 degrees.
 2. Ties are bent in the form of rectangular loops with ends bent downward for inserting into eyes projecting from masonry joint reinforcement specified in Section 042000 "Unit Masonry."
 3. Ties are bent in the form of triangular loops designed to be attached to masonry joint reinforcement specified in Section 042000 "Unit Masonry" with vertical wires passing through ties and through eyes projecting from masonry joint reinforcement.
- D. Corrugated-Metal Veneer Anchors: Not less than 0.030-inch- 0.060-inch- thick by 7/8-inch- wide hot-dip galvanized stainless steel sheet with corrugations having a wavelength of 0.3 to 0.5 inch and an amplitude of 0.06 to 0.10 inch.
- E. Adjustable Masonry-Veneer Anchors:
1. General: Provide anchors that allow vertical adjustment but resist a 100-lbf load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch.
 2. Fabricate sheet metal anchor sections and other sheet metal parts from [0.075-inch- thick steel sheet, galvanized after fabrication] [0.105-inch-thick steel sheet, galvanized after fabrication] [0.078-inch- thick, stainless steel sheet] [0.109-inch- thick, stainless steel sheet].
 3. Fabricate wire ties from [0.187-inch-] [0.25-inch-] diameter, hot-dip galvanized-steel wire unless otherwise indicated.
 4. Fabricate wire connector sections from [0.187-inch-] [0.25-inch-] diameter, hot-dip galvanized-steel wire.
 5. Contractor's Option: Unless otherwise indicated, provide any of the adjustable masonry-veneer anchors specified.

2.5 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing, complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
1. Stainless Steel: ASTM A240/A240M, Type 304, 0.016 inch thick.
 2. Copper: ASTM B370, Temper H00 or H01, cold-rolled copper sheet, 10-oz./sq. ft. weight or 0.0135 inch thick for fully concealed flashing; 16-oz./sq. ft. weight or 0.0216 inch thick elsewhere.
- B. Flexible Flashing: For flashing unexposed to the exterior, use[one of] the following unless otherwise indicated:
1. Copper-Laminated Flashing: 5-oz./sq. ft. 7-oz./sq. ft. copper sheet bonded with asphalt between two layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Advanced Building Products Inc.
 - 2) Hohmann & Barnard, Inc.
 - 3) Wire-Bond.
 - 4) York Manufacturing, Inc.
 2. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive, rubberized-asphalt compound, bonded to a high-density, cross-laminated, polyethylene film to produce an overall thickness of not less than 0.030 inch 0.040 inch.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Advanced Building Products Inc.
 - 2) Carlisle Coatings & Waterproofing Inc.
 - 3) Fiberweb, Clark Hammerbeam Corp.
 - 4) GCP Applied Technologies Inc.
 - 5) Heckmann Building Products, Inc.
 - 6) Hohmann & Barnard, Inc.
 - 7) Polyguard Products, Inc.
 - 8) Williams Products, Inc.
 - 9) Wire-Bond.
 3. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymers alloy as follows:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) DuPont.

- 2) Hohmann & Barnard, Inc.
 - 3) Mortar Net Solutions.
 - 4) Wire-Bond.
 - b. Monolithic Sheet: Elastomeric thermoplastic flashing, 0.040 inch thick.
 - c. Self-Adhesive Sheet: Elastomeric thermoplastic flashing, 0.025 inch thick, with a 0.015-inch- thick coating of rubberized-asphalt adhesive.
 - d. Self-Adhesive Sheet with Drip Edge: Elastomeric thermoplastic flashing, 0.025 inch thick, with a 0.015-inch- thick coating of rubberized-asphalt adhesive. Where flashing extends to masonry face, rubberized-asphalt coating is held back approximately 1-1/2 inches from edge.
 - 1) Color: Gray White Tan/buff Black.
 - e. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.
- C. Application: Unless otherwise indicated, use the following:
- 1. Where flashing is fully concealed, use metal flashing.
- D. Solder and Sealants for Sheet Metal Flashings: As specified in Section 076200 "Sheet Metal Flashing and Trim."
- E. Adhesives, Primers, and Seam Tapes for Flexible Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.6 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene urethane PVC.
- B. Cementitious Dampproofing for Limestone: Cementitious formulation recommended by ILI and nonstaining to stone, compatible with joint sealants, and noncorrosive to veneer anchors and attachments.
- C. Asphalt Dampproofing: Cut-back asphalt complying with ASTM D4479/D4479M, Type I asphalt emulsion complying with ASTM D1227, Type III or Type IV.
- D. Weep/Vent Products: Use one of the following unless otherwise indicated:

1. Wicking Material: Absorbent rope, made from cotton UV-resistant synthetic fiber, 1/4 to 3/8 inch in diameter, in length required to produce 2-inch exposure on exterior and 18 inches in cavity behind stone masonry. Use only for weeps.
 2. Round Plastic Tubing: Medium-density polyethylene, 3/8-inch OD by thickness of stone masonry.
 3. Rectangular Plastic Tubing: Clear butyrate, 3/8 by 1-1/2 inches by thickness of stone masonry.
 4. Mesh Weep Holes/Vents: Free-draining mesh; made from polyethylene strands, full width of head joint and 2 inches high by thickness of stone masonry; in color selected from manufacturer's standard.
- E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

2.7 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar and grout stains, efflorescence, and other new construction stains from stone masonry surfaces without discoloring or damaging masonry surfaces; expressly approved for intended use by cleaner manufacturer and stone producer.

2.8 FABRICATION

- A. General: Fabricate stone units in sizes and shapes required to comply with requirements indicated.
1. For limestone, comply with recommendations in ILI's "Indiana Limestone Handbook."
- B. Cut stone to produce pieces of thickness, size, and shape indicated, including details on Drawings and pattern specified in "Setting Stone Masonry" Article.
1. Shape stone specified to be laid in three-course, random range ashlar pattern with sawed beds.
- C. Thickness of Stone: Provide thickness indicated, but not less than the following:
1. Thickness: 4 inches plus or minus 1/4 inch.

2.9 MORTAR MIXES

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

1. Do not use calcium chloride.
 2. Use portland cement-lime mortar unless otherwise indicated.
 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
 4. Mixing Pointing Mortar: Thoroughly mix cementitious and aggregate materials together before adding water. Then mix again, adding only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for one to two hours. Add remaining water in small portions until mortar reaches required consistency. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in the form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Stone Masonry: Comply with ASTM C270, Proportion Property Specification.
1. Mortar for Setting Stone: Type S Type N.
 2. Mortar for Pointing Stone: Type N Type O.
- D. Pigmented Mortar: Use colored cement product.
1. Pigments do not exceed 10 percent of portland cement by weight.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces indicated to receive stone masonry, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stone masonry.
- B. Examine substrate to verify that dovetail slots, inserts, reinforcement, veneer anchors, flashing, and other items installed in substrates and required for or extending into stone masonry are correctly installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Coat concrete and unit masonry backup with asphalt dampproofing.

- B. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.3 INSTALLATION OF STONE MASONRY

- A. Perform necessary field cutting and trimming as stone is set.
 - 1. Use power saws to cut stone that is fabricated with saw-cut surfaces. Cut lines straight and true, with edges eased slightly to prevent snipping.
 - 2. Use hammer and chisel to split stone that is fabricated with split surfaces. Make edges straight and true, matching similar surfaces that were shop or quarry fabricated.
 - 3. Pitch face at field-split edges as needed to match stones that are not field split.
- B. Sort stone before it is placed in wall to remove stone that does not comply with requirements relating to aesthetic effects, physical properties, or fabrication, or that is otherwise unsuitable for intended use.
- C. Arrange stones in range ashlar pattern with course heights as indicated, [uniform] [random] lengths, and uniform joint widths, with offset between vertical joints as indicated.
- D. Arrange stones in broken-range ashlar pattern with uniform course heights, random lengths, and uniform joint widths.
- E. Arrange stones in three-course, random-range ashlar pattern with random course heights, random lengths (interrupted coursed), and uniform joint widths.
- F. Arrange stones in [coursed] [uncoursed] rubble pattern with joint widths within tolerances indicated.[Insert small stones into spaces between larger stones as needed to produce joints as uniform in width as practical.]
- G. Arrange stones with color and size variations uniformly dispersed for an evenly blended appearance.
- H. Install supports, fasteners, and other attachments indicated or necessary to secure stone masonry in place.
- I. Set stone accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.
- J. Install steel lintels where indicated. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

- K. Maintain uniform joint widths except for variations due to different stone sizes and where minor variations are required to maintain bond alignment if any. Lay walls with joints not less than [1/4 inch] [3/8 inch] at narrowest points or more than [3/8 inch] [1/2 inch] [5/8 inch] [1 inch] [1-1/2 inches] at widest points.
- L. Provide sealant joints of widths and at locations indicated.
 - 1. Keep sealant joints free of mortar and other rigid materials.
 - 2. Sealant joints are specified in Section 079200 "Joint Sealants."
- M. Install metal expansion strips in sealant joints at locations indicated. Build flanges of expansion strips into masonry by embedding in mortar between stone masonry and backup wythe. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
- N. Install embedded flashing[and weep holes] at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
 - 1. At stud-framed walls, extend flashing through stone masonry, up sheathing face at least [8 inches] [12 inches] [16 inches], and behind weather barrier.
 - 2. At multiwythe masonry walls, including cavity walls, extend flashing through stone masonry, turned up a minimum of [4 inches] [8 inches] [12 inches] [16 inches], and extend into or through inner wythe to comply with requirements in Section 042000 "Unit Masonry."
 - 3. At concrete backing, extend flashing through stone masonry, turned up a minimum of [4 inches] [6 inches] [8 inches] [12 inches], and insert in reglet.[Reglets are specified in Section 076200 "Sheet Metal Flashing and Trim."]
 - 4. At lintels and shelf angles, extend flashing full length of angles but not less than 6 inches into masonry at each end.
 - 5. At sills, extend flashing not less than 4 inches at ends.
 - 6. At ends of head and sill flashing, turn up not less than 2 inches to form end dams.
 - 7. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
 - 8. Install metal drip edges sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
 - 9. Extend sheet metal flashing 1/2 inch beyond masonry face at exterior, and turn flashing down to form a drip.
 - 10. Install metal drip edges beneath flexible flashing at exterior wall face. Stop flexible flashing 1/2 inch back from exterior wall face and adhere flexible flashing to top of metal drip edge.

11. Install metal flashing termination beneath flexible flashing at exterior wall face. Stop flexible flashing 1/2 inch back from exterior wall face and adhere flexible flashing to top of metal flashing termination.
 12. Cut flexible flashing flush with wall face after completing masonry wall construction.
- O. Place weep holes and vents in joints where moisture may accumulate, including at base of cavity walls, above shelf angles, and at flashing.
1. Use wicking material mesh weep holes/vents aluminum weep holes/vents vinyl weep holes/vents to form weep holes.
 2. Use wicking material to form weep holes above flashing in stone sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
 3. Space weep holes [16 inches] [24 inches] o.c.
 4. Space weep holes formed from [plastic tubing] [or] [wicking material] 16 inches o.c.
 5. Trim wicking material used in weep holes flush with exterior wall face after mortar has set.
 6. Place pea gravel in cavities as soon as practical to a height of not less than 2 inches above top of flashing, to maintain drainage.
 7. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.
- P. Install vents in head joints at top of each continuous cavity at spacing indicated. Use mesh weep holes/vents aluminum weep holes/vents vinyl weep holes/vents to form vents.
1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.
- Q. Coat limestone with cementitious dampproofing as follows:
1. Stone at Grade: Beds, joints, and back surfaces to at least 12 inches above finish-grade elevations.
 2. Stone Extending below Grade: Beds, joints, back surfaces, and face surfaces below grade.
 3. Allow cementitious dampproofing formulations to cure before setting dampproofed stone. Do not damage or remove dampproofing in the course of handling and setting stone.

3.4 CONSTRUCTION TOLERANCES

- A. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch in 40 feet or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet or 1/2 inch in 40 feet or more.

- B. Variation from Level: For[bed joints and] lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in 20 feet or 1/2 inch in 40 feet or more.
- C. Variation of Linear Building Line: For position shown in plan, do not exceed 1/2 inch in 20 feet or 3/4 inch in 40 feet or more.
- D. Measure variation from level, plumb, and position shown in plan as a variation of the average plane of each stone face from level, plumb, or dimensioned plane.
- E. Variation in Mortar-Joint Thickness: Do not vary from joint size range indicated.
- F. Variation in Plane between Adjacent Stones: Do not exceed one-half of tolerance specified for thickness of stone.

3.5 INSTALLATION OF ANCHORED STONE MASONRY

- A. Anchor stone masonry to concrete with corrugated-metal veneer anchors unless otherwise indicated. Secure anchors by inserting dovetailed ends into dovetail slots in concrete.
- B. Anchor stone masonry to unit masonry with [corrugated-metal] [or] [individual wire] veneer anchors unless otherwise indicated. Embed anchors in unit masonry mortar joints or grouted cells at a distance of at least one-half of unit masonry thickness.
- C. Anchor stone masonry to unit masonry with wire anchors unless otherwise indicated. Connect anchors to masonry joint reinforcement by inserting pintles into eyes of masonry joint reinforcement projecting from unit masonry.
- D. Anchor stone masonry to unit masonry with wire anchors unless otherwise indicated. Connect anchors to masonry joint reinforcement with vertical rods inserted through anchors and through eyes of masonry joint reinforcement projecting from unit masonry.
- E. Anchor stone masonry to unit masonry with [adjustable, screw-attached] [seismic] veneer anchors unless otherwise indicated. Fasten anchors to unit masonry with two screws.
- F. Anchor stone masonry to stud framing with [adjustable, screw-attached] [seismic] veneer anchors unless otherwise indicated. Fasten anchors through sheathing to framing with two screws.
- G. Anchor stone masonry to stud framing with screw-attached veneer anchors unless otherwise indicated.

- H. Anchor stone masonry to wood-stud framing with corrugated-metal veneer anchors unless otherwise indicated. Fasten anchors through sheathing to studs with corrosion-resistant roofing nails.
- I. Anchor stone masonry to wood-stud framing with wire anchors unless otherwise indicated. Fasten anchors through sheathing to wood studs with corrosion-resistant roofing nails.
- J. Anchor stone masonry to metal-stud framing with wire anchors unless otherwise indicated. Tie anchors to studs.
- K. Embed veneer anchors in mortar joints of stone masonry at least halfway, but not less than 1-1/2 inches, through stone masonry and with at least a 5/8-inch cover on exterior face.
 - 1. Install continuous wire reinforcement in horizontal joints and attach to seismic veneer anchors as stone is set.
- L. Space anchors to provide not less than one anchor per 2 sq. ft. of wall area. Install additional anchors within 12 inches of openings, sealant joints, and perimeter at intervals not exceeding 12 inches.
- M. Space anchors not more than 16 inches o.c. vertically and 24 inches o.c. horizontally. Install additional anchors within 12 inches of openings, sealant joints, and perimeter at intervals not exceeding 12 inches.
- N. Space anchors not more than 18 inches o.c. vertically and 32 inches o.c. horizontally, with not less than one anchor per 2.67 sq. ft. of wall area. Install additional anchors within 12 inches of openings, sealant joints, and perimeter at intervals not exceeding 12 inches.
- O. Anchor stone trim with stone trim anchors where indicated. Install anchors by fastening to substrate and inserting tabs and dowels into kerfs and holes in stone units. 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.
- P. Set stone in full bed of mortar with full head joints unless otherwise indicated. Build anchors into mortar joints as stone is set.
- Q. Fill [collar joint] [space between back of stone masonry and weather-resistant sheathing paper] with mortar as stone is set.
- R. Provide [1-inch] [2-inch] cavity between stone masonry and backup construction unless otherwise indicated. Keep cavity free of mortar droppings and debris.
 - 1. Slope beds toward cavity to minimize mortar protrusions into cavity.
 - 2. Do not attempt to trowel or remove mortar fins protruding into cavity.

- S. Rake out joints for pointing with mortar to depth of not less than [1/2 inch] [3/4 inch] before setting mortar has hardened. Rake joints to uniform depths with square bottoms and clean sides.

3.6 POINTING

- A. Prepare stone-joint surfaces for pointing with mortar by removing dust and mortar particles. Where setting mortar was removed to depths greater than surrounding areas, apply pointing mortar in layers not more than 3/8 inch deep until a uniform depth is formed.
- B. Point stone joints by placing and compacting pointing mortar in layers of not more than 3/8 inch deep. Compact each layer thoroughly and allow to it become thumbprint hard before applying next layer.
- C. Tool joints, when pointing mortar is thumbprint hard, with a smooth jointing tool to produce the following joint profile:
 - 1. Joint Profile: Concave

3.7 ADJUSTING AND CLEANING

- A. Remove and replace stone masonry of the following description:
 - 1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by Architect.
 - 2. Defective joints.
 - 3. Stone masonry not matching approved samples and mockups.
 - 4. Stone masonry not complying with other requirements indicated.
- B. Replace in a manner that results in stone masonry matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.
- C. In-Progress Cleaning: Clean stone masonry as work progresses. Remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean stone masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on mockup; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before cleaning stone masonry.
 - 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.

4. Wet wall surfaces with water before applying cleaner; remove cleaner promptly by rinsing thoroughly with clear water.
5. Clean stone masonry by bucket and brush hand-cleaning method described in BIA Technical Note No. 20, Revised II, using job-mixed detergent solution.
6. Clean stone masonry with proprietary acidic cleaner applied according to manufacturer's written instructions.
7. Clean limestone masonry to comply with recommendations in ILI's "Indiana Limestone Handbook."

3.8 EXCESS MATERIALS AND WASTE

- A. Excess Stone: Stack excess stone where directed by Owner for Owner's use.
- B. Disposal as Fill Material: Dispose of clean masonry waste, including mortar and excess or soil-contaminated sand, by crushing and mixing with fill material as fill is placed.
 1. Crush masonry waste to less than 4 inches in greatest dimension.
 2. Mix masonry waste with at least 2 parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
 3. Do not dispose of masonry waste as fill within 18 inches of finished grade.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other waste, and legally dispose of off Owner's property.

END OF SECTION

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural-steel materials.
2. Shrinkage-resistant grout.

B. Related Requirements:

1. Section 051213 "Architecturally Exposed Structural Steel Framing" for additional requirements for architecturally exposed structural steel.
2. Section 053100 "Steel Decking" for field installation of shear stud connectors through deck.
3. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame miscellaneous steel fabrications and other steel items not defined as structural steel.
4. Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for painting requirements.
5. Section 133419 "Metal Building Systems" for structural steel.

1.2 DEFINITIONS

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.
- B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.
- C. 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.
 3. Column base plates thicker than 2 inches.
- D. Protected Zone: Structural members or portions of structural members indicated as "protected zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.
- E. 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.

1.3 COORDINATION

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

1.4 ACTION SUBMITTALS

- A. Shop Drawings: Show fabrication of structural-steel components.
 - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Include embedment Drawings.
 - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
 - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
 - 5. Identify members and connections of the seismic-load-resisting system.
 - 6. Indicate locations and dimensions of protected zones.
 - 7. Identify demand-critical welds.
 - 8. Identify members not to be shop primed.
- B. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide in accordance with AWS D1.1/D1.1M for each welded joint whether prequalified or qualified by testing , including the following:
 - 1. Power source (constant current or constant voltage).
 - 2. Electrode manufacturer and trade name, for demand-critical welds.
- C. Delegated Design Submittal: For structural-steel connections indicated on Drawings to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer fabricator professional engineer .
- B. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Acceptance Criteria 172).

- B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE .
- C. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.
 - 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.

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 relubricate 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 341.
 - 3. ANSI/AISC 360.
 - 4. RCSC'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. Option 2: Fabricator's experienced steel detailer selects or completes connections in accordance with ANSI/AISC 303.

- a. Select and complete connections using schematic details indicated and ANSI/AISC 360 .
 - b. Use Allowable Stress Design; data are given at service-load level.
 3. Option 3 and 3A: Design connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer. Member reinforcement at connections is indicated on Drawings.
 - a. Use Allowable Stress Design; data are given at service-load level.
 4. Option 3 and 3B: Design connections and final configuration of member reinforcement at connections in accordance with ANSI/AISC 303 by fabricator's qualified professional engineer.
 - a. Use Allowable Stress Design; data are given at service-load level.
- C. Moment Connections: Type FR, fully restrained.
- D. Construction: Moment frame Braced frame .

2.2 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A992/A992M .
- B. Channels, Angles, M-Shapes: ASTM A572/A572M, **Grade 50** .
- C. Plate and Bar: ASTM A572/A572M, **Grade 50** .
- D. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade B structural tubing.
- E. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.
1. Weight Class: Standard .
 2. Finish: Black except where indicated to be galvanized.
- F. Welding Electrodes: Comply with AWS requirements.

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, 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.

2.4 RODS

- A. Headed Anchor Rods: ASTM F1554, Grade 55, weldable , straight.
1. Nuts: **ASTM A563** heavy-hex carbon steel.
 2. Plate Washers: ASTM A36/A36M carbon steel.
 3. Washers: **ASTM F436**, Type 1, hardened carbon steel.

4. Finish: Mechanically deposited zinc coating, ASTM B695, Class 50.

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. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

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.
 3. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
 4. Mark and match-mark materials for field assembly.
 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- C. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- D. Cleaning: Clean and prepare steel surfaces that are to remain unpainted in accordance with SSPC-SP 2.
- E. 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.

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 and AWS D1.8/D1.8M 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 ASTM 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 shelf angles and welded door frames attached to structural-steel frame and located in exterior walls.

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.
 6. Corrosion-resisting (weathering) steel surfaces.
 7. Surfaces enclosed in interior construction.
- 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.

- 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.

2. Weld plate washers to top of baseplate.
 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 4. Promptly pack 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.
- C. Maintain erection tolerances of structural steel within ANSI/AISC 303.
- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that 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.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

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 and AWS D1.8/D1.8M 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, back gouge, and grind steel smooth.
 3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.
- C. 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.
 - 2. Cleaning and touchup painting are specified in Section 099113 "Exterior Painting." Section 099123 "Interior Painting."
- C. Touchup Priming: Cleaning and touchup priming are specified in Section 099600 "High-Performance Coatings."

3.7 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform the following special inspections:
 - 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) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.

END OF SECTION 051200

SECTION 052100 - STEEL JOIST FRAMING

1.1 SUSTAINABILITY REQUIREMENTS

- A. :
 - 1. Recycled content.

1.2 PERFORMANCE REQUIREMENTS

- A. Engineering design of special joists and connections by Contractor.

1.3 MATERIALS

- A. K-series and KCS-type K-series steel joists with top-chord extensions .
- B. K-series steel joist substitutes with steel-angle or -channel members.
- C. LH-series steel joists .
 - 1. End Arrangement: Underslung .
 - 2. Top-Chord Arrangement: Pitched, two ways.
- D. Primer: SSPC-Paint 15.
- E. Primer: Comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1.4 INSTALLATION

- A. Connections: Field welded .

1.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner engaged.

END OF SECTION 052100

SECTION 053100 - STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof deck.
2. Acoustical roof deck.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
2. Section 035216 "Lightweight Insulating Concrete" for lightweight insulating concrete fill over steel deck.
3. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
4. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Roof deck.

B. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.3 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. FM Approvals' RoofNav Listing: Provide steel roof deck evaluated by FM Approvals and listed in its "RoofNav" for Class 1 fire rating and Class 1-75 windstorm ratings. Identify materials with FM Approvals Certification markings.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Store products in accordance with SDI MOC3. 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 in accordance with AISI S100.

2.2 ROOF DECK

- A. Low Roofs
- B. Manufacturers: Subject to compliance with requirements, undefined:
 - 1. ASC Steel Deck; ASC Profiles, LLC.
 - 2. Canam Buildings US Inc.; Canam Group Inc.
 - 3. New Millennium Building Systems, LLC.
 - 4. Vulcraft Group; Division of Nucor Corp.
 - 5. Vulcraft/Verco Group; a division of Nucor Corp.
- C. Fabrication of Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with SDI RD and with the following:
 - 1. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 33 , G60 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
 - a. Color: Manufacturer's standard .
 - 2. Deck Profile: Type WR, wide rib .
 - 3. Cellular Deck Profile: , with bottom plate.
 - 4. Profile Depth: As indicated .
 - 5. Design Uncoated-Steel Thickness: As indicated .
 - 6. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: As indicated .
 - 7. Span Condition: Triple span or more.
 - 8. Side Laps: Interlocking seam .

2.3 ACOUSTICAL ROOF DECK

- A. High Roof Over Market
- B. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Vulcraft Group; Division of Nucor Corp.
- C. Fabrication of Acoustical Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with SDI RD and with the following:
 - 1. Prime-Painted Steel Sheet: ASTM A1008/A1008M, Structural Steel (SS), Grade **40** minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
 - a. Color: Manufacturer's standard .
 - 2. Galvanized- and Shop-Primed Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade **40** , **G60** zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
 - a. Color: Manufacturer's standard .
 - 3. Aluminum-Zinc-Alloy-Coated Steel Sheet: ASTM A792/A792M, Structural Steel (SS), Grade **33** minimum, **AZ50** aluminum-zinc-alloy coating.
 - 4. Deck Profile: As indicated .
 - 5. Cellular Deck Profile: As indicated , with bottom plate.
 - 6. Profile Depth: As indicated .
 - 7. Design Uncoated-Steel Thickness: As indicated .
 - 8. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: As indicated .
 - 9. Span Condition: Double span .
 - 10. Side Laps: Overlapped .
 - 11. Acoustical Perforations: Deck units with manufacturer's standard perforated vertical webs .
 - 12. Sound-Absorbing Insulation: Manufacturer's standard premolded roll or strip of glass or mineral fiber. .
 - a. Factory install sound-absorbing insulation into cells of cellular deck.
 - b. Installation of sound-absorbing insulation is specified in .
 - 13. Acoustical Performance: NRC 0.80 , tested in accordance with ASTM C423.

2.4 ACCESSORIES

- A. Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, **No. 10** minimum diameter.
- D. 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.

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, GENERAL

- A. Install deck panels and accessories in accordance with SDI C, SDI NC, and SDI RD, as applicable; manufacturer's written instructions; and requirements in this Section.
- B. Install temporary shoring before placing deck panels if required to meet deflection limitations.
- C. Locate deck bundles to prevent overloading of supporting members.
- D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
 - 1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.
- E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install in accordance with deck manufacturer's written instructions.
- J. 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.

3.3 INSTALLATION OF ROOF DECK

- A. 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.

- B. 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 .
- C. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and mechanically fasten flanges to top of deck. Space mechanical fasteners not more than **12 inches** apart with at least one fastener at each corner.
 - 1. Install reinforcing channels or zees in ribs to span between supports and mechanically fasten.
- D. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels in accordance with deck manufacturer's written instructions. 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.
- E. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive in accordance with manufacturer's written instructions to ensure complete closure.

3.4 REPAIR

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint in accordance with ASTM A780/A780M and manufacturer's written instructions.
- B. Repair Painting:
 - 1. Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.
 - 2. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
 - 3. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 - 4. 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."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Special inspections and qualification of welding special inspectors for cold-formed steel floor and roof deck in accordance with quality-assurance inspection requirements of SDI QA/QC.

- a. Field welds will be subject to inspection.
 2. Steel decking will be considered defective if it does not pass tests and inspections.
 3. Shear Stud Connectors: In addition to visual inspection, test and inspect field-welded shear connectors in accordance with 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 in accordance with requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors that are already tested.
- C. Prepare test and inspection reports.

END OF SECTION 053100

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior non-load-bearing wall framing.
2. Interior non-load-bearing wall framing.
3. Ceiling joist framing.
4. Soffit framing.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel shapes, masonry shelf angles, and connections used with cold-formed metal framing.
2. Section 092116.23 "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies, with height limitations.
3. Section 092216 "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Cold-formed steel framing materials.
2. Exterior non-load-bearing wall framing.
3. Interior non-load-bearing wall framing.
4. Vertical deflection clips.
5. Single deflection track.
6. Double deflection track.
7. Drift clips.
8. Ceiling joist framing.
9. Soffit framing.
10. Power-actuated anchors.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

C. Delegated Design Submittal: For cold-formed steel framing.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of code-compliance certification for studs and tracks.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.
- B. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Steel Stud Manufacturers Association .
- C. Comply with AISI S230 "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings."

1.5 DELIVERY, STORAGE, AND HANDLING

- 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AllSteel & Gypsum Products, Inc.
 - 2. ClarkDietrich.
 - 3. Consolidated Fabricators Corp.; Building Products Division.
 - 4. Design Shapes in Steel.
 - 5. Formetal Co. Inc. (The).
 - 6. Marino\WARE.
 - 7. MBA Metal Framing.
 - 8. MRI Steel Framing, LLC.
 - 9. SCAFCO Steel Stud Company; Stone Group of Companies.
 - 10. Steel Construction Systems; Stone Group of Companies.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.
- B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
 - 1. Design Loads: As indicated on Drawings .

2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
 - a. Exterior Load-Bearing Wall Framing: Horizontal deflection of 1/600 of the wall height.
 - b. Interior Load-Bearing Wall Framing: Horizontal deflection of 1/360 of the wall height under a horizontal load of 5 lbf/sq. ft..
 - c. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/600 of the wall height.
 - d. Interior Non-Load-Bearing Framing: Horizontal deflection of 1/240 of the wall height under a horizontal load of 5 lbf/sq. ft..
 - e. Roof Rafter Framing: Vertical deflection of 1/240 of the horizontally projected span for live loads.
 - f. Ceiling Joist Framing: Vertical deflection of 1/240 of the span for live loads and 1/240 for total loads of the span.
3. 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.
4. 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:
 - a. Upward and downward movement of 1 inch .
5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

- C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing complies with AISI S100 and AISI S200 and ASTM C955, Section 8 .

2.3 COLD-FORMED STEEL FRAMING MATERIALS

- A. Framing Members, General: Comply with AISI S200 and ASTM C955, Section 8 for conditions indicated.
- B. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
1. Grade: As required by structural performance .
 2. Coating: G90 or equivalent .
- C. Steel Sheet for Vertical Deflection Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:
1. Grade: As required by structural performance .
 2. Coating: G90 .

2.4 EXTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch .
 2. Flange Width: 1-5/8 inches .
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch Matching steel studs .
 2. Flange Width: 1-1/4 inches .
- C. Vertical Deflection Clips, Exterior: Manufacturer's standard head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ClarkDietrich.
 - b. Marino\WARE.
 - c. SCAFCO Steel Stud Company; Stone Group of Companies.
 - d. Steel Construction Systems; Stone Group of Companies.
 - e. Steel Network, Inc. (The).
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch .
 2. Flange Width: 1 inch plus the design gap for one-story structures .
- 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.

2.5 INTERIOR NON-LOAD-BEARING WALL FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch .
 2. Flange Width: 1-5/8 inches .
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch .
 2. Flange Width: 1-1/4 inches .
- C. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with

flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch .
2. Flange Width: 1 inch plus the design gap for one-story structures .

- D. 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 CEILING JOIST FRAMING

- A. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, punched with standard holes, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch .
2. Flange Width: 1-5/8 inches , minimum.

2.7 SOFFIT FRAMING

- A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch .
2. Flange Width: 1-5/8 inches , minimum.

2.8 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.

- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Anchor clips.
4. Foundation clips.
5. Stud kickers and knee braces.

2.9 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.

- B. 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.

- C. 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.
- D. Welding Electrodes: Comply with AWS standards.

2.10 MISCELLANEOUS MATERIALS

- A. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.

2.11 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.
 - 2. Cut framing members by sawing or shearing; do not torch cut.
 - 3. 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.
 - 4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.
- C. 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. Examine substrates, areas, conditions, and abutting structural framing 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 PREPARATION

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

3.3 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
 - 1. 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**.
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
 - 1. Cut framing members by sawing or shearing; do not torch cut.

2. 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.
- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. 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.
- G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
- H. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- I. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 INSTALLATION OF EXTERIOR NONLOADBEARING WALL FRAMING

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
 1. Stud Spacing: **16 inches**.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
 1. Install single deep-leg deflection tracks and anchor to building structure.
 2. Install double deep-leg deflection tracks and anchor outer track to building structure.
 3. Connect vertical deflection clips to infill studs and anchor to building structure.
 4. Connect drift clips to cold-formed steel framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than **48 inches** apart. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within **12 inches** of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
1. Install solid blocking at **96-inch** centers .
- G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 INSTALLATION OF INTERIOR NONLOADBEARING WALL FRAMING

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

- F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within **12 inches** of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
 - 1. Install solid blocking at **96-inch** centers .
- G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.6 INSTALLATION OF JOIST FRAMING

- A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.
- B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.
 - 1. Install joists over supporting frame with a minimum end bearing of **1-1/2 inches**.
 - 2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections.
- C. Space joists not more than **2 inches** from abutting walls, and as follows:
 - 1. Joist Spacing: **16 inches** .
- D. Frame openings with built-up joist headers, consisting of joist and joist track or another combination of connected joists if indicated.
- E. Install bridging at intervals indicated on Shop Drawings. Fasten bridging at each joist intersection as follows:
 - 1. Joist-Track Solid Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
- F. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.
- G. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.7 INSTALLATION TOLERANCES

- A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of **1/8 inch in 10 feet** and as follows:
 - 1. 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.

3.8 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.

3.9 FIELD QUALITY CONTROL

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

3.10 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 054000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous framing and supports.
2. Prefabricated building columns.
3. Shelf angles.
4. Metal ladders.
5. Alternating tread devices.
6. Metal ships' ladders and pipe crossovers.
7. Metal floor plate.
8. Elevator pit sump covers.
9. Structural-steel door frames.
10. Miscellaneous steel trim.
11. Metal bollards.
12. Vehicular barrier cable systems.
13. Pipe and downspout guards.
14. Abrasive metal nosings, treads, and thresholds.
15. Cast-iron wheel guards.
16. Metal downspout boots.
17. Loose bearing and leveling plates.

B. 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.

C. Related Requirements:

1. Section 042000 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
2. Section 051200 "Structural Steel Framing" for steel framing, supports, elevator machine beams, hoist beams, divider beams, door frames, and other steel items attached to the structural-steel framing.
3. Section 077200 "Roof Accessories" for manufactured metal roof walkways and metal roof stairs.

1.2 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.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Nonslip aggregates and nonslip-aggregate surface finishes.
 - 2. Fasteners.
 - 3. Shop primers.
 - 4. Shrinkage-resisting grout.
 - 5. Prefabricated building columns.
 - 6. Slotted channel framing.
 - 7. Manufactured metal ladders.
 - 8. Alternating tread devices.
 - 9. Metal ships' ladders and pipe crossovers.
 - 10. Metal bollards.
 - 11. Vehicular barrier cable systems.
 - 12. Pipe and downspout guards.
 - 13. Abrasive metal nosings, treads, and thresholds.
 - 14. Cast-iron wheel guards.
 - 15. Metal downspout boots.
- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:
 - 1. Miscellaneous framing and supports for applications where framing and supports are not specified in other Sections.
 - 2. Elevator machine beams, hoist beams, and divider beams.
 - 3. Steel shapes for supporting elevator door sills.
 - 4. Steel girders for supporting wood frame construction.
 - 5. Steel pipe columns for supporting wood frame construction.
 - 6. Prefabricated building columns.
 - 7. Shelf angles.
 - 8. Metal ladders.
 - 9. Alternating tread devices.
 - 10. Metal ships' ladders and pipe crossovers.
 - 11. Metal floor plate and supports.
 - 12. Elevator pit sump covers.
 - 13. Structural-steel door frames.
 - 14. Metal bollards.

- 15. Loose steel lintels.
- 16. Vehicular barrier cable systems.

- C. Delegated Design Submittals: For ladders alternating tread devices , including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Mill Certificates: Signed by stainless steel manufacturers, certifying that products furnished comply with requirements.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Research Reports: For post-installed anchors.
- E. Delegated design engineer qualifications.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 - 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.6 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. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design ladders alternating tread devices .
- B. Structural Performance of Aluminum Ladders: Ladders , including landings, are to withstand the effects of loads and stresses within limits and under conditions specified in ANSI/ASC A14.3.

- C. Structural Performance of Alternating Tread Devices: Alternating tread devices are to 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. Alternating Tread Device Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
 - 5. Comply with applicable railing loadings in Section 055213 "Pipe and Tube Railings."
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F , ambient; 180 deg F , material surfaces .

2.2 METALS

- 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 Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Stainless Steel Sheet, Strip, and Plate: ASTM A240/A240M or ASTM A666, Type 304 .
- D. Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 304 .
- E. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.
- F. Rolled-Stainless Steel Floor Plate: ASTM A793.
- G. Abrasive-Surface Floor Plate: Steel plate with abrasive material metallurgically bonded to steel.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 - a. IKG.
 - b. Ohio Gratings, Inc.
 - c. SlipNOT Metal Safety Flooring, division of Traction Technologies Holdings, LLC.
 - d. .
 - 2. Source Limitations: Obtain floor plate from single source from single manufacturer.
- H. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
- I. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.
- J. Zinc-Coated Steel Wire Rope: ASTM A741.

1. Wire Rope Fittings: Hot-dip galvanized-steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.
- K. Stainless Steel Wire Rope: Wire rope manufactured from stainless steel wire complying with ASTM A492, Type 316.
 1. Wire Rope Fittings: Stainless steel connectors, Type 316, with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.
- L. Steel Prestressing Strand: ASTM A416/A416M, **Grade 270**, low-relaxation, seven-wire, with **0.9-lb/sq. ft.** zinc coating.
 1. Steel Prestressing Strand Fittings: Hot-dip galvanized-steel anchors and connectors with capability to sustain, without failure, a load equal to minimum breaking strength of steel prestressing strand with which they are used.
- M. 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. Galvanized Steel: ASTM A653/A653M, commercial steel, Type B structural steel, **Grade 33**, with **G90** coating; **0.064-inch** nominal thickness.
 3. Cold-Rolled Steel: ASTM A1008/A1008M, commercial steel, Type B structural steel, **Grade 33**; **0.0528-inch** minimum thickness; coated with rust-inhibitive, baked-on, acrylic enamel.
- N. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.
- O. Aluminum Plate and Sheet: **ASTM B209**, Alloy 6061-T6.
- P. Aluminum Extrusions: **ASTM B221**, Alloy 6063-T6.
- Q. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.
- R. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.
- S. Bronze Extrusions: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze).
- T. Bronze Castings: ASTM B584, Alloy UNS No. C83600 (leaded red brass) or UNS No. C84400 (leaded semired brass).
- U. Nickel Silver Extrusions: ASTM B151/B151M, Alloy UNS No. C74500.
- V. Nickel Silver Castings: ASTM B584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

2.3 FASTENERS

- 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 aluminum .
 - 2. Provide bronze fasteners for fastening bronze.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, **ASTM A307, Grade A**; with hex nuts, **ASTM A563**; and, where indicated, flat washers.
- C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, **Grade A325**, Type 3, heavy-hex steel structural bolts; **ASTM A563, Grade DH3**, heavy-hex carbon-steel nuts; and where indicated, flat washers.
- D. 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** .
- E. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, **ASTM A563**; and, where indicated, flat washers.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- F. 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.
- G. 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.
- H. 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**.
- I. 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.

2.4 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting."
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 - 1. Use primer that contains pigments that make it easily distinguishable from zinc-rich primer.
- C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.
- D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- H. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- I. 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**.

2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch 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 bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. 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.
- F. 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.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. 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.

2.6 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. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.
1. Provide bearing plates welded to beams where indicated.
 2. Drill or punch girders and plates for field-bolted connections where indicated.
 3. Where wood nailers are attached to girders with bolts or lag screws, drill or punch holes at **24 inches** o.c.
- D. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.
1. Unless otherwise indicated, fabricate from Schedule 40 steel pipe.

2. Unless otherwise indicated, provide **1/2-inch** baseplates with four **5/8-inch** anchor bolts and **1/4-inch** top plates.
- E. Galvanize miscellaneous framing and supports where indicated.
- F. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

2.7 SHELF ANGLES

- A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive **3/4-inch** bolts, spaced not more than **6 inches** from ends and **24 inches** o.c., unless otherwise indicated.
 1. Provide mitered and welded units at corners.
 2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately **2 inches** larger than expansion or control joint.
- B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
- C. Galvanize and prime shelf angles located in exterior walls.
- D. Prime shelf angles located in exterior walls with zinc-rich primer.
- E. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.8 METAL LADDERS

- A. Steel Ladders:
 1. Space siderails **16 inches** apart unless otherwise indicated.
 2. Siderails: Continuous, **3/8-by-2-1/2-inch** steel flat bars, with eased edges.
 3. Rungs: **3/4-inch** diameter, steel bars.
 4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
 5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
 6. Nonslip Surfaces for Steel Ladders: Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 - 1) IKG.
 - 2) SlipNOT Metal Safety Flooring, division of Traction Technologies Holdings, LLC.
 7. Source Limitations: Obtain nonslip surfaces from single source from single manufacturer.
 8. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than **1/2 inch** in least dimension.

9. Support each ladder at top and bottom and not more than 60 inches>o.c. with welded or bolted steel brackets.
10. Galvanize and prime exterior ladders, including brackets.
11. Prime exterior ladders, including brackets and fasteners, with zinc-rich primer.

B. Aluminum Ladders:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 - a. Fixfast USA.
 - b. Halliday Products.
 - c. O'Keeffe's Inc.
 - d. Precision Ladders, LLC.
 - e. Royalite Manufacturing, Inc.
 - f. Thompson Fabricating, LLC.
 - g. UPNOVR, Inc.
2. Source Limitations: Obtain aluminum ladders from single source from single manufacturer.
3. Space siderails 16 inches apart unless otherwise indicated.
4. Siderails: Continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches deep, 3/4 inch wide, and 1/8 inch thick.
5. Rungs: Extruded-aluminum tubes, not less than 3/4 inch deep and not less than 1/8 inch thick, with ribbed tread surfaces.
6. Fit rungs in centerline of siderails; fasten by welding or with stainless steel fasteners or brackets and aluminum rivets.
7. Provide platforms as indicated fabricated from extruded-aluminum plank grating, supported by extruded-aluminum framing. Limit openings in gratings to no more than 1/2 inch in least dimension.
8. Support each ladder at top and bottom and not more than 60 inches>o.c. with welded or bolted aluminum brackets.
9. Provide minimum 72-inch- high, hinged security door with padlock hasp at foot of ladder to prevent unauthorized ladder use.

2.9 METAL SHIPS' LADDERS AND PIPE CROSSOVERS

- A. Provide metal ships' ladders and pipe crossovers where indicated. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.
1. Treads are not to be less than 5 inches exclusive of nosing or less than 8-1/2 inches including the nosing, and riser height is not to be more than 9-1/2 inches.
 2. Fabricate ships' ladders and pipe crossovers, including railings from aluminum.
 3. Fabricate treads and platforms from pressure-locked stainless steel bar extruded-aluminum plank grating. Limit openings in gratings to no more than 1/2 inch in least dimension.
 4. Fabricate treads and platforms from rolled-aluminum-alloy tread plate.
 5. Comply with applicable railing requirements in Section 055213 "Pipe and Tube Railings."

- B. Galvanize and prime exterior steel ships' ladders and pipe crossovers, including treads, railings, brackets, and fasteners.
- C. Prime exterior steel ships' ladders and pipe crossovers, including treads, railings, brackets, and fasteners, with zinc-rich primer.

2.10 STRUCTURAL-STEEL DOOR FRAMES

- A. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with **5/8-by-1-1/2-inch** steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than **10 inches** o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.
 - 1. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.
- B. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.
- C. Galvanize and prime exterior steel frames.
- D. Prime exterior steel frames with zinc-rich primer.

2.11 MISCELLANEOUS STEEL TRIM

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

2.12 METAL BOLLARDS

- A. Fabricate metal bollards from Schedule 80 steel pipe .
 - 1. Cap bollards with **1/4-inch-** thick, steel plate with domed top.
 - 2. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.
 - 3. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.

- B. Fabricate internal sleeves for removable bollards from Schedule 80 steel pipe or **1/4-inch** wall-thickness steel tubing with an OD approximately **1/16 inch** less than ID of bollards. Match drill sleeve and bollard for **3/4-inch** steel machine bolt.
- C. Prime steel bollards with zinc-rich primer.

2.13 PIPE AND DOWNSPOUT GUARDS

- A. Fabricate downspout guards from **3/8-inch-** thick by **12-inch-** wide, steel plate, bent to fit flat against the wall or column at both ends and to fit around pipe with **2-inch** clearance between pipe and pipe guard. Drill each end for two **3/4-inch** anchor bolts.
- B. Galvanize and prime steel downspout guards.
- C. Prime steel downspout guards with zinc-rich primer.

2.14 METAL DOWNSPOUT BOOTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 - 1. J.R. Hoe & Sons Inc.
 - 2. Neenah Foundry Company.
- B. Source Limitations: Obtain downspout boots from single source from single manufacturer.
- C. Provide downspout boots made from cast aluminum in heights indicated with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.
 - 1. Outlet: Horizontal, to discharge into pipe .
- D. Prime cast-iron downspout boots with zinc-rich primer.

2.15 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. Size loose lintels to provide bearing length at each side of openings equal to one-twelfth of clear span, but not less than **8 inches** unless otherwise indicated.
- C. Galvanize and prime loose steel lintels located in exterior walls.
- D. Prime loose steel lintels located in exterior walls with zinc-rich primer.

2.16 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.

2.17 GENERAL FINISH REQUIREMENTS

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.18 ALUMINUM FINISHES

- A. As-Fabricated Finish: AA-M12.
- B. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- 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. 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.
- D. 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.

- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
 - 1. Cast Aluminum: Heavy coat of bituminous paint.
 - 2. Extruded Aluminum: Two coats of clear lacquer.

3.2 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 ceiling-hung toilet partitions overhead doors securely to, and rigidly brace from, building structure.
- C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
 - 1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.
- 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.

3.3 INSTALLATION OF PREFABRICATED BUILDING COLUMNS

- A. Install prefabricated building columns to comply with ANSI/AISC 360, "Specifications for Structural Steel Buildings," and with requirements applicable to listing and labeling for fire-resistance rating indicated.

3.4 INSTALLATION OF SHELF ANGLES

- A. Install shelf angles as required to keep masonry level, at correct elevation, and flush with vertical plane.

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 ALTERNATING TREAD DEVICES

- A. Secure top and bottom of alternating tread devices to construction to comply with manufacturer's written instructions.

3.7 INSTALLATION OF METAL SHIPS' LADDERS AND PIPE CROSSOVERS

- A. Secure top and bottom of ships' ladders to construction to comply with manufacturer's written instructions.
- B. Secure pipe crossovers to construction to comply with manufacturer's written instructions.

3.8 INSTALLATION OF METAL FLOOR PLATE

- A. Install metal floor plates flush with finished surface. Adjust as required to avoid lippage that could present a tripping hazard.

3.9 INSTALLATION OF ELEVATOR PIT SUMP COVERS

- A. Install tops of elevator sump pit cover plates and frames flush with finished surface. Adjust as required to avoid lippage that could present a tripping hazard.

3.10 INSTALLATION OF STRUCTURAL-STEEL DOOR FRAMES

- A. Fasten structural steel door frames to the floor slab by means of angle clips and expansion bolts. Anchor door jambs to adjacent construction in accordance with shop drawing details.

3.11 INSTALLATION OF MISCELLANEOUS STEEL TRIM

- A. Anchor to concrete construction to comply with manufacturer's written instructions.

3.12 INSTALLATION OF METAL BOLLARDS

- A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
 - 1. Do not fill removable bollards with concrete.
- B. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete . Fill annular space around bollard solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately **1/8 inch** toward bollard.
- C. Anchor bollards in place with concrete footings. Center and align bollards in holes **3 inches** above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

- D. Anchor internal sleeves for removable bollards in concrete by inserting in pipe sleeves preset into concrete . Fill annular space around internal sleeves solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately **1/8 inch** toward internal sleeve.
- E. Anchor internal sleeves for removable bollards in place with concrete footings. Center and align sleeves in holes **3 inches** above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace sleeves in position until concrete has cured.
- F. Place removable bollards over internal sleeves and secure with **3/4-inch** machine bolts and nuts. After tightening nuts, drill holes in bolts for inserting padlocks. Owner furnishes padlocks.
- G. Fill bollards solidly with concrete, mounding top surface to shed water.
 - 1. Do not fill removable bollards with concrete.

3.13 INSTALLATION OF VEHICULAR BARRIER CABLE SYSTEMS

3.14 INSTALLATION OF PIPE AND DOWNSPOUT GUARDS

3.15 INSTALLATION OF ABRASIVE METAL NOSINGS, TREADS, AND THRESHOLDS

- A. Center nosings on tread widths unless otherwise indicated.
- B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.
- C. Seal thresholds exposed to exterior with elastomeric sealant complying with Section 079200 "Joint Sealants" to provide a watertight installation.

3.16 INSTALLATION OF CAST-IRON WHEEL GUARDS

- A. Anchor wheel guards to concrete or masonry construction to comply with manufacturer's written instructions. Fill cores solidly with concrete.

3.17 INSTALLATION OF METAL DOWNSPOUT BOOTS

- A. Anchor metal downspout boots to concrete or masonry construction to comply with manufacturer's written instructions.
- B. Secure downspouts terminations to downspouts and substrate per manufacturer's instructions.

3.18 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.

3.19 REPAIRS

A. Touchup Painting:

- 1. 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.
 - a. 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."

- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055000

SECTION 055100 - METAL STAIRS

PART 1 – GENERAL

1.1 SUBMITTALS

- A. Product Data: The Basis-of-Design is a prefabricated stair by Upside Innovations.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.

1.2 QUALITY ASSURANCE

- A. Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in, or personnel under direct supervision of such an engineer.

PART 2 – PRODUCTS

2.1 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 the 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 Americans with Disabilities Act (ADA) Standards.
 - 3. Structural Design: Provide complete stair and railing assemblies that comply with the applicable local code.
- B. Metal Jointing and Finish Quality Levels:
 - 1. Architectural: All joints as inconspicuous as possible, whether welded or mechanical.
 - 2. Commercial: Exposed joints as inconspicuous as possible, whether welded or mechanical; underside of stair not covered by soffit is considered exposed to view.
- 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.

2.2 METAL STAIRS WITH METAL TREADS

- A. Jointing and Finish Quality Level: Architectural, as defined above.

2.3 PREFABRICATED STAIRS

- A. Prefabricated Rooftop Stairs: Welded unit, factory fabricated to greatest degree practical and in the largest components possible.
- B. Alternating Tread Stairs: Welded metal unit; factory fabricated to the greatest degree possible.

2.4 HANDRAILS AND GUARDS

- A. Wall-Mounted Rails: See Section 055213.
- B. Post-Mounted Rails: See Section 055213.

2.5 MATERIALS

- A. Extruded Aluminum: ASTM B211/B211M, 6063 alloy, T6 temper.
- B. Sheet Aluminum: ASTM B209/B209M, 5052 alloy, H32 or H22 temper.
- C. Aluminum-Alloy Drawn Seamless Tubes: ASTM B210/B210M, 6063 alloy, T6 temper.
- D. Aluminum-Alloy Bars: ASTM B211/B211M, 6061 alloy, T6 temper.
- E. Aluminum-Alloy Sand Castings: ASTM B26/B26M.
- F. Aluminum-Alloy Die Castings: ASTM B85/B85M.
- G. Bolts, Nuts, and Washers: Stainless-steel.
- H. Welding Materials: AWS D1.2/D1.2M; type required for materials being welded.
- I. Gratings: Bar gratings that comply with NAAMM MBG 531 or NAAMM MBG 532, whichever applies based on bar sizes.

2.6 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.

2.7 FINISHES - ALUMINUM

- A. Exterior Aluminum Surfaces: Class I natural anodized.
- B. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils thick.

PART 3 – EXECUTION

3.1 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.

END OF SECTION 055100

DOCUMENT 055133 - METAL LADDERS

PART 1 – GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include Erection Drawings, elevations, and details where applicable.

PART 2 – PRODUCTS

2.1 MATERIALS - ALUMINUM

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

2.2 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. Continuously seal joined members by intermittent welds and plastic filler.
- D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

2.3 PREFABRICATED LADDERS

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

2.4 FINISHES - ALUMINUM

- A. Exterior Aluminum Surfaces: Class I natural anodized.
- B. Interior Aluminum Surfaces: Class I natural anodized.
- C. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils thick.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Field weld components as indicated on Drawings.

END OF SECTION 055133

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SECTION 055213 - PIPE AND TUBE RAILINGS

PART 1 – GENERAL

1.1 SUBMITTALS

- A. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.

PART 2 – PRODUCTS

2.1 RAILINGS - GENERAL REQUIREMENTS

- A. Design, fabricate, and test railing assemblies in accordance with the most stringent requirements of applicable local code.
- B. Allow for expansion and contraction of members and building movement without damage to connections or members.
- C. Provide anchors and other components as required to attach to structure, made of same materials as railing components unless otherwise indicated; where exposed fasteners are unavoidable provide flush countersunk fasteners.
- D. Provide slip-on non-weld mechanical fittings to join lengths, seal open ends, and conceal exposed mounting bolts and nuts, including but not limited to elbows, T-shapes, splice connectors, flanges, escutcheons, and wall brackets.

2.2 ALUMINUM MATERIALS

- A. Aluminum Tube: Minimum wall thickness of 0.127-inch; ASTM B429/B429M, ASTM B241/B241M, or ASTM B483/B483M.
- B. Straight Splice Connectors: Concealed spigot; cast aluminum.
- C. Exposed Fasteners: No exposed bolts or screws.

2.3 FABRICATION

- A. Accurately form components to suit specific Project conditions and for proper connection to building structure.
- B. Fit and shop assemble components in largest practical sizes for delivery to site.

2.4 ALUMINUM FINISHES

- A. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils thick.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install components plumb and level, accurately fitted, free from distortion or defects, with tight joints.

END OF SECTION 055213

SECTION 057300 - DECORATIVE METAL RAILINGS - SITE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Aluminum decorative railings.
 - 2. Steel decorative railings.

1.3 COORDINATION AND SCHEDULING

- 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.
- B. Coordinate installation of anchorages for railings. 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 items to Project site in time for installation.

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's product lines of decorative metal railings assembled from standard components.
 - 2. Perforated metal infill panels.
 - 3. Fasteners.
 - 4. Post-installed anchors.
 - 5. Handrail brackets.
 - 6. Shop primer.
 - 7. Bituminous paint.
 - 8. Nonshrink, nonmetallic grout.
 - 9. Anchoring cement.

10. Metal finishes.

- B. Shop Drawings: Include plans, elevations, sections, and attachment details.
- C. Samples for Initial Selection: For products involving selection of color, texture, or design.
- D. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Mill Certificates: Signed by manufacturers of stainless steel products, certifying that products furnished comply with requirements.
- C. Welding certificates.
- D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- E. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces of railings from damage by applying a strippable, temporary protective covering before shipping.

1.7 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design railings, including attachment to building construction.

- B. Structural Performance: Railings, including attachment to building construction, 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. Infill load and other loads need not be assumed to act concurrently.

- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior railings by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Same metal and finish as supported rails unless otherwise indicated.

2.3 FASTENERS

A. Fastener Materials:

1. Aluminum Railing Components: Type 304 Type 316 stainless steel fasteners.
2. Stainless Steel Railing Components: Type 304 Type 316 stainless steel fasteners.
3. Ungalvanized-Steel Railing Components: Plated-steel fasteners complying with ASTM F1941/F1941M, Class Fe/Zn 5 for electrodeposited zinc coating where concealed; Type 304 stainless steel fasteners where exposed.

4. Hot-Dip Galvanized-Steel Railing Components: Type 304 stainless steel or hot-dip zinc-coated steel fasteners complying with ASTM A153/A153M or ASTM F2329/F2329M for zinc coating.
 5. Dissimilar Metal Railing Components: Type 304 Type 316 stainless steel fasteners.
 6. Finish exposed fasteners to match appearance, including color and texture, of railings.
- B. 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 and capable of withstanding design loads.
- C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless otherwise indicated exposed fasteners are unavoidable exposed fasteners are the standard fastening method for railings indicated.
1. Provide Phillips tamper-resistant square or hex socket flat-head machine screws for exposed fasteners unless otherwise indicated.
- D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, in accordance with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308.
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 Group 2 stainless steel bolts, ASTM F593 and nuts, ASTM F594.

2.4 MISCELLANEOUS MATERIALS

- A. Handrail Brackets: Cast-aluminum, Cast-bronze, Cast-brass, Cast-copper, Cast-nickel-silver, Cast stainless steel, Cast-iron center of handrail 2-1/2 inches 3-1/8 inches Insert dimension from face of railing wall.
1. Provide cast-metal brackets with flange tapped for concealed anchorage to threaded hanger bolt.
 2. Provide either formed- or cast-metal brackets with predrilled hole for exposed bolt anchorage.
 3. Provide extruded-aluminum brackets with interlocking pieces that conceal anchorage. Locate set screws on bottom of bracket.
 4. Provide formed-steel brackets with predrilled hole for bolted anchorage and with snap-on cover that matches rail finish and conceals bracket base and bolt head.

- B. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- C. Lacquer for Copper Alloys: Clear acrylic lacquer specially developed for coating copper-alloy products.
- D. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- 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. Shop Primer for Galvanized Steel: Cementitious galvanized metal primer complying with MPI#26 Vinyl wash primer complying with MPI#80 Water-based galvanized metal primer complying with MPI#134.
- G. Epoxy Intermediate Coat: Complying with MPI#77 and compatible with primer and topcoat.
- H. Polyurethane Topcoat: Complying with MPI#72 and compatible with undercoat.
- I. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- J. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- K. 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.
 - 1. Water-Resistant Product: At exterior locations and where indicated on Drawings, provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.5 FABRICATION

- A. Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.

1. Clearly mark units for reassembly and coordinated installation.
 2. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately.
1. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.
 2. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that will be exposed to weather in a manner to exclude water.
1. Provide weep holes where water may accumulate.
 2. 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 mechanical connections unless otherwise indicated.
- H. 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 Finish #1 welds; ornamental quality with no evidence of a welded joint.
- I. 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.
- J. Brazed Connections: Connect copper and copper-alloy railings by brazing. Cope components at connections to provide close fit, or use fittings designed for this purpose. Braze corners and seams continuously.
1. Use materials and methods that match color of base metal, minimize distortion, and develop maximum strength and corrosion resistance.
 2. Remove flux immediately.

3. At exposed connections, finish exposed surfaces smooth and blended, so no roughness shows after finishing and brazed surface matches contours of adjoining surfaces.
- K. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings.
1. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
 2. 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. By bending to smallest radius that will not result in distortion of railing member.
- 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 cap and end fittings of same metal and finish as railings.
- 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, handrail brackets, 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.
1. Fabricate anchorage devices capable of withstanding loads imposed by railings.
 2. Coordinate anchorage devices with supporting structure.
- R. For railing posts set in concrete, provide stainless steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.

- S. For removable railing posts, fabricate slip-fit sockets from stainless steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height.
 - 1. Provide socket covers designed and fabricated to resist being dislodged.
 - 2. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.
- T. Perforated-Metal Infill Panels: Fabricate infill panels from perforated metal made from same metal as railings in which they are installed.
 - 1. Edge panels with U-shaped channels made from metal sheet, of same metal as perforated metal and not less than 0.043 inch thick.
 - 2. Orient perforated metal with pattern per plans.
- U. Toe Boards: Where indicated on Drawings, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.6 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 unacceptable. 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.

2.7 ALUMINUM FINISHES

- A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: As indicated by manufacturer's designations Match Architect's sample As selected by Architect from manufacturer's full range Insert color and gloss.

2.8 STEEL FINISHES

A. Galvanized Railings:

1. Hot-dip galvanize exterior steel railings, including hardware, after fabrication.
2. Hot-dip galvanize indicated steel railings, including hardware, after fabrication.
3. Comply with ASTM A123/A123M for hot-dip galvanized railings.
4. Comply with ASTM A153/A153M for hot-dip galvanized hardware.
5. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
6. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner and as follows:

1. Comply with SSPC-SP 16.

D. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1 for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

1. Do not apply primer to galvanized surfaces.

E. Powder-Coat Finish for Galvanized Metal: Prepare, treat, and coat galvanized metal to comply with resin manufacturer's written instructions and as follows:

1. Prepare galvanized metal by thoroughly removing grease, dirt, oil, flux, and other foreign matter.
2. Treat prepared metal with zinc-phosphate pretreatment, rinse, and seal surfaces.
3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness of not less than 1.5 mils.
4. Color: As indicated by manufacturer's designations Match Architect's sample As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION, GENERAL

- A. Perform cutting, drilling, and fitting required for installing railings.
 - 1. Fit exposed connections together to form tight, hairline joints.
 - 2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
 - 3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
 - 4. 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.
 - 5. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 - 6. 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.
- B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
 - 1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- C. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 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.

3.4 ANCHORING POSTS

- A. Use stainless steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. 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.
- C. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material.
- D. Leave anchorage joint exposed with 1/8-inch buildup, sloped away from post.
- E. 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.

- F. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.5 ATTACHING RAILINGS

- A. Anchor railing ends to concrete and masonry with flanges connected to brackets on underside of rails connected to railing ends and anchored to wall construction with anchors and bolts.
- B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends connected to railing ends, using nonwelded connections.
- C. 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.
 - 1. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

3.6 REPAIR

- A. Touchup Painting:
 - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
 - 2. Touchup Painting: Clean and touchup painting of field welds, bolted connections, and abraded areas of shop paint per manufacturer's recommendations and specifications.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections and to prepare test reports. Payment for these services will be made by Owner.
- B. Extent and Testing Methodology: Testing agency will randomly select completed railing assemblies for testing that are representative of different railing designs and conditions in the completed Work. Test railings in accordance with ASTM E894 and ASTM E935 for compliance with performance requirements.

- C. Remove and replace railings where test results indicate that they do not comply with specified requirements unless they can be repaired in a manner satisfactory to Architect and comply with specified requirements.
- D. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.

3.8 CLEANING

- A. Clean by washing thoroughly with clean water and soap, rinsing with clean water, and wiping dry.

3.9 PROTECTION

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

END OF SECTION

SECTION 057500 - DECORATIVE FORMED METAL

PART 1 – GENERAL

1.1 SUBMITTALS

- A. Product Data - Metal Composite Material (MCM) Sheets: Manufacturer's data sheets on each product to be used, including thickness, physical characteristics, and finish.
- B. Shop Drawings: Show layout and elevations, dimensions and thickness of panels, connections, details and location of joints, sealants and gaskets, method of anchorage, number of anchors, supports, reinforcement, trim, flashings, and accessories.
- C. Verification Samples: For each finish product specified, minimum size 12 inches square, representing actual product in color and texture.

PART 2 – PRODUCTS

2.1 FORMED METAL FABRICATIONS - GENERAL

- A. Shop Assembly: Preassemble items to greatest extent possible. Minimize field splices and field assembly. Disassemble only as necessary for transportation and handling. Mark items clearly for assembly and installation.
- B. Coordination: Match dimensions and attachment of formed metal items to adjacent construction. Produce integrated assemblies. Closely fit joints: align edges and flat surfaces unless indicated otherwise.
- C. Forming: Profiles indicated. Maximize lengths. Fold exposed edges to form hem indicated or ease edges to radius indicated with concealed stiffener. Provide flat, flush surfaces without cracking or grain separation at bends.
- D. Reinforcement: Increase metal thickness; use concealed stiffeners, backing materials or both. Provide stretcher leveled standard of flatness and stiffness required to maintain flatness and hold adjacent items in flush alignment.
- E. Anchors: Straps, plates, and anchors as required to support and anchor items to adjacent construction.
- F. Supports: Miscellaneous framing, mounting, clips, sleeves, fasteners, and accessories required for installation.
- G. Welding and Brazing: Weld or braze joints continuously. Grind, fill or dress to produce smooth, flush, exposed surfaces. Do not discolor metal. Grind smooth, polish, and restore damaged finishes to required condition.

H. Performance Requirements:

1. Thermal Movements:

- a. Allow for thermal movements in exterior metal fabrications due to temperature changes. Prevent buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 - b. Temperature Change Range: 120 degrees F, ambient; 180 degrees F, on material surfaces.
2. Corrosion: Prevent galvanic action and other forms of corrosion by isolating metals and other materials from direct contact with incompatible materials.

2.2 MATERIALS

- A. General: Provide sheet metal without pitting, seam marks, roller marks, stains, discolorations, or other imperfections exposed to view on finished units.

2.3 FINISHES

- A. Finishes, 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 1/2 of range represented in approved samples. Noticeable variations in the same piece are not acceptable. Install components within range of approved samples to minimize contrast.

- B. Steel Finishes:

1. Surface Preparation: Comply with SSPC-SP 1; remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust from uncoated steel; comply with SSPC-SP 5.
2. Pretreatment: Immediately after cleaning, apply a conversion coating of type suited to organic coating applied over it.
3. Factory Prime: Apply shop primer to prepared surfaces of items where field painting after installation indicated, unless indicated otherwise.
4. Powder-Coat Finish: Manufacturer's standard thermosetting polyester or acrylic urethane powder coating; minimum cured-film thickness of 1.5-mils.

PART 3 – EXECUTION

3.1 INSTALLATION - SHEET METAL AND PLATE FABRICATIONS

- A. Locate and place decorative formed sheet metal items level and plumb; align with adjacent construction. Cut, drill, and fit as required to install.

END OF SECTION 057500

SECTION 061000 - ROUGH CARPENTRY

PART 1 – GENERAL

1.1 SUBMITTALS

- A. Product Data: Provide technical data on insulated sheathing, wood preservative materials, and application instructions.

PART 2 – PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
 - 1. If no species is specified, provide species graded by the agency specified; if no grading agency is specified, provide lumber graded by grading agency meeting the specified requirements.
 - 2. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee at www.alsc.org, and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.
- B. Lumber fabricated from old growth timber is not permitted.
- C. Provide sustainably harvested wood; see Section 016000 "Product Requirements" for requirements.

2.2 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- A. Grading Agency: Southern Pine Inspection Bureau, Inc; SPIB (GR).
- B. Sizes: Nominal sizes as indicated on Drawings, S4S.
- C. Moisture Content: S-dry or MC19.
- D. 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. Wall Sheathing: Plywood, PS 1, Grade C-D, Exposure I.
- B. Wall Sheathing: Particleboard, ANSI A208.1, Grade M-3 Exterior Glue.
- C. Wall Sheathing: Fiberboard, ASTM C208, Type IV, Grade 1 regular, square edges.
- D. Wall Sheathing: Glass mat-faced gypsum, ASTM C1177/C1177M, 5/8-inch Type X fire-resistant.

1. Assemblies Indicated with Fire-Rating: Use type required by indicated tested assembly.
2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
3. Edges: Square.

E. Wall Sheathing: Oriented strand board structural wood panel with factory laminated water-resistive barrier layer.

1. Sheathing Panel: PS 2, Exposure 1.

- a. Grade: Sheathing.
- b. Edge Profile: Square edge.

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.

B. Joist Hangers: Hot dipped galvanized steel, sized to suit framing conditions.

2.5 FACTORY WOOD TREATMENT

A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.

1. Fire-Retardant-Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.

PART 3 – EXECUTION

3.1 INSTALLATION - GENERAL

- A. Select material sizes to minimize waste.
- B. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.2 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.

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END OF SECTION 061000

SECTION 062000 - FINISH CARPENTRY

PART 1 – GENERAL

1.1 SUBMITTALS

- A. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
- B. Samples: Submit 2 samples of wood trim 8 inches long.

1.2 QUALITY ASSURANCE

- A. Fabricator Qualifications:
 - 1. Regularly fabricate specified products.
 - 2. Fabricated specified products with satisfactory service on five similar installations for a minimum of 5 years.

PART 2 – PRODUCTS

2.1 FINISH CARPENTRY ITEMS

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.

2.2 SUSTAINABILITY CHARACTERISTICS

- A. Provide sustainably harvested wood, certified or labeled; see Section 016000.

2.3 SHEET MATERIALS

- A. Softwood Plywood, Exposed to View: Face species as indicated, plain sawn, medium density fiberboard core; PS 1 Grade A-B, glue type as recommended for application.

2.4 ACCESSORIES

- A. Wood Filler: Solvent base, tinted to match surface finish color.

2.5 HARDWARE

- A. Hardware: Comply with BHMA A156.9.

2.6 FABRICATION

- A. Shop assemble work for delivery to site, permitting passage through building openings.

2.7 SHOP FINISHING

- A. Sand work smooth and set exposed nails and screws.
- B. Apply wood filler in exposed nail and screw indentations.
- C. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install custom fabrications in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.
- B. Set and secure materials and components in place, plumb and level.
- C. Carefully scribe work abutting other components, with maximum gaps of 1/32-inch. Do not use additional overlay trim to conceal larger gaps.

END OF SECTION 062000

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SECTION 068316 - FIBERGLASS REINFORCED PANELING

PART 1 – GENERAL (NOT USED)

PART 2 – PRODUCTS

2.1 PANEL SYSTEMS

A. Wall Panels:

1. Panel Size: 4 by 8 feet.
2. Panel Thickness: 0.10-inch.
3. Surface Design: Embossed.
4. Color: As selected by Architect.
5. Attachment Method: Adhesive only, with trim and sealant in joints.

2.2 MATERIALS

A. Panels: Fiberglass-reinforced plastic (FRP), complying with ASTM D5319.

1. Surface Burning Characteristics: Maximum flame spread index of 25 and smoke developed index of 450; when system tested in accordance with ASTM E84.
2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
3. Impact Strength: Greater than 6-foot-pound-force per inch, when tested in accordance with ASTM D256.
4. Chemical Cleanability: Excellent chemical resistance to common cleaners and detergents when tested in accordance with ISO 2812-1.

B. Trim: Vinyl; color coordinating with panel.

C. Adhesive: Type recommended by panel manufacturer.

D. Sealant: Type recommended by panel manufacturer; white.

PART 3 – EXECUTION

3.1 INSTALLATION - WALLS

A. Install panels in accordance with manufacturer's instructions.

- B. Seal gaps at floor, ceiling, and between panels with applicable sealant to prevent moisture intrusion.

END OF SECTION 068316

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SECTION 071113 - BITUMINOUS DAMPPROOFING

PART 1 – GENERAL

1.1 SUBMITTALS

- A. Product Data: Provide properties of primer, bitumen, and mastics.

1.2 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 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. Asphalt-Base Emulsion for Metal Protective Coating: ASTM D1187/D1187M, Type I - Continuous water exposure within few days after drying or Type II - Continuous weather exposure after drying.
 - 2. Emulsified Asphalt for Roofing Protective Coating: ASTM D1227/D1227M, Type II, Class 1 - Mineral colloid emulsifying agents with non-asbestos fibers.
 - 3. VOC Content: Not more than permitted by local, State, and Federal regulations.
 - 4. Applied Thickness: 1/16-inch, minimum, wet film.
- B. Bituminous Dampproofing: Cold-applied, spray-grade; asphalt base, volatile petroleum solvents, and other content, suitable for application by spray, brush, roller, or squeegee; asbestos-free; suitable for application on vertical and horizontal surfaces.
 - 1. Composition: ASTM D4479/D4479M Type I, asbestos-free.
 - 2. VOC Content: Not more than permitted by local, State, and Federal regulations.
 - 3. Applied Thickness: 1/16-inch, minimum, wet film.
- C. Bituminous Dampproofing: Cold-applied, trowel-grade; asphalt base, volatile petroleum solvents, and other content, suitable for application by trowel on vertical and horizontal surfaces.
 - 1. Composition: ASTM D4586/D4586M Type I, asbestos-free.
 - 2. VOC Content: Not more than permitted by local, State, and Federal regulations.
 - 3. Applied Thickness: 1/16-inch, minimum, wet film.

- D. Primers, Mastics, and Related Materials: Type as recommended by dampproofing manufacturer.

2.2 BITUMEN MATERIALS

A. Hot Asphaltic Type:

1. Asphalt: ASTM D449/D449M, Type I.
2. Primer: ASTM D41/D41M, compatible with substrate.
3. Asphalt Roof Cement: ASTM D4586/D4586M, Type I, asbestos-free.

B. Coal Tar Type:

1. Coal Tar Pitch: ASTM D450/D450M, Type II.
2. Primer: ASTM D43/D43M, coal tar type.
3. Sealing Mastic: ASTM D5643/D5643M, coal tar roof cement, asbestos-free.

C. 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.

PART 3 – EXECUTION (NOT USED)

END OF SECTION 071113

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SECTION 071300 - SHEET WATERPROOFING

PART 1 – GENERAL

1.1 SUBMITTALS

- A. Product Data: Provide data for membrane.
- B. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.
- C. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.2 WARRANTY

- A. Provide 5-year manufacturer warranty for waterproofing failing to resist penetration of water, except where such failures are the result of structural failures of building. Hairline cracking of concrete due to temperature change or shrinkage is not considered a structural failure.

PART 2 – PRODUCTS

2.1 SHEET WATERPROOFING APPLICATIONS

- A. Self-Adhered Modified Bituminous Sheet Membrane:
 - 1. Location: As identified in Drawings.

2.2 SHEET WATERPROOFING MATERIALS

- A. Rolled, Self-Adhered Modified Bituminous Sheet Membrane:
 - 1. Thickness: 60-mil, 0.060-inch, minimum.
 - a. Carrier Film: 4 mils
 - b. Polymeric Membrane: 56 mils
 - 2. Sheet Width: 36 inches, minimum.
- B. Surface Conditioner: Epoxy type, compatible with membrane.

2.3 ACCESSORIES

- A. Sealant for Cracks and Joints in Substrates: Resilient elastomeric joint sealant compatible with substrates and waterproofing materials.
- B. Protection Board: Provide type capable of preventing damage to waterproofing due to backfilling and construction traffic.

PART 3 – EXECUTION

3.1 INSTALLATION - MEMBRANE

- A. Install membrane waterproofing in accordance with manufacturer's instructions and NRCA (WM) applicable requirements.
- B. Self-Adhering Membrane: Remove release paper layer and roll out onto substrate with a mechanical roller to provide full contact bond.
- C. Overlap edges and ends, minimum 3 inches, seal permanently waterproof by method recommended by manufacturer, and apply uniform bead of sealant to joint edge.

3.2 INSTALLATION - DRAINAGE PANEL AND PROTECTION BOARD

- A. Follow manufacturer's installation procedures.
- B. Place drainage panel directly against membrane, butt joints, place to encourage drainage downward; scribe and cut boards around projections, penetrations, and interruptions.
- C. Place protection board directly against drainage panel; butt joints, and scribe and cut boards around projections, penetrations, and interruptions.

END OF SECTION 071300

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SECTION 071400 - FLUID-APPLIED WATERPROOFING

PART 1 – GENERAL

1.1 SUBMITTALS

- A. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.
- B. Manufacturer's qualification statement.
- C. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.2 WARRANTY

- A. 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 FLUID-APPLIED WATERPROOFING APPLICATIONS

- A. Hot-Applied Rubberized Asphalt Waterproofing:
 - 1. Location: Exterior Walls.
 - 2. Cover with protection board.

2.2 FLUID-APPLIED WATERPROOFING MATERIALS

- A. Hot-Applied Rubberized Asphalt Waterproofing: Elasticized rubberized asphaltic compound, hot-applied and quick setting.
 - 1. Suitable for installation over concrete, gypsum board, and plywood substrates.
 - 2. Reinforcing: Continuous; manufacturer's standard reinforcing fabric, approved for use with specified product.
 - 3. Finished Coating Thickness: 215-mil, 0.215-inch, minimum.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install waterproofing to specified minimum thickness in accordance with manufacturer's instructions and NRCA (WM) applicable requirements.

3.2 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.

END OF SECTION 071400

SECTION 072100 - THERMAL INSULATION

PART 1 – GENERAL

1.1 SUBMITTALS

- A. Product Data: Provide data on product characteristics, performance criteria, and product limitations.

PART 2 – PRODUCTS

2.1 APPLICATIONS

- A. Insulation in Metal Framed Walls: Batt insulation with separate vapor retarder.
- B. Insulation Above Lay-In Acoustical Ceilings: Batt insulation with no vapor retarder.

2.2 FOAM BOARD INSULATION MATERIALS

- A. Expanded Polystyrene (EPS) Board Insulation: Comply with ASTM C578.
 - 1. Flame-Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
 - 2. Smoke-Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
 - 3. Board Size: 48 inches by 96 inches.
 - 4. Board Thickness: 1-1/2-inch.
 - 5. Board Edges: Square.
 - 6. Type and Compressive Resistance: Type XI, 5 psi, minimum.
 - 7. Type and Water Absorption: Type XI, 4.0 percent by volume, maximum, by total immersion.

2.3 MINERAL FIBER BOARD INSULATION MATERIALS

- A. Mineral Wool Block and Board Thermal Insulation: Complying with ASTM C612.
 - 1. Flame-Spread Index: 25 or less, when tested with facing, if any, in accordance with ASTM E84.
 - 2. Smoke-Developed Index: 50 or less, when tested with facing, if any, in accordance with ASTM E84.
 - 3. Board Thickness: 1-1/2-inch.

- B. Mineral Wool Block, Board, or Blanket Thermal Insulation: Complying with ASTM C612 or ASTM C553.
1. Where indicated, provide fiberglass reinforced polypropylene facing on 1 side; with flame-spread index of 25 or less, when tested in accordance with ASTM E84.
 2. Smoke-Developed Index: 450 or less, when tested in accordance with ASTM E84.
 3. Board Size: 48 inches by 48 inches.
 4. Board Thickness: 1 inch.
 5. Thermal Resistance: R-value of 4.2 per inch at 75 degrees F, minimum, when tested in accordance with ASTM C518.
 6. Maximum Density: 8 pcf, nominal.

2.4 MINERAL FIBER BLANKET INSULATION MATERIALS

- A. Flexible Glass Fiber Blanket Thermal Insulation: Preformed insulation, complying with ASTM C665; friction fit.
1. Flame-Spread Index: 25 or less, when tested in accordance with ASTM E84.
 2. Smoke-Developed Index: 450 or less, when tested in accordance with ASTM E84.
 3. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
 4. Facing: Aluminum foil, flame spread 25 rated; 1 side.
- B. Mineral Wool Blanket Thermal Insulation: Flexible or semi-rigid preformed insulation, complying with ASTM C665.
1. Flame-Spread Index: 25 or less, when tested in accordance with ASTM E84.
 2. Smoke-Developed Index: 450 or less, when tested in accordance with ASTM E84.

2.5 ACCESSORIES

- A. Tape: Reinforced polyethylene film with acrylic pressure-sensitive adhesive.
1. Application: Sealing of interior circular penetrations, such as pipes or cables.
- B. Insulation Fasteners: Lengths of unfinished, 13-gauge, 0.072-inch-high carbon spring steel with chisel or mitered tips, held in place by tension, length to suit insulation thickness and substrate, capable of securely supporting insulation in place.
- C. Insulation Fasteners: Impaling clip of unfinished steel with washer retainer and clips, to be adhered to surface to receive insulation, length to suit insulation thickness and substrate, capable of securely and rigidly fastening insulation in place.

PART 3 – EXECUTION

3.1 BATT INSTALLATION

- A. Install insulation and vapor retarder in accordance with manufacturer's instructions.

- B. Install in exterior wall and ceiling spaces without gaps or voids. Do not compress insulation.

END OF SECTION 072100

SECTION 072500 - WEATHER BARRIERS

PART 1 – GENERAL

1.1 SUBMITTALS

- A. Product Data: Provide data on material characteristics.
- B. Shop Drawings: Provide Drawings of special joint conditions.

PART 2 – PRODUCTS

2.1 AIR BARRIER MATERIALS (WATER VAPOR PERMEABLE AND WATER-RESISTIVE)

- A. Air Barrier, Fluid Applied: Vapor permeable, elastomeric waterproofing.
 - 1. Air Barrier Coating:
 - a. Air Permeance: 0.001-cfm/sq. ft. per square foot, maximum, when tested in accordance with ASTM E2178.
 - b. Water Vapor Permeance: 18 perms, minimum, when tested in accordance with ASTM E96/E96M, Procedure B.
 - c. Ultraviolet (UV) and Weathering Resistance: Approved in writing by manufacturer for up to 6 months of weather exposure after application.
 - d. Elongation: 300 percent, minimum, when tested in accordance with ASTM D412.
 - e. Surface Burning Characteristics: Flame-spread index of 25 or less, smoke-developed index of 450 or less, when tested in accordance with ASTM E84.
 - f. Complies with NFPA 285 wall assembly requirements.
 - g. Code Acceptance: Comply with applicable requirements of ICC-ES AC212.
 - h. Sealants, Tapes and Accessories: As recommended by coating manufacturer.

2.2 ACCESSORIES

- A. Sealants, Tapes, and Accessories Used for Sealing Water-Resistive Barrier and Adjacent Substrates: As indicated or complying with water-resistive barrier manufacturer's installation instructions.
- B. Sealant for Cracks and Joints in Substrates: Resilient elastomeric joint sealant compatible with substrates and weather barrier materials.
 - 1. Application: Apply at 30- to 40-mil, 0.030-to-0.040-inch nominal thickness.
 - 2. Color: Green.
- C. Flexible Flashing: Self-adhering or mechanically attached flashing used for wall penetrations in accordance with ICC-ES AC148 requirements.

- D. Liquid Flashing: 1-part, fast curing, nonsag, elastomeric, gun grade, trowelable liquid flashing.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install materials in accordance with manufacturer's installation instructions.
- B. Coatings: Prepare substrate in accordance with coating manufacturer's installation instructions; treat joints in substrate and between dissimilar materials as indicated.
- C. Openings and Penetrations in Exterior Water-Resistive Barriers: Install flashing over sills, covering entire sill framing member, and extend at least 5 inches onto water-resistive barrier and at least 6 inches up jambs; mechanically fasten stretched edges.

3.2 FIELD QUALITY CONTROL

- A. Owner's Inspection and Testing: Cooperate with Owner's testing agency.

END OF SECTION 072500

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SECTION 072600 - VAPOR RETARDERS

PART 1 – GENERAL

1.1 SUBMITTALS

- A. Product Data: Provide data on material characteristics, performance criteria, and limitations.

PART 2 – PRODUCTS

2.1 VAPOR RETARDERS

- A. Vapor Retarder Sheet: Butyl, black color.
1. Thickness: 45-mil, 0.045-inch.
 2. Water Vapor Permeance: 0.1-perm, maximum, when tested in accordance with ASTM E96/E96M.
 3. Seam Lap and Perimeter Adhesive: Elastomeric, same composition as sheet or other compatible material.
- B. Vapor Retarder Sheet: Polyamide nylon sheet intended for use with unfaced, vapor-permeable insulation such as fiberglass and mineral wool in wall and ceiling cavities.
1. Thickness: 2-mil, 0.002-inch.
 2. Water Vapor Permeance: 1.0 perm, maximum, when tested in accordance with ASTM E96/E96M using Desiccant Method.
 3. 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.
- C. Vapor Retarder, Self-Adhering Membranes:
1. Vapor Retarder Class I: 0.1-perm (5.72 ng/(Pa s sq m)) or less, when tested in accordance with ASTM E96/E96M, Procedure A.
 2. System Accessory Products: As recommended by membrane manufacturer.
- D. Vapor Retarder Sheet: Polyethylene sheeting complying with ASTM D4397, clear colored.
- E. Vapor Retarder Coating: Liquid applied, resilient, ultra-violet (UV)-light-resistant coating; associated joint treatment.
1. Water Vapor Permeance: 1.0-perm, maximum, when tested in accordance with ASTM E96/E96M.
 2. VOC Content: Less than 6.68 oz/gal, when tested in accordance with 40 CFR 59, Subpart D - EPA Method 24.
 3. Joint Preparation Treatment: Provide coating manufacturer's recommended method, either tape or reinforcing mesh saturated with coating material.

2.2 ACCESSORIES

- A. Sealants, Tapes, and Accessories for Sealing Vapor Retarder and Adjacent Substrates: As indicated, complying with vapor retarder manufacturer's installation instructions.
- B. Sealant for Cracks and Joints in Substrates: Resilient elastomeric joint sealant compatible with substrates and vapor retarder materials.
 - 1. Application: Apply at 30 to 40 mil, 0.030- to 0.040-inch, nominal thickness.
 - 2. Color: Green.
- C. Primer: Liquid applied polymer.
 - 1. Color: Green.
- D. Flexible Flashing: Self-adhesive sheet flashing complying with ASTM D1970/D1970M; slip resistance requirement waived if not installed on roof.
 - 1. Width: 4 inches.
- E. Flexible Flashing: Self-adhering or mechanically attached flashing used for wall penetrations in accordance with ICC-ES AC148 requirements.
- F. Sill Plate Sealer: Closed-cell foam tape with rubberized adhesive membrane; bridges gap between foundation structure and sill plate or skirt board.
 - 1. Width: 3-1/2 inches.
- G. Preformed Transition Membrane: Semirigid silicone or polyester composition, tapered edges, tear resistant.
- H. Stainless Steel Flashing: Flexible flashing with 2 mil, 0.002-inch-thick Type 304 stainless-steel sheet, 8 mil, 0.008-inch of butyl adhesive and siliconized release liner.
 - 1. Width: 6 inches wide.
- I. Vapor Retarder Tape: Coated polyester film with acrylic adhesive backing; pressure sensitive.
- J. Sheet Membrane Mounting Tape: Double-sided strip of pressure-sensitive tape, acrylic adhesive reinforced with embedded fiber-strand carrier layer and plastic backing.
 - 1. Width: 3/4-inch.
- K. Vapor Retarder Self-Sealing Flat Attachment Washers: Solid plastic flat cap washers with flexible perimeter seal attached with screws to substrate for attachment of vapor retarder to help seal against air and moisture penetration through vapor retarder assembly.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install materials in accordance with manufacturer's installation instructions.
- B. Vapor Retarders: Install continuous airtight barrier over surfaces indicated, with sealed seams and sealed joints to adjacent surfaces.
- C. Apply sealants and adhesives within the recommended temperature range in accordance with manufacturer's installation instructions.

END OF SECTION 072600

SECTION 072726 - FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 – GENERAL

1.1 SUBMITTALS

- A. Product Data: Provide data on material characteristics, performance criteria, and limitations.

1.2 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of type specified in this section.

1.3 WARRANTY

- A. See Section 017800 "Closeout Submittals" for additional warranty requirements.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Fluid-Applied Membrane Air Barrier:

2.2 FLUID-APPLIED MEMBRANE AIR BARRIER ASSEMBLY

- A. Applications:

1. Concrete Walls: See Section 033000 for concrete.
2. Exterior Sheathing on Steel Stud Walls:
 - a. See Section 054000 for steel studs.
 - b. See Section 061000 for exterior sheathing.
 - c. See Section 079200 for joint sealants applied to adjacent work.

- B. Fluid-Applied Membrane Air Barrier: Single-component, vapor permeable, 100 percent silicone elastomeric air barrier.

1. Vapor Permeance: 10 perms, minimum, when tested in accordance with ASTM E96/E96M using Desiccant Method at 73.4 degrees F.

2. 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.

PART 3 – EXECUTION (NOT USED)

END OF SECTION 072726

SECTION 074113 - METAL ROOF PANELS

PART 1 – GENERAL

1.1 SUBMITTALS

- A. Shop Drawings: Include layouts of roof panels, details of edge and penetration conditions, spacing and type of connections, flashings, underlayments, and special conditions.

PART 2 – PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Metal Roof Panels: Provide complete roofing assemblies, including roof panels, clips, fasteners, connectors, and miscellaneous accessories, tested for compliance with the following minimum standards:
 - 1. Structural Design Criteria: Provide panel assemblies designed to safely support design loads at support spacing indicated, with deflection not to exceed $L/180$ of span length(L) when tested in accordance with ASTM E1592.
 - 2. Overall: Complete weathertight system tested and approved in accordance with ASTM E1592.
 - 3. Thermal Movement: Design system to accommodate without deformation anticipated thermal movement over ambient temperature range of 100 degrees F.

2.2 METAL ROOF PANELS

- A. Metal Roof Panels: Provide a complete engineered system complying with specified requirements and capable of remaining weathertight while withstanding anticipated movement of substrate and thermally induced movement of roofing system.
- B. Metal Panels: Factory-formed panels with factory-applied finish.
 - 1. Texture: Smooth.
 - 2. Width: Maximum panel coverage of 24 inches.

2.3 ATTACHMENT SYSTEM

- A. Concealed System: Provide manufacturer's standard stainless-steel or nylon-coated aluminum concealed anchor clips designed for specific roofing system and engineered to meet performance requirements, including anticipated thermal movement.

2.4 FINISHES

- A. Acrylic Enamel Coating: Epoxy primer and acrylic enamel topcoat with minimum dry film thickness (DFT) of 0.8 mil; color and gloss as indicated on Drawings.

2.5 ACCESSORIES

- A. Thermal Insulation: Provide flexible blanket, rigid, or semi-rigid type, faced with white, flexible, non-dusting vapor retarder tested for maximum flame spread index of 50, per ASTM E84; for installation using spacer blocks.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Overall: Install roofing system in accordance with approved Shop Drawings and metal roof panel manufacturer's instructions and recommendations, as applicable to specific Project conditions; securely anchor components of roofing system in place allowing for thermal and structural movement.
- B. Accessories: Install necessary components that are required for complete roofing assembly, including flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, equipment curbs, rib closures, ridge closures, and similar roof accessory items.
- C. Insulation: Install insulation between roof covering and supporting members to present a neat appearance; fold, staple, and tape seams unless otherwise approved by Architect.

END OF SECTION 074113

City of Lee's Summit
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DOCUMENT 074243 – COMPOSITE WALL PANELS

PART 1 – GENERAL

1.1 FIBER-CEMENT SIDING

- A. Exterior, panelized fiber-cement cladding system and accessories to complete a drained and back-ventilated rainscreen.
- B. Interior fiber-cement panelized cladding system and accessories.

1.2 RELATED SECTIONS

- A. Section 054100 - Structural Metal Stud Framing
- B. Section 061000 - Rough Carpentry
- C. Section 061600 - Sheathing
- D. Section 072000 - Thermal Protection
- E. Section 072500 - Weather Barriers
- F. Section 076000 - Flashing and Sheet Metal
- G. Section 079000 - Joint Protection

1.3 REFERENCES

- A. American Architectural Manufacturers Association (AAMA):
 - 1. AAMA 509-14 – Voluntary Test and Classification Method of Drained and Back Ventilated Rain Screen Wall Cladding Systems.
- B. ASTM International (ASTM):
 - 1. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - 2. ASTM C1185 - Standard Test Methods for Sampling and Testing Non-Asbestos Fiber Cement.
 - 3. ASTM C1186 – Standard Specification for Flat Fiber-Cement Sheets.
 - 4. ASTM E-84 - Standard Test for Surface Burning Characteristics of Building Materials.
 - 5. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 6. ASTM E228 - Standard Test Method for Linear Thermal Expansion of Solid Materials with a Vitreous Silica Dilatometer.
 - 7. ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

8. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

C. Florida Building Code - Test Protocol HVHZ:

1. Testing Application Standard (TAS) 202, 203 – HVHZ Test Procedures

D. National Fire Protection Association (NFPA):

1. NFPA 285 - Fire Test Method for Exterior Wall Assemblies Containing Combustible Material.
2. NFPA 268 – Ignition Resistance of Exterior Wall Assemblies.

E. Standards Council of Canada & Underwriters Laboratories Canada (ULC):

1. CAN/ULC S-102 – Standard Method of Test for Surface Burning Characteristics.
2. CAN/ULC S-134 – Standard Method of Fire Test of Exterior Wall Assembly.

1.4 SUBMITTALS

- A. Submit under provisions of Section 013300.
- B. Product Data: Submit manufacturer's product description, storage and handling requirements, and installation instructions.
- C. Product Test Reports and Code Compliance: Documents demonstrating product compliance with local building code, such as test reports or Evaluation Reports from qualified, independent testing agencies.
- D. LEED Credits: Provide documentation of LEED Credits for Project certification under USGBC LEED 2009 (Version 3.0) or 2012 v.4.
- E. Manufacturer's Details: Submit Drawings (.dwg, .rvt, and/or .pdf formats), including Plans, Sections, showing installation details that demonstrate product dimensions, edge/termination conditions/treatments, compression and control joints, corners, openings, and penetrations.
- F. Samples: Submit samples of each product type proposed for use.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. All fiber-cement panels specified in this Section must be supplied by a manufacturer with a minimum of 10 years of experience in fabricating and supplying fiber-cement cladding systems.
 - a. Products covered under this Section are to be manufactured in an ISO 9001 certified facility.

2. Provide technical and design support as needed regarding installation requirements and warranty compliance provisions.
- B. Installer Qualifications: All products listed in this Section are to be installed by a single installer trained by the manufacturer or representative.
- C. Mock-Up Wall: Provide a mock-up wall as evaluation tool for product and installation workmanship.
- D. Pre-Installation Meetings: Prior to beginning installation, conduct conference to verify and discuss substrate conditions, manufacturer's installation instructions and warranty requirements, and Project requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Panels must be stored flat and kept dry before installation. A waterproof cover over panels and accessories should be used at all times prior to installation. Do not stack pallets more than 2 high. Refer to the information included on each pallet.
- B. If panels are exposed to water or water vapor prior to installation, allow to completely dry before installing. Failure to do so may result in panel shrinkage at ship-lap joints, and such action may void warranty.
- C. Panels MUST be carried on edge. Do not carry or lift panels flat. Improper handling may cause cracking or panel damage.
- D. Direct contact between the panels and the ground should be avoided at all times. It is necessary to keep panels clean during installation process.

1.7 WARRANTY

- A. Provide manufacturer's 15-year warranty against manufactured defects in fiber-cement panels. Additional 5-year extension available when refinished in year 14 to 15.
- B. Provide manufacturer's 15-year warranty against manufactured defects in panel finish.
- C. Warranty is provided for the original purchaser. See warranty for detailed information on terms, conditions, and limitations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 1. Nichiha USA, Inc., 3150 Avondale Mill Road, Macon, GA 31216, USA.
 2. Nichiha Corporation, 18-19 Nishiki 2-chome Naka-ku, Nagoya, Aichi 460-8610, Japan.

- B. Acceptable Manufacturer's Representative: Nichiha USA, Inc., 6465 E. Johns Crossing, Suite 250, Johns Creek, GA 30097. Toll free: 1-866-424-4421, Office: 770-805-9466, Fax: 770-805-9467, www.nichiha.com.

1. Basis-of-Design Product: Nichiha Ribbed.

- a. Profile colors: Gunsmoke, Mother of Pearl.
- b. Profile: Each panel has nine 35 mm ribs with chamfered edges, spaced with 10 mm grooves between.
- c. Finish: Metallic, moderately textured ribs. Grooves are smooth.
- d. Accessory/Component Options:
 - 1) Manufactured Corners with 3-1/2-inch returns for each profile color.
 - 2) Aluminum Trim Options: Corner Key, Open Outside Corner, H-Mold, J-Mold, Compression Joint, Inside Corner
 - a) Finish: Clear Anodized or Primed.
 - 3) Essential Flashing System: Starter, Overhang.
 - a) Finish: Matte black.
- e. Dimensions - AWP-3030: 17-7/8" H x 119-5/16" L.
- f. Panel Thickness: 5/8-inch.
- g. Weight: 57.32 pounds. per panel.
- h. Coverage: 14.81 square foot per panel.
- i. Factory sealed on 6 sides.

- C. Substitutions: Not permitted.

- D. Requests for substitutions will be considered in accordance with the provisions of Section 016000.

2.2 MATERIALS

- A. Fiber-cement panels manufactured from a pressed, stamped, and autoclaved mix of Portland cement, fly ash, silica, recycled rejects, and wood-fiber bundles.
- B. Panel surface pre-finished and machine applied.
- C. Panels profiled along 3030 mm edges so that the long joints between the installed panels are ship-lapped.
- D. Factory-applied sealant gasket added to top panel edge; all 3030mm edge joints contain a factory sealant.

2.3 PERFORMANCE REQUIREMENTS:

- A. Fiber-Cement Cladding – Must comply with ASTM C1186, Type A, Grade II requirements:

1. Wet Flexural Strength: Result: 1,418 psi, Lower Limit: 1,015 psi.
 2. Water Tightness: No water droplets observed on any specimen.
 3. Freeze-thaw: No damage or defects observed.
 4. Warm Water: No evidence of cracking, delamination, swelling, or other defects observed.
 5. Heat-Rain: No crazing, cracking, or other deleterious effects, surface or joint changes observed in any specimen.
- B. Mean Coefficient of Linear Thermal Expansion ASTM E228: Max 1.0×10^{-5} in./in. F.
- C. Surface Burning CAN-ULC S102/ASTM E-84: Flame Spread: 0, Smoke Developed: 0.
- D. Wind Load ASTM E330: Contact manufacturer for ultimate test pressure data corresponding to framing type, dimensions, fastener type, and attachment clips. Project Engineers must determine Zone 4 and 5 design pressures based on Project specifics.
1. Minimum lateral deflection: L/120.
- E. Water Penetration ASTM E331: No water leakage observed into wall cavity.
- F. Steady-State Heat Flux and Thermal Transmission Properties Test ASTM C518: 16-mm-thick panel thermal-resistance R Value of 0.47.
- G. Fire Resistant ASTM E119: The wall assembly must successfully endure 60-minute fire exposure without developing excessive unexposed surface temperature or allowing flaming on the unexposed side of the assembly.
- H. Ignition Resistance NFPA 268: No sustained flaming of panels, assembly when subjected to a minimum radiant heat flux of $12.5 \text{ kW/m}^2 \pm 5\%$ in the presence of a pilot ignition source for a 20-minute period.
- I. Fire Propagation NFPA 285: Wall assembly of Nichiha AWP, Ultimate Clips and Starter Track, Tyvek Commercial Wrap, 1/2-inch Densglass Gold Sheathing, 16-inch o.c. 18-gauge steel studs, mineral wool in-cavity insulation, and interior 5/8-inch Type X gypsum met the acceptance criteria of NFPA 285.
- J. Fire Propagation CAN/ULC S-134: Wall assembly of Nichiha AWP, Ultimate Clips and Starter Track, Tyvek Housewrap, 5/8-inch FRT plywood, 16-inch o.c. 2x wood studs, fiberglass in-cavity insulation, and interior 5/8-inch Type X gypsum met the acceptance criteria of CAN/ULC S-134.
- K. Drained and Back-Ventilated Rainscreen AAMA 509-14: System classifications: W1, V1. L. Florida Building Code - Test Protocol HVHZ TAS 202, 203: Horizontal Application Design Pressure: 95 psf, Vertical Application Design Pressure: 85 psf.

2.4 INSTALLATION COMPONENTS

A. Ultimate Clip System:

1. Starter Track:
 - a. Horizontal Panel Installations - FA 700 – 3,030-mm-long galvalume-coated-steel.
 - b. Vertical Panel Installations AWP-3030 only – FA 710T – 3,030mm L galvalume-coated-steel.
2. Panel Clips: JEL 778 "Ultimate Clip II" – 10 mm rainscreen for 16mm AWP – Zinc-Aluminum-Magnesium alloy coated steel.
 - a. Joint Tab Attachments (included) – used at all AWP-1818 panel to panel vertical joints – NOT used with AWP-3030 installations.
3. Corner Clips: JE 777C 10mm rainscreen for 5/8-inch AWP Manufactured Corners - Zinc-Aluminum-Magnesium alloy coated steel.
4. Single Flange Sealant Backer – FHK 1015 R 10 mm – 6-1/2-foot-long fluorine coated galvalume.
5. Double-Flange Sealant Backer – FH 1015 R 10 mm – 10-foot-long fluorine coated galvalume.
6. Corrugated Spacer – FS 1005 5 mm, FS 1010 10 mm – 4-feet-long.

B. Aluminum Trim (optional): Paint primed trim as specified in Finish Schedule.

C. Essential Flashing System (optional):

1. Starter: Main segments 3,030 mm, inside corners, outside corners.
2. Overhang: Main segments 3,030 mm, inside corners, outside corners, joint clips.

D. Fasteners: Corrosion-resistant fasteners, such as hot-dipped galvanized screws, appropriate to local building codes and practices, must be used. Use stainless-steel fasteners in high-humidity and high-moisture regions. The panel manufacturer is not liable for corrosion-resistance of fasteners. Do not use aluminum fasteners, staples, or fasteners that are not rated or designed for intended use. See manufacturer's instructions for appropriate fasteners for construction method used.

E. Flashing: Flash all areas specified in manufacturer's instructions. Do not use raw aluminum flashing. Flashing must be galvanized, anodized, or PVC coated.

F. Sealant: Sealant shall comply with ASTM C920, Class 35.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Fiber-cement panels can be installed over braced wood, steel studs and sheathing including plywood, OSB, plastic foam 1 inch or less or fiberboard sheathing. Fiber-cement panels can also be installed over structural insulated panels (SIP), concrete masonry units (CMU) and concrete block structures (CBS) with furring strips, and pre-engineered metal construction. Insulated concrete forms (ICF) require added measures. Consult with Nichiha Technical Services.
2. Allowable Stud Spacing: 16-inch o.c. maximum.
3. A weather-resistive barrier (WRB) is required when installing fiber-cement panels. Use an approved weather-resistive barrier as defined by the 2015 IBC or IRC. Refer to local building codes.
4. Appropriate metal flashing should be used to prevent moisture penetration around all doors, windows, wall bottoms, material transitions and penetrations. Refer to local building codes for best practices.

B. Examine site to ensure substrate conditions are within alignment tolerances for proper installation.

C. Do not begin installation until unacceptable conditions have been corrected.

D. Do not install panels or components that appear to be damaged or defective. Do not install wet panels.

3.2 TOLERANCE

A. Wall surface plane must be plumb and level within plus or minus 1/4-inch in 20 feet in any direction.

1. One layer of Nichiha 3/16-inch spacer may be used as shim.

3.3 INSTALLATION

A. General: Install products in accordance with the latest installation guidelines of the manufacturer and all applicable building codes and other laws, rules, regulations, and ordinances. Review all manufacturer installation, maintenance instructions, and other applicable documents before installation.

1. Consult with your local dealer or Nichiha Technical Department before installing any Nichiha fiber-cement product on a building higher than 45 feet or 3 stories or for conditions not matching prescribed standard installation guide requirements and methods. A Technical Design Review (TDR) process is available to evaluate project feasibility.
2. Vertical Control/Expansion Joints are required at each AWP-3030 vertical joint, or H-Mold trim may be used instead.

3. Horizontal/Compression Joints are required for multi-story installations of AWP. Locate joints at floor lines. Joints are flashed minimum 1/2-inch breaks. Do not caulk. Refer to installation guides.
 - a. Wood-framed buildings of 3 or more floors require a compression joint at each floor.
 - b. Steel-framed buildings, including reinforced concrete core with LGMF exterior walls, of more than 3 floors, or 45 feet, require a compression joint every 25 feet at a floor line.

B. Panel Cutting:

1. Always cut fiber cement panels outside or in a well-ventilated area. Do not cut the products in an enclosed area.
2. Always wear safety glasses and NIOSH/OSHA approved respirator whenever cutting, drilling, sawing, sanding, or abrading the products. Refer to manufacturer safety data sheet (SDS) for more information.
3. Use a dust-reducing circular saw with a diamond-tipped or carbide-tipped blade.
 - a. Recommended Circular Saw: Makita 7-1/4-inch Circular Saw with Dust Collector #5057KB.
 - b. Recommended Blade: Tenryu Board-Pro Plus PCD Blade #BP-18505.
 - c. Shears (electric or pneumatic) or jig saw can be used for complicated cuttings, such as service openings, curves, radii, and scrollwork.
4. Silica Dust Warning: Fiber-cement products may contain some amounts of crystalline silica, a naturally occurring, potentially hazardous mineral when airborne in dust form. Consult product SDS or visit <https://www.osha.gov/dsg/topics/silicacrystalline/>.
5. Immediately clean dust from cut panels as it may bind to the finish.

3.4 CLEANING AND MAINTENANCE

- A. Review manufacturer guidelines for detailed care instructions.

END OF SECTION 074646

SECTION 075423 - THERMOPLASTIC-POLYOLEFIN (TPO) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermoplastic polyolefin (TPO) roofing system.
2. Accessory roofing materials.
3. Roof insulation.
4. Insulation accessories and cover board.
5. Asphalt materials.
6. Walkways.

B. Section includes installation of sound-absorbing insulation strips in ribs of roof deck. Sound-absorbing insulation strips are furnished under Section 053100 "Steel Decking."

C. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking; and for wood-based, structural-use roof deck panels.
2. Section 072100 "Thermal Insulation" for insulation beneath the roof deck.
3. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
4. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
5. Section 221400 "Storm Drainage Piping Specialties."

1.2 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.3 PREINSTALLATION MEETINGS

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

1. Meet with Owner, Architect, Construction Manager, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, Deck Installer, Air Barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Thermoplastic polyolefin (TPO) roofing system.
2. Accessory roofing materials.
3. Roof insulation.
4. Insulation accessories and cover board.
5. Asphalt materials.
6. Electronic leak detection (ELD) materials.
7. Walkways.

B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:

1. Layout and thickness of insulation.
2. Base flashings and membrane termination details.
3. Flashing details at penetrations.
4. Tapered insulation layout, thickness, and slopes.
5. Tie-in with adjoining air barrier.

C. Samples for Verification: For the following products:

1. Roof membrane and flashings, of color required.
2. Walkway pads or rolls, of color required.

D. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Manufacturer Certificates:

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.

C. Product Test Reports: For roof membrane and insulation, for tests performed by a qualified testing agency, indicating compliance with specified requirements.

D. Evaluation Reports: For components of roofing system, from ICC-ES.

E. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is UL listed for roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by a roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. 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.

- D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
 - 1. Special warranty includes roof membrane, base flashings, roof insulation, fasteners, and other components of roofing system.
 - 2. Warranty Period: 20 years from date of Substantial Completion.
- B. Special Project Warranty: Submit Roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roof membrane, base flashing, roof insulation, fasteners, and walkway products, for the following warranty period:
 - 1. Warranty Period: 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed roofing system and flashings to 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 to remain watertight.
 - 1. Accelerated Weathering: Roof to withstand 2,000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.
 - 2. Impact Resistance: Roof membrane to resist impact damage when tested according to ASTM D3746, ASTM D4272, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.
- B. Material Compatibility: Roofing materials to 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.
 - 1. Zone 1 (Roof Area Field): 30 lbf/sq. ft.

2. Zone 2 (Roof Area Perimeter): 40 lbf/sq. ft.
 - a. Location: From roof edge to 9 feet inside roof edge.
 3. Zone 3 (Roof Area Corners): 55 lbf/sq. ft.
 - a. Location: 9 feet in each direction from each building corner.
 4. Fire/Windstorm Classification: Class 1A-90.
 5. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 SH.
 6. Wind Uplift Load Capacity: 75 psf.
- C. Exterior Fire-Test Exposure: ASTM E108 or UL 790, Class A for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings from an applicable testing agency.
- D. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings from an applicable testing agency.

2.2 THERMOPLASTIC POLYOLEFIN (TPO) ROOFING SYSTEM

- A. TPO Sheet: ASTM D6878/D6878M, internally fabric- or scrim-reinforced, fabric-backed TPO sheet.
1. Carlisle SynTec Systems; Sure-Weld Source Limitations:
 2. Obtain components for roofing system from roof membrane manufacturer or manufacturers approved by roof membrane manufacturer.
 3. Thickness: 60 mils
 4. Exposed Face Color: White

2.3 ACCESSORY ROOFING MATERIALS

- A. General: Accessory materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.
1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.
- B. Sheet Flashing: Manufacturer's standard unreinforced TPO sheet flashing, 55 mils thick, minimum, of same color as TPO sheet.
- C. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
- D. Roof Vents: As recommended by roof membrane manufacturer.
1. Size: Not less than 4-inch diameter.
- E. Bonding Adhesive: Manufacturer's standard.

- F. Slip Sheet: ASTM D2178/D2178M, Type IV; glass fiber; asphalt-impregnated felt.
- G. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8-inch thick; with anchors.
- H. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05-inch thick, prepunched.
- I. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.
- J. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.4 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by TPO roof membrane manufacturer.
- B. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
 - 1. Compressive Strength: 25 psi.
 - 2. Size: 48 by 96 inches.
 - 3. Thickness:
 - a. Base Layer: 2 inches.
 - b. Upper Layer: 2 inches
- C. Tapered Insulation: Provide factory-tapered insulation boards.
 - 1. Material: Match roof insulation.
 - 2. Minimum Thickness: 1/4-inch.
 - 3. Slope:
 - a. Roof Field: 1/4-inch per foot unless otherwise indicated on Drawings.
 - b. Saddles and Crickets: 1/2-inch per foot unless otherwise indicated on Drawings.

2.5 INSULATION ACCESSORIES AND COVER BOARD

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.
- B. Fasteners: Factory-coated steel fasteners with metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.

- C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
 - 1. Modified asphaltic, asbestos-free, cold-applied adhesive.
 - 2. Bead-applied, low-rise, 1-component or multicomponent urethane adhesive.
- D. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric; water permeable and resistant to UV degradation; type and weight as recommended by roofing system manufacturer for application.

2.6 ASPHALT MATERIALS

- A. Roofing Asphalt: ASTM D312/D312M, Type III or Type IV.
- B. Asphalt Primer: ASTM D41/D41M.

2.7 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway rolls, approximately 3/16-inch thick and acceptable to roofing system manufacturer.
 - 1. Size: Approximately 36 by 60 inches
 - 2. Color: Matching with roof membrane.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 - 1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
 - 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
 - 3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation according to roofing system manufacturer's written instructions. Remove sharp projections.

- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Install sound-absorbing insulation strips according to acoustical roof deck manufacturer's written instructions.

3.3 INSTALLATION OF ROOFING, GENERAL

- A. Install roofing system according to roofing system manufacturer's written instructions, listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.
- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning Work on adjoining roofing.
- C. Coordinate installation and transition of roofing system component serving as an air barrier with air barrier specified under Section 072726 "Fluid-Applied Membrane Air Barriers."

3.4 INSTALLATION OF INSULATION

- A. Coordinate installing roofing system components, so insulation is not exposed to precipitation or left exposed at end of workday.
- B. Comply with roofing system and roof insulation manufacturer's written instructions for installing roof insulation.
- C. Installation Over Metal Decking:
 - 1. Install base layer of insulation with end joints staggered not less than 12 inches in adjacent rows and with long joints continuous at right angle to flutes of decking.
 - a. Locate end joints over crests of decking.
 - 1) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
 - 2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches from previous layer of insulation.
 - a. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
 - b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - c. Make joints between adjacent insulation boards not more than 1/4-inch in width.

- d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - 1) Trim insulation so that water flow is unrestricted.
- e. Fill gaps exceeding 1/4-inch with insulation.
- f. Cut and fit insulation within 1/4-inch of nailers, projections, and penetrations.
 - 1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 degrees F of equiviscous temperature.

3.5 INSTALLATION OF ADHERED ROOF MEMBRANE

- A. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.
- B. Unroll roof membrane and allow to relax before installing.
- C. Accurately align roof membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- D. Hot Roofing Asphalt: Apply a solid mopping of hot roofing asphalt to substrate at temperature and rate required by manufacturer and install fabric-backed roof membrane. Do not apply to splice area of roof membrane.
- E. Fabric-Backed Roof Membrane Adhesive: Apply to substrate at rate required by manufacturer and install fabric-backed roof membrane.
- F. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.
- G. Apply roof membrane with side laps shingled with slope of roof deck where possible.
- H. Seams: Clean seam areas, overlap roof membrane, and hot-air weld side and end laps of roof membrane and sheet flashings, to ensure a watertight seam installation.
 - 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.
- I. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.6 INSTALLATION OF BASE FLASHING

- A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.7 INSTALLATION OF WALKWAYS

- A. Flexible Walkways:
 - 1. Install flexible walkways at the following locations:
 - a. Perimeter of each rooftop unit.
 - b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
 - c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
 - d. Top and bottom of each roof access ladder.
 - e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
 - f. Locations indicated on Drawings.
 - g. As required by roof membrane manufacturer's warranty requirements.
 - 2. Provide 6-inch clearance between adjoining pads.
 - 3. 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. Testing Agency: Engage a qualified testing agency to perform tests and to inspect substrate conditions, surface preparation, roof membrane application, sheet flashings, protection, and drainage components, and to furnish reports to Architect.
- B. Perform the Following Tests:
 - 1. Flood Testing: Flood test each roof area for leaks, according to recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is

placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

- a. Perform tests before overlying construction is placed.
- b. Flood to an average depth of 2-1/2 inches with a minimum depth of 1 inch and not exceeding a depth of 4 inches. Maintain 2 inches of clearance from top of base flashing.
- c. Flood each area for 24 hours.
- d. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

- e. Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

2. Infrared Thermography: Testing agency surveys entire roof area using infrared color thermography according to ASTM C1153.

- a. Perform tests before overlying construction is placed.
- b. After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or nuclear hydrogen detection tests.
- c. After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

1) Cost of retesting is Contractor's responsibility.

- d. Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture, if any.

C. 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.

D. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.9 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. 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.

- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.10 ROOFING INSTALLER'S WARRANTY

- A. WHEREAS _____ of _____, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following Project:
 - 1. Owner:
 - 2. Owner Address:
 - 3. Building Name/Type:
 - 4. Building Address:
 - 5. Area of Work:
 - 6. Acceptance Date:
 - 7. Warranty Period:
 - 8. Expiration Date:
- B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,
- C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing Installer will, at Roofing Installer's own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.
- D. This Warranty is made subject to the following terms and conditions:
 - 1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:
 - a. Lightning.
 - b. Peak gust wind speed exceeding 180 mph.
 - c. Fire.
 - d. Failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition.
 - e. Faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work.
 - f. Vapor condensation on bottom of roofing.
 - g. Activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.
 - 2. When Work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.

3. Roofing Installer is responsible for damage to Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect Work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 075423

SECTION 076100 - SHEET METAL ROOFING

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: Provide data on metal types, finishes, characteristics, and profiles.
- B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

1.2 QUALITY ASSURANCE

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

1.3 WARRANTY

- A. Correct defective work within a 5-year period after Date of Substantial Completion. Defective work includes degradation of metal finish.

PART 2 - PRODUCTS

2.1 SHEET MATERIALS

- A. Pre-Finished Galvanized Steel Sheet: ASTM A653/A653M, with G90/Z275 zinc coating; 24 gauge, 0.0239-inch minimum base metal thickness, shop precoated with polyvinylidene fluoride (PVDF) coating; color as selected.

2.2 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Form pieces in longest practical lengths.
- C. Hem exposed edges on underside 1/2-inch. Miter and seam corners.
- D. Form material with standing seams, except where otherwise indicated. At moving joints, use sealed, lapped, bayonet-type or interlocking hooked seams.

2.3 FINISHES

- A. Polyvinylidene Fluoride (PVDF) Coating: Superior Performance Organic Finish, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system.
- B. Color: As selected by Architect from manufacturer's standard colors.
- C. Primer Coat: On coated sheets, finish concealed side of sheet with primer compatible with finish system as recommended by finish system manufacturer.

2.4 ACCESSORIES

- A. Fasteners: Galvanized steel, with soft neoprene washers.
- B. Underlayment: Per standing-seam roofing manufacturer recommendations.
- C. Concealed Sealants: Non-curing butyl sealant or butyl tape.
- D. Exposed Sealants: ASTM C920 elastomeric sealant, with minimum movement capability as recommended by manufacturer for sealed substrates. Color to match adjacent material.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Roofing:
 - 1. Apply underlayment over entire roof area.
 - 2. Cleat and seam sheet metal roofing joints.
- B. Standing-Seam Roofing:
 - 1. Comply with CDA A4050 details.
 - 2. Stagger transverse joints of roofing sheets.
- C. Flashing:
 - 1. Reglets installation, see Section 076200 "Sheet Metal Flashing."
 - 2. Comply with SMACNA (ASMM) details.
 - 3. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted.
 - 4. Seal metal joints watertight.

END OF SECTION 076100

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 SHEET MATERIALS

- A. Pre-Finished Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24-gauge, 0.0239-inch-thick base metal, shop pre-coated with PVDF coating.
 - 1. Polyvinylidene Fluoride (PVDF) Coating: Superior performing organic powder coating, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system.
 - 2. Color: As selected by Architect from manufacturer's standard colors.
- B. Pre-Finished Aluminum: ASTM B209/B209M, 3005 alloy, H12 or H14 temper; 18-gauge, 0.040-inch-thick; plain finish, shop pre-coated with silicone-modified polyester coating.
 - 1. Fluoropolymer Coating: High-performance organic powder coating, AAMA 2604; multiple coat, thermally cured fluoropolymer finish system.
 - 2. Color: As indicated on Drawings.

2.2 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Form pieces in longest possible lengths.
- C. Form material with flat lock seams, except where otherwise indicated. At moving joints, use sealed, lapped, bayonet-type or interlocking hooked seams.

2.3 GUTTERS AND DOWNSPOUTS

- A. Downspouts: Rectangular profile.
- B. Gutters and Downspouts: Size for rainfall intensity determined by a storm occurrence of 1 in 10 years in accordance with SMACNA (ASMM).

2.4 ACCESSORIES

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

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted.
- B. Seal metal joints watertight.

END OF SECTION 076200

SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ROOF CURBS

- A. 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 standing-seam metal roof panel system.
 2. Sheet Metal Material:
 - a. Aluminum: 0.080-inch minimum thickness, with 3003 alloy, and H14 temper.
 3. Galvanized Steel: Hot-dip zinc coated steel sheet complying with ASTM A653/A653M, SS Grade 33 (230); G60 (Z180) coating designation; 18 gauge, 0.048-inch thick.
 4. Roofing Cants: Provide integral sheet metal roofing cants dimensioned to begin slope at top of roofing system at 1:1 slope; minimum cant height 4 inches.
 5. Fabricate curb bottom and mounting flanges for installation directly on metal roof panel system to match slope and configuration of system.
 - a. Extend side flange to next adjacent roof panel seam and comply with seam configurations and seal connection, providing at least 6-inch clearance between curb and metal roof panel flange allowing water to properly flow past curb.
 - b. Where side of curb aligns with metal roof panel flange, attach fasteners on upper slope of flange to curb connection allowing water to flow past below fasteners, and seal connection.
 - c. Maintain at least 12-inch clearance from curb, and lap upper curb flange on underside of down sloping metal roof panel, and seal connection.
 - d. Lap lower curb flange overtop of down sloping metal roof panel and seal connection.
- B. Curbs Adjacent to Roof Openings: Provide curb on each side of opening, with top of curb horizontal for equipment mounting.
- C. Equipment Rail Curbs: Straight curbs on each side of equipment, with top of curbs horizontal and level with each other for equipment mounting.

- D. Equipment Support: Straight curbs on each side of equipment, with top of curbs parallel with metal roofing system and each other for equipment mounting.
- E. Pipe, Duct, or Conduit Mounting Curbs: Vertical posts, minimum 8 inches square unless otherwise indicated.

2.2 ROOF HATCHES

- A. Roof Hatches and Smoke Vents: Factory-assembled aluminum frame and cover, complete with operating and release hardware.
 - 1. Style: Provide flat metal covers unless otherwise indicated.
 - 2. Mounting Substrate: Provide frames and curbs suitable for mounting on standing-seam metal roof panel system.
 - 3. Size: As indicated on Drawings. Single-leaf style unless indicated as double-leaf.
- B. Frames and Curbs: 1-piece curb and frame with integral cap flashing to receive roof flashings; extended bottom flange to suit mounting.
 - 1. Material: Stainless steel, Type 304, 14 gauge, 0.0747-inch thick.
 - 2. Finish: Factory prime paint.
 - 3. Insulation: Manufacturer's standard; 1-inch rigid glass fiber, located on outside face of curb.
- C. Metal Covers: Flush, insulated, hollow metal construction.
 - 1. Capable of supporting 40 psf live load.
 - 2. Material: Galvanized steel; outer cover 14 gauge, 0.0747-inch thick; liner 22 gauge, 0.03-inch thick.
 - 3. Finish: Factory prime paint.
 - 4. Insulation: Manufacturer's standard 1-inch rigid glass fiber.
- D. Safety Railing System: Manufacturer's standard accessory safety rail system mounted directly to curb.
 - 1. Comply with 29 CFR 1910.23, with a safety factor of 2.
 - 2. Posts and Rails: Aluminum tube.
 - 3. Gate: Same material as railing, automatic closing with latch.
 - 4. Finish: Manufacturer's standard, factory-applied finish.
 - 5. Gate Hinges and Post Guides: ASTM B221 (ASTM B221M), 6063 alloy, T5 temper aluminum.
 - 6. Mounting Brackets: Hot dipped galvanized steel, 1/4-inch thick, minimum.
 - 7. Fasteners: Stainless steel, Type 316.
- E. Hardware: Steel, zinc coated and chromate sealed, unless otherwise indicated or required by manufacturer.
 - 1. Lifting Mechanisms: Compression or torsion spring operator with shock absorbers that automatically opens upon release of latch; capable of lifting covers despite 10 psf load.

2. Hinges: Heavy-duty pintle type.
3. Hold-open arm with vinyl-coated handle for manual release.
4. Latch: Upon closing, engage latch automatically and reset manual release.
5. Locking: Padlock hasp on interior.

PART 3 - EXECUTION

3.1 INSTALLATION

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

END OF SECTION 077200

SECTION 078100 - APPLIED FIRE PROTECTION

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: Provide data indicating product characteristics.
- B. Manufacturer's Installation Instructions: Indicate special procedures.
- C. Manufacturer's Qualification Statement.

1.2 FIELD CONDITIONS

- A. Do not apply fireproofing when temperature of substrate material and surrounding air is below 40 degrees F or when temperature is predicted to be below said temperature for 24 hours after application.
- B. Provide ventilation in areas to receive fireproofing during application and 24 hours afterward, to dry applied material.

1.3 WARRANTY

- A. Correct defective Work within a 2-year period after Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FIREPROOFING ASSEMBLIES

- A. Provide assemblies as indicated on Drawings.
- B. Provide fire resistance ratings for following building elements as required by local building code:
 - 1. Primary Structural Frame, Including Columns, Girders, and Trusses: 1 hour.
 - 2. Bearing Walls, Interior: 1 hour.
 - 3. Floor Construction, Including Supporting Beams and Joists: 1 hour.
 - 4. Roof Construction, Including Supporting Beams and Joists: 1 hour.

2.2 MATERIALS

- A. Applied Fireproofing Material for Interior Applications, Concealed: Manufacturer's standard factory-mixed material, which when combined with water is capable of providing indicated fire resistance, and complying with following requirements:
1. Composition: Gypsum-based, not mineral-fiber-based.
 2. Bond Strength: 150 pounds per square foot, minimum, when tested in accordance with ASTM E736/E736M when set and dry.
 3. Dry Density: As required by fire resistance design.
 4. Compressive Strength: 8.33 pounds per square inch, minimum.
 5. Effect of Impact on Bonding: No cracking, spalling or delamination, when tested in accordance with ASTM E760/E760M.
 6. Corrosivity: No evidence of corrosion, when tested in accordance with ASTM E937/E937M.
 7. Surface Burning Characteristics: Maximum flame spread index of 0 (zero) and maximum smoke developed index of 0 (zero), when tested in accordance with ASTM E84.

2.3 ACCESSORIES

- A. Primer Adhesive: Of type recommended by applied fireproofing manufacturer.
- B. Overcoat: As recommended by manufacturer of applied fireproofing material.
- C. Metal Lath: Expanded metal lath; minimum weight of 1.7 psf, galvanized finish.
- D. Water: Clean, potable.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Install metal lath over structural members as indicated or as required by UL Assembly Design Numbers.
- B. Apply primer adhesive in accordance with manufacturer's instructions.
- C. Apply fireproofing in uniform thickness and density as necessary to achieve required ratings.

END OF SECTION 078100

SECTION 078123 - INTUMESCENT FIRE PROTECTION

PART 1 – GENERAL

1.1 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Performance characteristics and test results.
 - 2. Preparation instructions and recommendations.
 - 3. Storage and handling requirements and recommendations.
 - 4. Installation methods.
- B. Field Quality Control Submittals: Submit field test report.
- C. Manufacturer's Qualification Statement.
- D. Installer's Qualification Statement.
- E. Mock-Up:
 - 1. Provide a mock-up for evaluation of surface preparation techniques and application workmanship; approved mock-up will serve as a standard of comparison for subsequent Work of this Section.
 - 2. Finish at least 100 square feet of surface in areas as designated by Architect.
 - 3. Evaluate mock-up for compliance with specified requirements, including thickness and finish texture.
 - 4. Do not proceed with remaining Work until workmanship, color, and sheen are approved by Architect.
 - 5. Refinish mock-up area as required to produce acceptable work.
 - 6. Approved mock-up may remain as part of the Project.

PART 2 – PRODUCTS

2.1 SYSTEM REQUIREMENTS

- A. Fireproofing: Provide intumescent thin-film fire-resistive coating systems tested by an independent testing agency in accordance with ASTM E119 and acceptable to authorities having jurisdiction (AHJ).
 - 1. Provide assemblies listed by UL or FM and bearing listing agency label or mark.
- B. Rating: Provide 1 hour for all structural steel framing and roof assembly.

2.2 MATERIALS

- A. Fire Resistive Coating System: Thin film intumescent mastic fireproofing system for fire-protection of structural steel, gypsum board, wood, oriented strand board (OSB), concrete, and concrete masonry units (CMU).
 - 1. Surface Burning Characteristics: Tested in accordance with ASTM E84.
 - a. Flame-Spread Index (FSI): 25, maximum.
 - b. Smoke-Developed Index (SDI): 50, maximum.
 - 2. For Interior Use:
 - a. Use only water-based products.
 - b. Use only products without fiber-content.
 - c. VOC Content: Less than 500 g per L when tested in accordance with 40 CFR 59, Subpart D (EPA Method 24).
- B. Sealers and Primer: As required by tested and listed assemblies and recommended by fireproofing manufacturer to suit specific substrate conditions.
- C. Reinforcement: Glass fiber fabric matching type used in tested and listed assemblies.

PART 3 – EXECUTION

3.1 APPLICATION

- A. Comply with manufacturer's instructions for particular conditions of installation applications.
- B. Apply manufacturer's recommended primer to required coating thickness.
- C. Apply fireproofing to full thickness over the entire area of each substrate to be protected.
- D. Apply coats at manufacturer's recommended rate to achieve dry film thickness (DFT) as required for fire resistance ratings designated for each condition.
- E. Apply intumescent fireproofing by spraying to maximum extent possible, and as necessary complete coverage by roller application or other method acceptable to manufacturer.

END OF SECTION 078123

SECTION 078400 - FIRESTOPPING

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: Provide data on product characteristics, performance ratings, and limitations.

1.2 QUALITY ASSURANCE

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

1.3 FIELD CONDITIONS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.

PART 2 - PRODUCTS

2.1 FIRESTOPPING SYSTEMS

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

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- B. Do not cover installed firestopping until inspected by authorities having jurisdiction.

END OF SECTION 078400

SECTION 079200 - JOINT SEALANTS

PART 1 – GENERAL

1.1 SUBMITTALS

- A. Product Data: Submit manufacturer's technical datasheets for each product to be used; include the following:
 - 1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
 - 2. List of backing materials approved for use with the specific product.
 - 3. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
 - 4. Substrates the product should not be used on.
 - 5. Substrates for which use of primer is required.
 - 6. Substrates for which laboratory adhesion and/or compatibility testing is required.
 - 7. Installation instructions, including precautions, limitations, and recommended backing materials and tools.
 - 8. Sample product warranty.
 - 9. Certification by manufacturer indicating that product complies with specification requirements.
 - 10. SWRI Validation: Provide currently available sealant product validations as listed by SWRI (VAL) for specified sealants.
- B. 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.
- C. Color Cards for Selection: Where sealant color is not specified, submit manufacturer's color cards showing standard colors available for selection.
- D. Samples for Verification: Where custom sealant color is specified, obtain directions from Architect and submit at least 2 physical samples for verification of color of each required sealant.

1.2 WARRANTY

- A. See Section 017800 "Closeout Submittals" for additional warranty requirements.
- B. Manufacturer Warranty: Provide 2-year manufacturer warranty for installed sealants and accessories that fail to achieve a watertight seal, exhibit loss of adhesion or cohesion, or do not cure. Complete forms in Owner's name and register with manufacturer.

PART 2 – PRODUCTS

2.1 JOINT SEALANT APPLICATIONS

A. Scope:

1. Do Not Seal:

- a. Intentional weep holes in masonry.
- b. Joints indicated to be covered with expansion joint cover assemblies.
- c. Joints where sealant is specified to be furnished and installed by manufacturer of product to be sealed.
- d. Joints where sealant installation is specified in other Sections.
- e. Joints between suspended ceilings and walls.

B. Interior Joints: Use non-sag polyurethane sealant, unless otherwise indicated.

1. Wall and Ceiling Joints in Non-Wet Areas: Acrylic emulsion latex sealant.
2. Wall and Ceiling Joints in Wet Areas: Non-sag polyurethane sealant for continuous liquid immersion.
3. Joints between Fixtures in Wet Areas and Floors, Walls, and Ceilings: Mildew-resistant silicone sealant; white.
4. In Sound-Rated Assemblies: Use 1 of the following sealants.
 - a. Pecora AIS-919
 - b. Tremco® Acoustical/Curtainwall Sealant

C. Interior Wet Areas: Bathrooms, restrooms, kitchens, food service areas, and food processing areas; fixtures in wet areas include plumbing fixtures, food service equipment, countertops, cabinets, and other similar items.

D. Sound-Rated Assemblies: Walls and ceilings identified as STC-rated, sound-rated, or acoustical.

2.2 JOINT SEALANTS - GENERAL

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

2.3 NONSAG JOINT SEALANTS

A. Non-Staining Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.

1. Movement Capability: Plus, and minus 35 percent, minimum.

2. Nonstaining to Porous Stone: Nonstaining to light-colored natural stone when tested in accordance with ASTM C1248.
 3. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.
 4. Color: Match adjacent finished surfaces.
- B. Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
1. Movement Capability: Plus, and minus 25 percent, minimum.
 2. Color: Match adjacent finished surfaces.
- C. Mildew-Resistant Silicone Sealant: ASTM C920, Grade NS, Uses M and A; single component, mildew resistant; not expected to withstand continuous water immersion or traffic.
1. Color: Clear.
- D. Polyurethane Sealant: ASTM C920, Grade NS, Uses M and A; single or multi-component; not expected to withstand continuous water immersion or traffic.
1. Movement Capability: Plus, and minus 25 percent, minimum.
- E. Polyurethane Sealant for Continuous Water Immersion: ASTM C920, Grade NS, Uses M and A; single or multi-component; explicitly approved by manufacturer for continuous water immersion; suitable for traffic exposure when recessed below traffic surface.
1. Movement Capability: Plus, and minus 35 percent, minimum.
 2. Color: Match adjacent finished surfaces.

2.4 ACCESSORIES

- A. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install this Work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Provide joint sealant installations complying with ASTM C1193.
- C. Install acoustical sealant application work in accordance with ASTM C919.
- D. Install bond breaker backing tape where backer rod cannot be used.

- E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
- F. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

END OF SECTION 079200

SECTION 079513 - EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: Provide joint assembly profiles, profile dimensions, anchorage devices and available colors and finish.
- B. Shop Drawings: Indicate joint and splice locations, miters, layout of the work, affected adjacent construction and anchorage locations.

PART 2 - PRODUCTS

2.1 EXPANSION JOINT COVER ASSEMBLIES

- A. Expansion Joint Cover Assemblies - General: Factory-fabricated and assembled. Designed to completely fill joint openings, sealed to prevent passage of air, dust, water, smoke. Suitable for traffic expected.
 - 1. Joint Dimensions and Configurations: As indicated on Drawings.
 - 2. Joint Cover Sizes: Selected to suit joint width and configuration, based on manufacturer's published recommendations and limitations.
- B. Floor Joint Covers: Coordinate with indicated floor coverings. Floor joints are to be visible (in polished concrete to define patterns).
- C. Covers in Fire-Rated Assemblies: Provide cover assembly having fire rating equivalent to that of assembly into which it is installed.

2.2 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper; or ASTM B308/B308M, 6061 alloy, T6 temper.
 - 1. Exposed Finish Outdoors: Natural anodized.
 - 2. Exposed Finish at Floors: Mill finish or natural anodized.
 - 3. Exposed Finish at Walls and Ceilings: Natural anodized.
- B. Backing Paint for Aluminum Components in Contact with Cementitious Materials: Asphaltic type.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install components and accessories in accordance with manufacturer's instructions.
- B. Align work plumb and level, flush with adjacent surfaces.
- C. Rigidly anchor to substrate to prevent misalignment.

END OF SECTION 079513

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 – GENERAL

1.1 SUBMITTALS

- A. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and 1 copy of referenced standards/guidelines.
- B. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.

1.2 DELIVERY, STORAGE, AND HANDLING

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

PART 2 – PRODUCTS

2.1 DESIGN CRITERIA

- A. Requirements for Hollow Metal Doors and Frames:
 - 1. Steel used for fabrication of doors and frames shall comply with 1 or more of the following requirements: Galvannealed-steel conforming to ASTM A653/A653M, cold-rolled steel conforming to ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel conforming to ASTM A1011/A1011M, Commercial Steel (CS) Type B for each.
 - 2. Accessibility: Comply with ICC A117.1 and ADA Standards.
 - 3. Door Edge Profile: Manufacturer's standard for application indicated.
 - 4. Typical Door Face Sheets: Flush.
 - 5. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on Drawings. Style: Manufacturer's standard.
 - 6. Hardware Preparations, Selections and Locations: Comply with NAAMM HMMA 830 and NAAMM HMMA 831 or BHMA A156.115 and ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
 - 7. Zinc Coating for Typical Interior and/or Exterior Locations: Provide metal components zinc-coated (galvanized) and/or zinc-iron alloy-coated (galvannealed) by the hot-dip process in accordance with ASTM A653/A653M, with manufacturer's standard coating thickness, unless noted otherwise for specific hollow metal doors and frames.
 - a. Based on SDI Standards: Provide at least A40/ZF120 (galvannealed) when necessary, coating not required for typical interior door applications, and at least A60/ZF180 (galvannealed) for corrosive locations.

- B. Hollow Metal Panels: Same construction, performance, and finish as doors.
- C. Combined Requirements: If a particular door and frame unit is indicated to comply with more than 1 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 2 requirements conflict, comply with the most stringent.

2.2 HOLLOW METAL DOORS

- A. Exterior Doors: Thermally insulated.
 - 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 1 - Standard-duty.
 - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 20 gauge, 0.032-inch, minimum.
 - 2. Door Core Material: Manufacturers standard core material/construction and in compliance with requirements.
 - 3. Door Thickness: 1-3/4-inch, nominal.
 - 4. Top Closures for Outswinging Doors: Flush with top of faces and edges.
 - 5. Weather stripping: Refer to Section 087100.
 - 6. Door Finish: Factory primed, and field finished.
- B. Interior Doors, Non-Fire Rated:
 - 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 1 - Standard-duty.
 - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 20 gauge, 0.032-inch, minimum.
 - 2. Door Thickness: 1-3/4-inch, nominal.
 - 3. Door Finish: Factory primed, and field finished.
- C. Fire-Rated Doors:
 - 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 1 - Standard-duty.
 - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 20 gauge, 0.032-inch, minimum.

2. Fire-Rating: As indicated on Door Schedule, tested in accordance with UL 10C and NFPA 252 "positive pressure fire tests."
3. Temperature-Rise Rating (TRR) Across Door Thickness: In accordance with local building code and authorities having jurisdiction.
4. Provide units listed and labeled by UL (DIR) or ITS (DIR).
 - a. Attach fire rating label to each fire-rated unit.
5. Smoke and Draft Control Doors (Indicated with letter "S" on Drawings and/or Door Schedule): Self-closing or automatic closing doors in accordance with NFPA 80 and NFPA 105, with fire-resistance-rated wall construction rated the same or greater than the fire-rated doors, and the following:
 - a. Maximum Air Leakage: 3.0 cfm/sq ft of door opening at 0.10-inch w.g. pressure, when tested in accordance with UL 1784 at both ambient and elevated temperatures.
 - b. Gasketing: Provide gasketing or edge sealing as necessary to achieve leakage limit.
 - c. Label: Include the "S" label on the fire-rating label of door.
6. Door Core Material: Manufacturers standard core material/construction in compliance with requirements.
7. Door Thickness: 1-3/4-inch, nominal.
8. Door Finish: Factory primed and field finished.

D. Sound-Rated Interior Doors:

1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 1 - Standard-duty.
 - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 20 gauge, 0.032 inch, minimum.
 - e. Zinc Coating: A60/ZF180 galvanized coating; ASTM A653/A653M.
2. Sound Transmission Class (STC) Rating of Door and Frame Assembly: STC of 45, calculated in accordance with ASTM E413, and tested in accordance with ASTM E90.
3. Door Core Material: Manufacturer's standard construction as required to meet acoustic requirements indicated.
4. Door Thickness: As required to meet acoustic requirements indicated.
5. Door Finish: Factory primed, and field finished.
6. Sound Seals: Integral, in door and/or frame.
7. Opening Force of Sound-Rated Doors, Non-Fire Rated: 5 lbs., maximum, in compliance with ADA Standards.

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. Exterior Door Frames: Face welded type.
 - 1. Frame Metal Thickness: 18 gauge, 0.042 inch, minimum.
 - 2. Frame Finish: Factory finished.
 - 3. Weather stripping: Separate, see Section 087100.
- C. Interior Door Frames, Non-Fire-Rated: Face welded type.
 - 1. Terminated Stops: Provide at interior doors; closed end stop terminated 6-inch, maximum, above floor at 45-degree angle.
 - 2. Frame Metal Thickness: 18 gauge, 0.042-inch, minimum.
 - 3. Frame Finish: Factory primed, and field finished.
- D. Door Frames, Fire-Rated: Face welded type.
 - 1. Fire Rating: Same as door, labeled.
 - 2. Terminated Stops: Provide at interior doors; closed end stop terminated 6-inch, maximum, above floor at 45-degree angle.
 - 3. Frame Metal Thickness: 18 gauge, 0.042-inch, minimum.
 - 4. Frame Finish: Factory primed, and field finished.
- E. Sound-Rated Door Frames: Full profile/continuously welded type.
 - 1. Frame Metal Thickness: 18 gauge, 0.042 inch, minimum.
 - 2. Frame Finish: Factory primed, and field finished.
- F. Frames for Wood Doors: Comply with frame requirements in accordance with corresponding door.
- G. Borrowed Lites Glazing Frames: Construction and face dimensions to match door frames, and as indicated on Drawings.
- H. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inches high to fill opening without cutting masonry units.
- I. Frames Wider than 48 inches: Reinforce with steel channel fitted tightly into frame head, flush with top.

2.4 FINISHES

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

2.5 ACCESSORIES

- A. Silencers: Resilient rubber, fitted into drilled hole; provide 3 on strike side of single door, 3 on center mullion of pairs, and 2 on head of pairs without center mullions.

PART 3 – EXECUTION

3.1 INSTALLATION

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

END OF SECTION 081113

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SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.
- B. Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling, blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.

1.2 WARRANTY

- A. Interior Doors: Provide manufacturer's warranty for the life of the installation.
- B. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 - PRODUCTS

2.1 DOORS AND PANELS

- A. Doors: Refer to Drawings for locations and additional requirements.
 - 1. Quality Standard: Custom Grade, Heavy-Duty performance, in accordance with AWI/AWMAC/WI (AWS), AWMAC/WI (NAAWS) or WDMA I.S. 1A.
 - 2. Wood-Veneer-Faced Doors: 5-ply unless otherwise indicated.
 - 3. High-Pressure Decorative Laminate (HPDL) Faced Doors: 5-ply unless otherwise indicated.
 - 4. Where plastic laminate (PLAM) is indicated on Door Schedule, use either high-pressure decorative laminate (HPDL) faced doors in compliance with AWI/AWMAC/WI (AWS), AWMAC/WI (NAAWS) or WDMA I.S. 1A, or low-pressure decorative laminate (LPDL) faced doors in compliance with WDMA I.S. 1A.
- B. Interior Doors: 1-3/4 inches thick unless otherwise indicated; flush construction.
 - 1. Provide solid core doors at each location.
 - 2. Fire-Rated Doors: Tested to ratings indicated on Drawings in accordance with UL 10C - Positive Pressure; Underwriters Laboratories Inc (UL) or Intertek/Warnock Hersey (WHI) labeled without any visible seals when door is open.
 - 3. Smoke- and Draft-Control Doors (Indicated as "S" on Drawings): In addition to required fire rating, provide door assemblies tested in accordance with UL 1784 with maximum air leakage of 3.0 cfm/sq. ft. of door opening at 0.10-inch wg pressure at both ambient

- and elevated temperatures for "S" label; if necessary, provide additional gasketing or edge sealing.
 - 4. Wood veneer facing for field transparent finish as indicated on Drawings.
 - 5. High-pressure decorative laminate (HPDL) finish as indicated on Drawings.
- C. Transom Panels: Same construction and finish as door; same performance rating as door.

2.2 DOOR AND PANEL CORES

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

2.3 DOOR FACINGS

- A. Veneer Facing for Transparent Finish: Red oak, veneer grade in accordance with quality standard indicated, plain sliced (flat cut), with book match between leaves of veneer, running match of spliced veneer leaves assembled on door or panel face.
 - 1. Transoms: Continuous match to doors.
- B. High-Pressure Decorative Laminate (HPDL) Facing for Non-Fire-Rated Doors: NEMA LD 3, HGS; color(s) as indicated; textured, low-gloss finish.

2.4 DOOR CONSTRUCTION

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

2.5 FACTORY FINISHING - WOOD VENEER DOORS

- A. Finish Work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:
 - 1. Opaque:
 - a. System - 1, Lacquer, Nitrocellulose.
 - b. Color: As selected by Architect.
 - c. Sheen: Flat.

B. Finish work in accordance with WDMA I.S. 1A for grade specified and as follows:

1. Opaque:
 - a. System - OP-2, Catalyzed Lacquer.
 - b. Color: As selected by Architect.
 - c. Sheen: Flat.

2.6 ACCESSORIES

A. Glazed Openings:

1. Heat-Strengthened and Fully Tempered Glass: ASTM C1048.
2. Laminated Glass: Float glass laminated in accordance with ASTM C1172.
3. Glazing: Sealed insulating units, 1 inch thick, made of 1/4-inch glass.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install doors in accordance with manufacturer's instructions and specified quality standard.
1. Install fire-rated doors in accordance with NFPA 80 requirements.
 2. Install smoke- and draft-control doors in accordance with NFPA 105 requirements.
- B. Coordinate installation of doors with installation of frames and hardware.

END OF SECTION 081416

SECTION 083100 - ACCESS DOORS AND PANELS

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.
- B. Shop Drawings: Indicate exact position of each access door and/or panel unit.

PART 2 - PRODUCTS

2.1 ACCESS DOORS AND PANELS ASSEMBLIES

A. Wall-Mounted Units:

- 1. Location: As indicated on Drawings.
- 2. Material: Steel at non-public locations and gypsum at visible public locations.
- 3. Size: 12-inch by 12-inch typical unless otherwise noted on Drawings. See Drawings for coordination of sizes.
- 4. Door/Panel, Typical:
 - a. Basis of Design: Best Access Doors, hinged radius corner, slotted keyless camlock. See Plans to confirm size and location.
 - b. Website: <https://www.bestaccessdoors.com>
- 5. Door/Panel at Tile Walls:
 - a. Basis of Design: Babcock Davis, tile-ready access door, drywall bead flange, knurled knob/key-operated slam latch. See Plans to confirm size and location.
 - b. Website: <https://www.babcockdavis.com/products/access-doors/tile-ready>.
- 6. Wall Mounting Criteria: Provide surface-mounted face frame and door surface flush with frame surface. Doors to be installed vertical and flush with floor finish for easy access to platform.
- 7. Gypsum Board Mounting Criteria: Provide drywall bead frame with door surface flush with wall surface.

B. Fire-Rated Wall-Mounted Units:

- 1. Location: As indicated on Drawings.
- 2. Wall Fire Rating: As indicated on Drawings.
- 3. Material: Steel.
- 4. Size: 12 inches by 12 inches.

5. Door/Panel: Insulated double-surface panel, with tool-operated spring or cam lock and no handle.

C. Ceiling-Mounted Units:

1. Location: As indicated on Drawings.
2. Material:
 - a. Basis of Design for Gypsum Ceiling Installations: Bauco Access Panel Solutions, Inc.; Bauco Plus series access panels. www.accesspanelsolutions.com.
3. Size, Lay-In Grid Ceilings: To match module of ceiling grid.
4. Size, Other Ceilings: 12 inches by 12 inches.
5. Size, Gypsum Ceilings – Mechanical, Electrical and Plumbing (MEP) Access: Refer to MEP Drawings for size requirements.
6. Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.

2.2 WALL- AND CEILING-MOUNTED UNITS

A. Wall- and Ceiling-Mounted Units: Factory-fabricated door and frame, fully assembled units with corner joints welded, filled and ground flush, square and without rack or warp. Coordinate requirements with type of installation assembly being used for each unit.

1. Style: Recessed door panel for infill with wall/ceiling finish.
 - a. Gypsum Board Mounting Criteria: Use drywall bead type frame.
 - b. Plaster Mounting Criteria: Use plaster bead type frame.
2. Door Style: Single thickness with rolled or turned in edges.
3. Units in Fire-Rated Assemblies: Fire rating as required by applicable code for fire-rated assembly that access doors are being installed.
 - a. Provide products listed by ITS (DIR) or UL (FRD) as suitable for purpose indicated.
 - b. Provide certificate of compliance from authorities having jurisdiction indicating approval of fire-rated doors.
4. Steel Finish: Primed.
5. Primed and Factory Finish: Polyester powder coat; color to match adjacent materials.
6. Hardware:
 - a. Hardware for Fire-Rated Units: As required for listing.
 - b. Hinges for Non-Fire-Rated Units: Concealed, constant force closure spring type.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units in accordance with manufacturer's instructions.
- B. Install frames plumb and level in openings, and secure units rigidly in place.

END OF SECTION 083100

SECTION 083313 - COILING COUNTER DOORS

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: Submit manufacturer's standard literature showing materials and details of construction and finish. Include data on electrical operation.
- B. Shop Drawings: Indicate rough and actual opening dimensions, anchorage methods, hardware locations, and installation details.

1.2 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by ITS (DIR), UL (DIR), or testing firm acceptable to authorities having jurisdiction as suitable for the purpose specified and indicated.

1.3 WARRANTY

- A. Manufacturer Warranty: Provide 2-year manufacturer warranty for counterbalance shaft assembly. Complete forms in Owner's name and register with manufacturer.

PART 2 - PRODUCTS

2.1 COILING COUNTER DOORS

- A. Coiling Counter Metal Doors, Non-Fire-Rated: Stainless-steel slat curtain.
 - 1. Mounting: Between jambs, within prepared opening.
 - 2. Provide integral frame and sill of same material and finish.
 - 3. Nominal Slat Size: 1-1/4 inches wide.
 - 4. Slat Profile: Flat, perforated.
 - 5. Finish, Stainless Steel: No. 4 - Brushed.
 - 6. Guides: Formed track, same material and finish unless otherwise indicated.
 - 7. Hood Enclosure: Manufacturer's standard, primed steel.
 - 8. Electric operation.
 - 9. Locking Devices: Slide bolt on inside.

2.2 COMPONENTS

- A. Metal Curtain Construction: Interlocking, single-thickness slats.
- B. Guide Construction: Continuous, of profile to retain door in place, with mounting brackets of same metal.

1. Stainless-Steel Guides: ASTM A666, Type 304, rollable temper.
 2. Aluminum Guides: Extruded aluminum channel, with wool pile runners along inside.
- C. Hood Enclosure: Internally reinforced to maintain rigidity and shape.
- D. Lock Hardware:
1. For motor operated units, additional lock or latching mechanisms are not required.
 2. Latch Handle: Manufacturer's standard.
 3. Slide Bolt: Provide on single-jamb side, extending into slot in guides, with padlock on 1 side.

2.3 ELECTRIC OPERATION

- A. Operator, Controls, Actuators, and Safeties: Listed and classified by ITS (DIR), UL (DIR), or testing agency acceptable to authorities having jurisdiction (AHJ) as suitable for purpose specified and indicated.
1. Provide interlock switches on motor operated units.
- B. Electric Operators:
1. Mounting: Side mounted.
 2. Motor Enclosure: NEMA MG 1.
 3. Motor Rating: As recommended by manufacturer, continuous duty.
 4. Motor Voltage: 110 to 120 VAC, single phase, 60 Hz.
- C. Control Station: Standard 3-button (OPEN-STOP-CLOSE) momentary control for each electrical operator.
1. Controls: 24-VAC circuit.
 2. Surface mounted.
- D. Safety Edge: Located at bottom of curtain, full width, electro-mechanical sensitized type, wired to stop operator upon striking object, hollow neoprene covered.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units in accordance with manufacturer's instructions.
- B. Complete wiring from disconnect to unit components.

END OF SECTION 083313

SECTION 083613 - SECTIONAL DOORS

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Shop Drawings: Indicate opening dimensions and required tolerances, connection details, anchorage spacing, hardware locations, and installation details.
- B. Product Data: Show component construction, anchorage method, and hardware.

1.2 WARRANTY

- A. Extended Correction Period: Correct defective work within a 2-year period commencing on Date of Substantial Completion.
- B. Manufacturer Warranty: Provide 5-year manufacturer warranty for electric operating equipment. Complete forms in Owner's name and register with manufacturer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Performance: Withstand positive and negative wind loads equal to 1.5 times design wind loads specified by local code without damage or permanent set, when tested in accordance with ASTM E330/E330M, using 10-second duration of maximum load.

2.2 ALUMINUM DOORS

- A. Type ASD-1 - Doors: Flush aluminum, insulated; standard lift operating style with track and hardware; complying with DASMA 102, Commercial application.
 - 1. Door Panels:
 - a. Basis of Design: Overhead Door Aluminum Glass Door model 521.
 - b. Website: <https://www.overheaddoor.com/aluminum-glass-doors-521>.
 - 2. Door Nominal Thickness: 1-3/4 inches thick.
 - 3. Finish: Factory anodized; Dark Bronze Anodized.
 - 4. Glazed Lites: Full panel width, 6 rows; set in place with resilient glazing channel.
 - a. Glazing: Laminated safety glass; insulated glass units; clear; 1/8-inch overall thickness.

- 5. Electric Operation: Electric control station.

2.3 COMPONENTS

- A. Track: Rolled galvanized steel, 0.090-inch minimum thickness; 2 inches wide, continuous 1 piece per side; galvanized steel mounting brackets 1/4-inch thick.
- B. Hinge and Roller Assemblies: Heavy-duty hinges and adjustable roller holders of galvanized steel; floating hardened steel bearing rollers, located at top and bottom of each panel, each side.
- C. Lift Mechanism: Torsion spring on cross-head shaft, with braided galvanized steel lifting cables.
- D. Garage Door Seal:
 - a. Basis of Design: ThermoTraks Garage Door Seal.
 - b. Website: <https://thermotraks.com>.
- E. Sill Weather Stripping: Resilient hollow rubber strip, 1 piece; fitted to bottom of door panel, full-length contact.
- F. Jamb Weather Stripping: Roll-formed steel section full height of jamb, fitted with resilient weather stripping, placed in moderate contact with door panels.
- G. Head Weather Stripping: EPDM rubber seal, 1 piece, full length.
- H. Panel Joint Weather Stripping: Neoprene foam seal, 1 piece, full length.
- I. Lock: Inside center mounted, adjustable keeper, spring-activated latch bar with feature to retain in locked or retracted position; interior and exterior handle.
- J. Lock Cylinders: Keyed alike.

2.4 ELECTRIC OPERATION

- A. Operator, Controls, Actuators, and Safeties: Comply with UL 325; provide products listed by ITS (DIR), UL (DIR), or testing agency acceptable to authorities having jurisdiction.
 - 1. Provide interlock switches on motor operated units.
 - 2. Provide tamperproof operation cycle counter.
- B. Electric Operators:
 - 1. Mounting: Side-mounted on cross-head shaft.
 - 2. Motor Enclosure:
 - a. Exterior Doors: NEMA MG 1, Type 4; open drip-proof.

3. Motor Rating: 1/3-hp; continuous duty.
 4. Motor Voltage: 120 volts, single phase, 60 Hz.
 5. Motor Controller: NEMA ICS 2, full-voltage, reversing magnetic motor starter.
 6. Controller Enclosure: NEMA 250, Type 1.
 7. Opening Speed: 12 inches per second.
 8. Brake: Adjustable friction clutch type, activated by motor controller.
 9. Manual override in case of power failure.
- C. Control Station: Provide standard 3-button (Open-Close-Stop), momentary-contact control device for each operator complying with UL 325.
1. 24-volt circuit.
 2. Surface mounted, at interior door jamb.
 3. Entrapment Protection Devices: Provide sensing devices and safety mechanisms complying with UL 325.
 - a. Primary Device: Provide electric sensing edge, wireless sensing, NEMA 1 photo eye sensors, or NEMA 4X photo eye sensors as required with momentary-contact control device.
- D. Safety Edge: Located at bottom of sectional door panel, full width; electro-mechanical sensitized type, wired to stop and reverse door direction upon striking object; hollow neoprene covered to provide weather strip seal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install door unit assembly in accordance with manufacturer's instructions.
- B. Anchor assembly to wall construction and building framing without distortion or stress.
- C. Securely brace door tracks suspended from structure. Secure tracks to structural members only.
- D. Coordinate installation of electrical service. Complete power and control wiring from disconnect to unit components.

END OF SECTION 083613

SECTION 084313 - ALUMINUM-FRAMED STOREFRONTS

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, internal drainage details.
- B. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.
- C. Manufacturer's Qualification Statement.

1.2 WARRANTY

- A. Correct defective Work within a 5-year period after Date of Substantial Completion.
- B. Provide 5-year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.
- C. Provide 5-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 BASIS OF DESIGN – FRAMING FOR INSULATING GLAZING

- A. Front-Set Style, Thermally Broken:
 - 1. Basis of Design: Kawneer 450 Framing System.
 - 2. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep.

2.2 BASIS OF DESIGN – SWINGING DOORS

- A. Narrow Stile, Monolithic Glazing:
 - 1. Basis of Design: EFCO Corporation; Series D200: www.efcocorp.com/#sle.
 - 2. Thickness: 1-3/4-inches.

2.3 STOREFRONT

- A. Aluminum-Framed Storefront: Factory-fabricated, factory-finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
 - 1. Glazing Rabbet: For 1-inch insulating glazing.
 - 2. Finish: Superior performing organic coatings.
 - a. Factory finish all surfaces that will be exposed in completed assemblies.
 - b. Touch up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.
 - 3. Finish Color: Dark bronze.
 - 4. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured. Prepared to receive anchors and hardware. Fasteners and attachments concealed from view. Reinforced as required for imposed loads.
 - 5. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
 - 6. 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.

2.4 COMPONENTS

- A. Aluminum Framing Members: Tubular aluminum sections, drainage holes and internal weep drainage system.
 - 1. Glazing Stops: Flush.
- B. Swing Doors: Glazed aluminum.
 - 1. Thickness: 1-3/4 inches.
 - 2. Top Rail: 4 inches wide.
 - 3. Vertical Stiles: 4-1/2 inches wide.
 - 4. Bottom Rail: 6 inches wide.
 - 5. Glazing Stops: Square.
 - 6. Finish: Same as storefront.

2.5 MATERIALS

- A. Extruded Aluminum: ASTM B221.
- B. Structural Steel Sections: ASTM A36/A36M; shop primed.
- C. Fasteners: Stainless steel.

2.6 FINISHES

- A. Class I Color Anodized Finish: AAMA 611 AA-M12C22A44 Electrolytically deposited colored anodic coating not less than 0.7 mils thick.
- B. Superior Performing Organic Coatings: AAMA 2605 multiple coats, thermally cured polyvinylidene fluoride (PVDF) system.

2.7 HARDWARE

- A. For each door, include weather stripping, sill sweep strip, threshold, and hardware per Drawing.
- B. Other Door Hardware: Storefront manufacturer's standard type to suit application.
 - 1. Finish on Hand-Contacted Items: Brushed Nickel.
 - 2. For each door, include butt hinges, pivots, push handle, pull handle, exit device, narrow stile handle latch, and closer. Coordinate ADA push button location.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install wall system in accordance with manufacturer's instructions.
- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

END OF SECTION 084313

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this Project, and includes construction details, material descriptions, finishes, and dimensions and profiles of individual components.
- B. Shop Drawings - Door Hardware Schedule: Submit detailed listing that includes each item of hardware to be installed on each door. Use door numbering scheme as included in Contract Documents.
 - 1. Prepared by or under supervision of Architectural Hardware Consultant (AHC).
 - 2. Comply with DHI (H&S) using door numbers and hardware set numbers as indicated in Construction Documents.
 - 3. List groups and suffixes in proper sequence.
 - 4. Provide complete description for each door listed.
 - 5. Provide manufacturers and product names, and catalog numbers. Include functions, types, styles, sizes and finishes of each item.
- C. Shop Drawings - Electrified Door Hardware: Submit diagrams for power, signal, and control wiring for electrified door hardware that include details of interface with building safety and security systems. Provide elevations and diagrams for each electrified door opening as follows:
 - 1. Prepared by or under supervision of Architectural Hardware Consultant (AHC) and Electrified Hardware Consultant (EHC).
 - 2. Elevations: Submit front and back elevations of each door opening showing electrified devices with connections installed and an operations narrative describing how opening operates from either side at any given time.
 - 3. Diagrams: Submit point-to-point wiring diagram that shows each device in door opening system with related colored wire connections to each device.

1.2 WARRANTY

- A. Warranty against defects in material and workmanship for period indicated, from Date of Substantial Completion.
 - 1. Closers: 5 years, minimum.
 - 2. Exit Devices: 3 years, minimum.
 - 3. Locksets and Cylinders: 3 years, minimum.
 - 4. Other Hardware: 2 years, minimum.

PART 2 - PRODUCTS

2.1 DESIGN AND PERFORMANCE CRITERIA

- A. Provide specified door hardware as required to make doors fully functional, compliant with applicable codes, and secure to extent indicated.
- B. Provide door hardware products that comply with the following requirements:
 - 1. Applicable provisions of Federal, State, and local codes.
 - 2. Fire-Rated Doors: NFPA 80, listed and labeled by qualified testing agency for fire protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
 - 3. Hardware on Fire-Rated Doors: Listed and classified by UL (DIR), ITS (DIR), testing firm acceptable to authorities having jurisdiction.
 - 4. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified.
- C. Electrically Operated and/or Controlled Hardware: Provide necessary power supplies, power transfer hinges, relays, and interfaces as required for proper operation. Provide wiring between hardware and control components and to building power connection in compliance with NFPA 70.

2.2 HINGES

- A. Hinges: Comply with BHMA A156.1, Grade 1.
 - 1. Provide hinges on every swinging door.
 - 2. Provide following quantity of butt hinges for each door: 3.

2.3 EXIT DEVICES

- B. Exit Devices: Comply with BHMA A156.3, Grade 1.
 - 1. Lever design to match lockset trim.
 - 2. Provide cylinders with cylinder dogging or locking trim.
 - 3. Provide exit devices properly sized for door width and height.
 - 4. Provide strike as recommended by manufacturer for application indicated.
 - 5. Provide UL (DIR) listed exit device assemblies for fire-rated doors and panic device assemblies for non-fire-rated doors.

2.4 DOOR PULLS AND PUSH PLATES

- A. Door Pulls and Push Plates: Comply with BHMA A156.6.
 - 1. Pull Type: Straight, unless otherwise indicated.

2. Push Plate Type: Flat, with square corners, unless otherwise indicated.
 - a. Edges: Beveled, unless otherwise indicated.
3. Material: Bronze, unless otherwise indicated.

2.5 DOOR PULLS AND PUSH BARS

- A. Door Pulls and Push Bars: Comply with BHMA A156.6.
 1. Bar Type: Bar set, unless otherwise indicated.
 2. Material: Bronze, unless otherwise indicated.

2.6 CLOSERS

- A. Closers: Comply with BHMA A156.4, Grade 1.
 1. Type: Surface mounted to door.
 2. Provide door closer on each exterior door.

2.7 OVERHEAD STOPS AND HOLDERS

- A. Overhead Stops and Holders (Door Checks): Comply with BHMA A156.8, Grade 1.
 1. Provide a stop for every swinging door, unless otherwise indicated.

2.8 KICK PLATES

- A. Kick Plates: Provide along bottom edge of push side of every door with closer, except aluminum storefront and glass entry doors, unless otherwise indicated.
 1. Size: 8 inches high by 2 inches less door width (LDW) on push side of door.

2.9 FLOOR STOPS

- A. Floor Stops: Comply with BHMA A156.16, Grade 1 and Resilient Material Retention Test as described in this standard.
 1. Provide floor stops when wall surface is not available; be cautious not to create a tripping hazard.
 2. Type: Manual hold-open, with pencil floor stop.
 3. Material: Aluminum housing with rubber insert.

2.10 WALL STOPS

- A. Wall Stops: Comply with BHMA A156.16, Grade 1 and Resilient Material Retention Test as described in this standard.
 - 1. Provide wall stops to prevent damage to wall surface upon opening door.
 - 2. Type: Bumper, concave, wall stop.
 - 3. Material: Aluminum housing with rubber insert.

2.11 THRESHOLDS

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

2.12 WEATHER STRIPPING AND GASKETING

- A. Weather Stripping and Gasketing: Comply with BHMA A156.22.
 - 1. Head and Jamb Type: Adjustable.
 - 2. Door Sweep Type: Encased in retainer.
 - 3. Material: Aluminum, with neoprene weather stripping.

2.13 KEY CONTROL SYSTEMS

- A. Key Control Systems: Comply with guidelines of BHMA A156.28.
 - 1. Keying: Grand Master keyed.
 - 2. Include construction keying and control keying with removable core cylinders.

2.14 FIRE DEPARTMENT LOCK BOX

- A. Fire Department Lock Box:
 - 1. Heavy-duty, surface-mounted, solid stainless-steel box with hinged door and interior gasket seal; single drill-resistant lock with dust covers and tamper alarm.
 - 2. Capacity: Holds 10 keys.
 - 3. Finish: Manufacturer's standard dark bronze.

2.15 KEYPAD

- A. Keypad: Indoor or outdoor use, 12-key digital keypad with silicone rubber keys, and compatible with access control systems using standard Wiegand output.
 - 1. Power: 12 VDC; 35mA Active and 7mA at Rest.
 - 2. Mounts on narrow mullion, 1-1/2 inches wide by 7 inches high by 1 inch deep.

2.16 FINISHES

- A. Finishes: Provide door hardware of same finish, unless otherwise indicated.
 - 1. Primary Finish: 619; satin nickel, with brass or bronze base material (former US equivalent US15); BHMA A156.18.
 - 2. Secondary Finish: 626; satin chromium-plated over nickel, with brass or bronze base material (former US equivalent US26D); BHMA A156.18.
 - a. Use secondary finish in kitchens, bathrooms, and other spaces containing chrome or stainless-steel finished appliances, fittings, and equipment. Provide primary finish on 1 side of door and secondary finish on other side if necessary.
 - 3. Exceptions:
 - a. Where base material metal is specified to be different, provide finish that is an equivalent appearance in accordance with BHMA A156.18.
 - b. Hinges for Fire-Rated Doors: Steel base material with painted finish, in compliance with NFPA 80.
 - c. Door Closer Covers and Arms: Color as selected by Architect from manufacturer's standard colors unless otherwise indicated.
 - d. Aluminum Surface Trim and Gasket Housings: Anodized to match door panel finish, not other hardware, unless otherwise indicated.
 - e. Hardware for Aluminum Storefront Doors: Finished to match door panel finish, except at hand contact surfaces provide stainless steel with satin finish, unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

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

3.2 ADJUSTING

- A. Adjust hardware for smooth operation.

END OF SECTION 087100

SECTION 087113 - POWER DOOR OPERATORS

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: Provide data on system components, sizes, features, and finishes.

PART 2 - PRODUCTS

2.1 POWER DOOR OPERATORS - GENERAL

- A. Electrically Operated or Controlled Hardware: Provide necessary power supplies, relays, and interfaces as required for proper operation; provide wiring between control components and to building power connection in compliance with NFPA 70.
- B. Comply with ADA Standards for egress requirements.
- C. Comply with NFPA 101 and requirements of authorities having jurisdiction; provide units selected for actual door weight and for light pedestrian traffic unless otherwise indicated.
- D. Exterior and Vestibule Doors: Provide equipment suitable for ambient operating temperature range of minus 20 to plus 140 degrees F.
- E. Exterior Doors: Provide units capable of operating, closing, and holding doors closed under positive and negative differential pressure; if necessary, provide power closing.
- F. System Integration: Integrate operator functionality with other systems as required for a complete working installation.

2.2 FINISHES

- A. Aluminum Finishes: Manufacturer's standard.
 - 1. Class I Color Anodized Finish: Electrolytically deposited colored anodic coating; AAMA 611 AA-M12C22A44, minimum dry film thickness (DFT) of 0.7 mil, 0.0007-inch.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment in accordance with manufacturer's instructions.

- B. Install pneumatic lines and door power units in a manner to prevent condensation or freezing.

END OF SECTION 087113

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data on Insulating Glass Unit, Glazing Unit, and Spandrel Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- B. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
- C. Samples: Submit 2 samples 12 by 12 inches in size of glass units.

1.2 QUALITY ASSURANCE

- A. Perform Work in accordance with GANA (GM), GANA (SM), GANA (LGRM), and IGMA TM-3000, for glazing installation methods. Maintain 1 copy on site.

1.3 WARRANTY

- A. Insulating Glass Units: Provide a 5-year manufacturer warranty to include coverage for seal failure, interpane dusting or misting, including providing products to replace failed units.
- B. Laminated Glass: Provide a 5-year manufacturer warranty to include coverage for delamination, including providing products to replace failed units.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS - EXTERIOR GLAZING ASSEMBLIES

- A. Provide type and thickness of exterior glazing assemblies to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of glass.
 - 1. Design Pressure: Calculated in accordance with ASCE 7.
 - 2. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
 - 3. Provide glass edge support system sufficiently stiff to limit the lateral deflection of supported glass edges to less than 1/175 of their lengths under specified design load.
 - 4. Glass thicknesses listed are minimum.

- B. Vapor Retarder and Air Barrier Seals: Provide completed assemblies that maintain continuity of building enclosure vapor retarder and air barrier.
 - 1. In conjunction with vapor retarder and joint sealer materials described in other sections.
- C. Thermal and Optical Performance: Provide exterior glazing products with performance properties as indicated. Performance properties are in accordance with manufacturer's published data as determined with the following procedures and/or test methods:
 - 1. Center of Glass U-Value: Comply with NFRC 100 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
 - 2. Center of Glass Solar Heat Gain Coefficient (SHGC): Comply with NFRC 200 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
 - 3. Solar Optical Properties: Comply with NFRC 300 test method.

2.2 GLASS MATERIALS

- A. Float Glass: Provide float glass-based glazing unless otherwise indicated.
 - 1. Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality - Q3.
 - 2. Kind HS - Heat-Strengthened Type: Complies with ASTM C1048.
 - 3. Kind FT - Fully Tempered Type: Complies with ASTM C1048.
 - 4. Fully Tempered Safety Glass: Complies with ANSI Z97.1 or 16 CFR 1201 criteria for safety glazing used in hazardous locations.
 - 5. Impact-Resistant Safety Glass: Complies with ANSI Z97.1 - Class B, or 16 CFR 1201 - Category I criteria.
 - 6. Thicknesses: As indicated. Provide greater thickness as required for exterior glazing wind load design.
- B. Laminated Glass: Float glass laminated in accordance with ASTM C1172.
 - 1. Laminated Safety Glass: Complies with ANSI Z97.1 - Class B or 16 CFR 1201 - Category I impact test requirements.

2.3 INSULATING GLASS UNITS

- A. Insulating Glass Units: Types as indicated.
 - 1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
 - 2. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
 - 3. Metal Edge Spacers: Aluminum, bent and soldered corners.
 - 4. Spacer Color: Black.

5. Edge Seal:

- a. Dual-Sealed System: Provide polyisobutylene sealant as primary seal applied between spacer and glass panes, and silicone, polysulfide, or polyurethane sealant as secondary seal applied around perimeter.

6. Color: Black.

7. Purge interpane space with dry air, hermetically sealed.

B. Type IG-1 - Insulating Glass Units: Vision glass, double-glazed.

1. Applications: Exterior glazing unless otherwise indicated.

2. Space between lites filled with argon.

3. Outboard Lite: Heat-strengthened, Kind FT (fully tempered) float glass, 1/4-inch thick, minimum.

- a. Tint: Clear.

- b. Coating: Self-cleaning type, on #1 surface.

4. Inboard Lite: Heat-strengthened, Kind FT (fully tempered) float glass float glass, 1/4-inch thick, minimum.

- a. Tint: Clear.

- b. Coating: Low-emissivity coated glass, on #3 surface.

- c. Basis-of-Design Product: PPG Solarban 90 Clear + Clear.

5. Total Thickness: 1 inch.

6. Thermal Transmittance (U-Value), Summer - Center of Glass: 22, nominal.

7. Visible Light Transmittance (VLT): 51 percent, minimum.

8. Solar Heat Gain Coefficient (SHGC): 0.23, maximum.

9. Visible Light Reflectance, Outside: 12 percent, nominal.

10. Visible Light Reflectance, Inside: 19 percent, nominal.

2.4 GLAZING COMPOUNDS

- A. Glazing Putty: Polymer modified latex recommended by manufacturer for outdoor use, knife grade consistency; grey color.

- B. Butyl Sealant: Single component; ASTM C920 Grade NS, Class 12-1/2, Uses M and A, Shore A hardness of 10 to 20; black color.

2.5 ACCESSORIES

- A. Setting Blocks: Silicone, with 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1-inch for each square foot of glazing or minimum 4 inches by width of glazing rabbet space minus 1/16-inch by height to suit glazing method and pane weight and area.

- B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness; ASTM C864 Option II. Minimum 3 inches long by one-half the height of the glazing stop by thickness to suit application, self-adhesive on 1 face.
- C. Glazing Tape, Back Bedding Mastic Type: Preformed, butyl-based, 100 percent solid compound with integral resilient spacer rod applicable to application indicated; 5 to 30 cured Shore A durometer hardness; coiled on release paper; black color.
- D. Glazing Splines: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; color black.

PART 3 - EXECUTION

3.1 INSTALLATION - DRY GLAZING METHOD (GASKET GLAZING)

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

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

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

3.3 INSTALLATION - PRESSURE GLAZED SYSTEMS

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

3.4 INSTALLATION - STRUCTURAL SILICONE GLAZING

- A. Provide design review of the glazing system and project details, adhesion testing, proper surface preparation, training and a quality service program.
- B. Provide only structural silicone sealant, tested and manufactured for structural glazing.

END OF SECTION 088000

SECTION 088300 - MIRRORS

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data on Mirror Types: Submit structural, physical and environmental characteristics, size limitations, special handling and installation requirements.

1.2 WARRANTY

- A. Provide 5-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. Edges: Arrised.

2.2 GLAZING COMPOUNDS

- A. Polyurethane Sealant: ASTM C920, Type S, Grade NS, Class 25, Uses M and A; single-component, chemical curing, non-staining, non-bleeding, Shore A Hardness Range 20 to 35; color as selected.

2.3 ACCESSORIES

- A. Setting Blocks: Neoprene, 80 to 90 Shore A durometer hardness.
- B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness.
- C. Mirror Attachment Accessories: Stainless-steel clips.
- D. Channel Frame: One-piece, channel frame, stainless steel, Type 430, satin finish, 1/2-inch by 1/2-inch by 3/8-inch deep with 90-degree mitered corners.

PART 3 - EXECUTION

3.1 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.

END OF SECTION 088300

SECTION 090561 - COMMON WORK RESULTS FOR FLOORING PREPARATION

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Floor Covering and Adhesive Manufacturers' Product Literature: For each specific combination of substrate, floor covering, and adhesive to be used.
- B. Testing Agency's Report:
 - 1. Recommendations for remediation of unsatisfactory surfaces.
 - 2. Product data for recommended remedial coating.
- C. Adhesive Bond and Compatibility Test Report.

1.2 QUALITY ASSURANCE

- A. Moisture and alkalinity (pH) testing shall be performed by an independent testing agency employed and paid by Contractor.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Patching Compound: Floor covering manufacturer's recommended product, suitable for conditions, and compatible with adhesive and floor covering. In the absence of any recommendation from flooring manufacturer, provide a product with the following characteristics:
 - 1. Cementitious moisture-, mildew-, and alkali-resistant compound, compatible with floor, floor covering, and floor covering adhesive, and capable of being feathered to nothing at edges.
 - 2. Compressive Strength: 3,000 psi, minimum, after 28 days, when tested in accordance with ASTM C109/C109M or ASTM C472, whichever is appropriate.
- B. Alternate Flooring Adhesive: Floor covering manufacturer's recommended product, suitable for the moisture and pH conditions present; low-VOC. In the absence of any recommendation from flooring manufacturer, provide a product recommended by adhesive manufacturer as suitable for substrate and floor covering and for conditions present.
- C. Remedial Floor Coating: Single- or multi-layer coating or coating/overlay combination intended by its manufacturer to resist water vapor transmission to degree sufficient to meet flooring manufacturer's emission limits, resistant to the level of alkalinity (pH) found, and suitable for adhesion of flooring without further treatment.

- D. Remedial Floor Sheet Membrane: Pre-formed, multi-ply sheet membrane installed over concrete subfloor and intended by its manufacturer to resist water vapor transmission to degree sufficient to meet flooring manufacturer's emission limits, resistant to the level of alkalinity (pH) found, and suitable for adhesion of flooring without further treatment.

PART 3 - EXECUTION

3.1 CONCRETE SLAB PREPARATION

- A. Perform following operations in the order indicated:
 - 1. Existing concrete slabs (on-grade and elevated) with existing floor coverings:
 - a. Visual observation of existing floor covering, for adhesion, water damage, alkaline deposits, and other defects.
 - 2. Preliminary cleaning.
 - 3. Internal relative humidity tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
 - 4. Specified remediation, if required.
 - 5. Patching, smoothing, and leveling, as required.
 - 6. Other preparation specified.
 - 7. Adhesive bond and compatibility test.
 - 8. Protection.
- B. Remediations:
 - 1. Active Water Leaks or Continuing Moisture Migration to Surface of Slab: Correct this condition before doing any other remediation; re-test after correction.
 - 2. Excessive Moisture Emission or Relative Humidity: If an adhesive that is resistant to the level of moisture present is available and acceptable to flooring manufacturer, use that adhesive for installation of the flooring. If not, apply remedial floor coating or remedial sheet membrane over entire suspect floor area.
 - 3. Excessive Alkalinity (pH): If remedial floor coating is necessary to address excessive moisture, no additional remediation is required. If not, if an adhesive that is resistant to the level present is available and acceptable to the flooring manufacturer, use that adhesive for installation of the flooring; otherwise, apply a skim coat of specified patching compound over entire suspect floor area.

3.2 INTERNAL RELATIVE HUMIDITY TESTING

- A. Test in accordance with ASTM F2170 Procedure A and as follows.
- B. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if any test value exceeds 75 percent relative humidity.

3.3 ADHESIVE BOND AND COMPATIBILITY TESTING

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

3.4 APPLICATION OF REMEDIAL FLOOR COATING

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

3.5 INSTALLATION OF REMEDIAL FLOOR Sheet Membrane

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

END OF SECTION 090561

SECTION 092116 - GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Shop Drawings: Indicate special details associated with fireproofing and acoustic seals.
- B. Product Data: Provide data on metal framing, gypsum board, accessories, and joint finishing system.
- C. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

PART 2 - PRODUCTS

2.1 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
- 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-Rated Assemblies: Provide completed assemblies with the following characteristics:
 - 1. Fire-Rated Partitions: As shown on code sheets; 1- and 2-hour rating.
 - 2. Head of Fire-Rated Partitions: UL listed assembly No. as indicated on wall types and UL assemblies pages.; 1- and 2-hour rating.
 - 3. Fire-Rated Ceilings and Soffits: One-hour fire rating.
 - 4. UL Assembly Numbers: Provide construction equivalent to that listed for the particular assembly in the current UL (FRD).

2.2 METAL FRAMING MATERIALS

- A. Exterior Non-Load-bearing Studs and Furring for Application of Gypsum Board: As specified in Section 092216.

2.3 BOARD MATERIALS

- A. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.

1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
2. Glass mat-faced gypsum panels as defined in ASTM C1658/C1658M, suitable for paint finish, of the same core type and thickness may be substituted for paper-faced board.
3. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - a. Mold-resistant board is required at all wet walls within restrooms, kitchens and bar locations.
4. At Assemblies Indicated with Fire-Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
5. Thickness:
 - a. Vertical Surfaces: 5/8-inch.
 - b. Curved surfaces: 1/4-inch.
 - c. Ceilings: 1/2-inch.
 - d. Multi-Layer Assemblies: Thicknesses as indicated on Drawings.

B. Backing Board For Wet Areas: One of the following products:

1. Application: Surfaces behind tile in wet areas including restrooms, kitchens and back-bars.
2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
3. ANSI Cement-Based Board: Non-gypsum-based; aggregated Portland cement panels with glass-fiber mesh embedded in front and back surfaces complying with ANSI A118.9 or ASTM C1325.
4. ASTM Cement-Based Board: Non-gypsum-based, cementitious board complying with ASTM C1288.
5. Glass Mat-Faced Board: Coated glass mat water-resistant gypsum backing panel as defined in ASTM C1178/C1178M.

C. Ceiling Board: Special sag-resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.

1. Application: Ceilings, unless otherwise indicated.
2. Thickness: 1/2-inch.
3. Edges: Tapered.

2.4 ACCESSORIES

A. Water-Resistive Barrier: As specified in Section 072500.

B. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.

1. Tape: 2-inch-wide, coated glass-fiber tape for joints and corners.
2. Ready-mixed vinyl-based joint compound.
3. Powder-type vinyl-based joint compound.
4. Chemical hardening type compound.

- C. High-Build Drywall Surfer: Vinyl acrylic latex-based coating for spray application, designed to take the place of skim coating and separate paint primer in achieving Level 5 finish.
- D. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033-inch in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion resistant.
- E. 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.
- F. Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

PART 3 - EXECUTION

3.1 SHAFT WALL INSTALLATION

- A. Shaft Wall Framing: Install in accordance with manufacturer's installation instructions.
- B. Shaft Wall Liner: Cut panels to accurate dimension and install sequentially between special friction studs.

3.2 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.

3.3 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. Fire-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
- C. Exposed Gypsum Board in Interior Wet Areas: Seal joints, cut edges, and holes with water-resistant sealant.
- D. Cementitious Backing Board: Install over steel framing members and plywood substrate where indicated, in accordance with ANSI A108.11 and manufacturer's instructions.

3.4 JOINT TREATMENT

- A. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
 - 1. Level 5: Walls and ceilings to receive semigloss or gloss paint finish and other areas specifically indicated.

2. Level 4: Walls and ceilings to receive paint finish or wallcoverings, unless otherwise indicated.
3. Level 3: Walls to receive textured wall finish.
4. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
5. Level 1: Fire-rated wall areas above finished ceilings, whether or not accessible in the completed construction.

END OF SECTION 092116

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Shop Drawings: 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.
- B. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

PART 2 - PRODUCTS

2.1 FRAMING MATERIALS

- A. Fire-Rated Assemblies: Comply with applicable code and as follows:
 - 1. Fire-Rated Partitions: Listed assembly by UL.
 - 2. Top of Fire-Rated Partitions: Listed assembly by UL.
 - 3. Fire-Rated Shaft Wall Requirements: Listed assembly by UL, No. on Drawings; 1-hour rating.
- B. Non-Load-bearing Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of $L/240$ at 5 psf.
 - 1. Studs: C-shaped with flat or formed webs with knurled faces.
 - 2. Runners: U-shaped, sized to match studs.
 - 3. Ceiling Channels: C-shaped.
 - 4. Furring: Hat-shaped sections, minimum depth of 7/8-inch.
 - 5. Sound Isolation Clips: Molded rubber isolator and steel clip, fastens directly to framing or structure to provide acoustical separation in gypsum board walls and ceilings.
 - 6. Contractor to provide bracing as required to complete system.
- C. Load-bearing Studs: As specified in Section 054000.
- D. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
- E. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection using slotted holes, screws and anti-friction bushings, preventing rotation of studs while maintaining structural performance of partition.
 - 1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI S100-12.
 - 2. Contractor shall provide bracing as required to complete system and installation.
 - 3. Material: ASTM A653/A653M steel sheet, SS Grade 50, with G60/Z180 hot-dipped galvanized coating.

- 4. Provide components UL-listed for use in UL-listed fire-rated head of partition joint systems indicated on Drawings.
- F. Tracks and Runners: Same material and thickness as studs, bent leg retainer notched to receive studs with provision for crimp locking to stud.
- G. Furring and Bracing Members: Of same material as studs; thickness to suit purpose; complying with applicable requirements of ASTM C754.
- H. Fasteners: ASTM C1002 self-piercing tapping screws.
- I. Acoustic Insulation: As specified in Section 072100.
- J. Acoustic Sealant: As specified in Section 079200

2.2 FABRICATION

- A. Fabricate assemblies of framed sections to sizes and profiles required.
- B. Fit, reinforce, and brace framing members to suit design requirements.

PART 3 - EXECUTION

3.1 INSTALLATION OF STUD FRAMING

- A. Comply with requirements of ASTM C754.
- B. Extend partition framing to structure where indicated and to ceiling in other locations.
- C. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
- D. Align and secure top and bottom runners at 24 inches on center.

3.2 CEILING AND SOFFIT FRAMING

- A. Install furring after work above ceiling or soffit is complete. Coordinate the location of hangers with other work.
- B. Space main carrying channels at maximum 72 inches on center, and not more than 6 inches from wall surfaces. Lap splice securely.
- C. Place furring channels perpendicular to carrying channels, not more than 2 inches from perimeter walls, and rigidly secure. Lap splices securely.
- D. Laterally brace suspension system.

END OF SECTION 092216

SECTION 093000 - TILING

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
- B. Shop Drawings: Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, control and expansion joints, thresholds, ceramic accessories, and setting details.
- C. Samples: Mount tile and apply grout on 2 plywood panels, minimum 18 by 18 inches in size illustrating pattern, color variations, and grout joint size variations.

1.2 FIELD CONDITIONS

- A. Maintain ambient and substrate temperature of 50 degrees F during installation of mortar materials.

PART 2 - PRODUCTS

2.1 TILE

- A. Basis of Design: See Drawings for tile descriptions, manufacturers, product numbers, colors, sizes and contact information.
- B. Manufacturers: As indicated on Drawings.
- C. Ceramic Tile, Type T: ANSI A137.1 standard grade.
 - 1. Surface Finish: Refer to Finish Schedule.
 - 2. Color(s): As indicated on Drawings.
 - 3. Pattern: As indicated on Drawings.
 - 4. Trim Units: Matching bead, cove, and surface bullnose shapes in sizes coordinated with field tile.
- D. Porcelain Tile, Type T2: ANSI A137.1 standard grade.
 - 1. Thickness: 3/8-inch.
 - 2. Edges: Cushioned.
 - 3. Surface Finish: As indicated on Drawings.
 - 4. Color(s): As indicated on Drawings.
 - 5. Pattern: As indicated on Drawings.

2.2 TRIM AND ACCESSORIES

- A. Ceramic Accessories: Glazed finish, same color and finish as adjacent field tile; same manufacturer as tile.
- B. Ceramic Trim: Matching bullnose, double bullnose, cove base, and cove ceramic shapes in sizes coordinated with field tile.
- C. Non-Ceramic Trim: Satin aluminum anodized extruded aluminum, style and dimensions as indicated on drawings, for setting using tile mortar or adhesive.

2.3 SETTING MATERIALS

- A. Epoxy Adhesive and Mortar Bond Coat: ANSI A118.3.
 - 1. Applications: Where indicated on Drawings.

2.4 GROUTS

- A. Epoxy Grout: ANSI A118.3 chemical resistant and water-cleanable epoxy grout.
 - 1. Applications: Where indicated.

2.5 MAINTENANCE MATERIALS

- A. Tile Sealant: Gunnable, silicone, siliconized acrylic, or urethane sealant; moisture- and mildew-resistant type.
 - 1. Applications: Between tile and plumbing fixtures.
- B. Grout Sealer: Liquid-applied, moisture and stain protection for existing or new Portland cement grout.
 - 1. Composition: Water-based colorless silicone.
- C. Tile Sealer: Stain protection for natural stone.

2.6 ACCESSORY MATERIALS

- A. Concrete Floor Slab Crack Isolation Membrane: Material complying with ANSI A118.12; not intended as waterproofing.
 - 1. Type: Fluid-applied.
 - 2. Thickness: 20 mils, maximum.
 - 3. Crack Resistance: No failure at 1/16-inch gap, minimum.

- B. Waterproofing Membrane at All Tile Locations: Specifically designed for bonding to cementitious substrate under thick mortar bed or thin-set tile; complying with ANSI A118.10.
 - 1. Crack Resistance: No failure at 1/16-inch, minimum; comply with ANSI A118.12.
 - 2. Fluid- or Trowel-Applied Type:
 - a. Material: Synthetic rubber or Acrylic.
 - b. Thickness: 25 mils, minimum, dry film thickness.
 - 3. Bonded Sheet Membrane Type:
 - a. Material: PVC sheet membrane with polyester fleece laminated to both sides, 40 mils thick, nominal.
 - b. Material: Polyethylene sheet membrane with non-woven fabric laminated to both sides, 20 to 30 mils thick, nominal.
- C. Waterproofing Membrane Under Thick Mortar Bed:
 - 1. Material: Chlorinated polyethylene sheet, 40 mils thick, minimum; complying with ASTM D4068.
- D. Backer Board: Cementitious type complying with ANSI A118.9; high density, glass-fiber reinforced, 1/2-inch-thick; 2-inch-wide coated glass-fiber tape for joints and corners.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

- A. Install tile, thresholds, and stair treads and grout in accordance with applicable requirements of ANSI A108.1a through ANSI A108.13, manufacturer's instructions, and TCNA (HB) recommendations.
- B. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.

3.2 INSTALLATION - WALL TILE

- A. Over cementitious backer units on studs, install in accordance with TCNA (HB) Method W244, using membrane at toilet rooms.
- B. Over gypsum wallboard on wood or metal studs install in accordance with TCNA (HB) Method W243, thin-set with dry-set or latex-Portland cement bond coat, unless otherwise indicated.
- C. Over metal studs without backer install in accordance with TCNA (HB) Method W241, mortar bed, with membrane where indicated.

END OF SECTION 093000

SECTION 095100 - ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Shop Drawings: Indicate grid layout and related dimensioning.
- B. Product Data: Provide data on suspension system components.
- C. Samples: Submit 4 samples 6 by 6 inches in size, illustrating material and finish of acoustical units.

1.2 QUALITY ASSURANCE

- A. Fire-Resistive Assemblies: Complete assembly listed and classified by UL (FRD) for the fire resistance indicated.

1.3 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 ACOUSTICAL UNITS

- A. Acoustical Units - General: ASTM E1264, Class A.
 - 1. Units for Installation in Fire-Rated Suspension System: Listed and classified for the fire-resistive assembly as part of suspension system.
- B. Metal-Faced Acoustical Panels: Aluminum flat-formed sheet, with glass-fiber acoustical media backing; with the following characteristics:
 - 1. Basis of Design: Longboard Products - Endura Linear Direct Mount Ceiling System.
 - 2. Size: 6 by 144 inches.
 - 3. Panel Edge: Square.
 - 4. Surface Pattern: Perforated.
 - 5. Surface Color: As indicated on Drawings.
 - 6. Suspension System: Exposed-grid, type 15/16-inch suspension system.

C. Vinyl-faced Lay-in Ceiling Panels:

1. Surface Burning Characteristics: Flame-spread index of 25 or less, smoke-developed index of 450 or less, when tested in accordance with ASTM E84.
2. Size: 24 by 24 inches.
3. Surface Texture: To be selected by Architect from manufacturer's standard range.
4. Panel Edge: Square.
5. Color: As indicated on Drawings.
6. Suspension System: Exposed-grid, type 15/16-inch suspension system.

2.2 SUSPENSION SYSTEM(S)

- A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with stabilizer bars, clips, splices, perimeter moldings, and hold down clips as required.
- B. Exposed Steel Suspension System: Formed steel, commercial quality cold rolled; heavy duty.
1. Profile: Tee; 15/16-inch-wide face.
 2. Construction: Double web.
- C. Fire-Rated Exposed Steel Suspension System: Formed steel, commercial quality cold rolled; light duty.
1. Profile: Tee; 15/16-inch-wide face.
 2. Construction: Double web.
 3. Fire Rating: Listed and classified for use in a 1-hour fire-resistive assembly.
- D. Exposed Suspension System: Extruded Steel.
1. Profile: Tee; 15/16-inch-wide face.
 2. Finish: Clean room co-extruded steel (gasketed).
 3. Location: Kitchen and food storage areas.

2.3 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
- B. Perimeter Moldings: Same material and finish as grid.
- C. Acoustical Insulation: ASTM C665 friction-fit type, unfaced batts.
- D. Gypsum Board: Fire-rated type; 5/8-inch thick, ends and edges square, paper faced.
- E. Acoustical Separation Ceiling: Floor to floor, auditorium from auditorium, kitchen from auditorium.

1. Quick-connect Wire Tie Ceiling Hanger: Kinetics IsoGrid - Neoprene isolator with internal bulge areas.
 2. Resilient Sound Isolation Clip: Kinetics IsoMax - Resilient sound isolation clips.
- F. Acoustical Isolated Wall Braces for Wall Assemblies: PSB-S Large Airspace and Stud Wall Support – Kinetics.
- G. Plumbing Insulation: Any piping that is above a ceiling in an auditorium to receive sound insulation.
- H. Acoustic Access Panels: Provide acoustical access panels at all clean-outs for all plumbing lines.
- I. Acoustical Sealant for Perimeter Moldings: Non-hardening, non-skinning, for use in conjunction with suspended ceiling system.

PART 3 - EXECUTION

3.1 INSTALLATION - SUSPENSION SYSTEM

- A. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions and as supplemented in this Section.
- B. Install light fixture boxes constructed of gypsum board above light fixtures in accordance with fire-rated assembly requirements and light fixture ventilation requirements.

3.2 INSTALLATION - ACOUSTICAL UNITS

- A. Replace/repair any damaged acoustical units due to construction.
- B. Install acoustical units in accordance with manufacturer's instructions.
- C. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.

END OF SECTION 095100

SECTION 099113 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Scope: Finish exterior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
1. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
 2. Exposed surfaces of steel lintels and ledge angles.
 3. Mechanical and Electrical: On the roof and outdoors, paint equipment that is exposed to weather or to view, including factory-finished materials.
 4. Exposed steel canopy structure.
- B. Do Not Paint or Finish the Following Items:
1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
 2. Items indicated to receive other finishes.
 3. Items indicated to remain unfinished.
 4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
 5. Stainless steel, anodized aluminum, bronze, terne-coated stainless steel, zinc, and lead.
 6. Floors, unless specifically indicated.
 7. Ceramic and other types of tiles.
 8. Brick, glass unit masonry, architectural concrete, cast stone, integrally colored plaster and stucco.
 9. Glass.
 10. Concealed pipes, ducts, and conduits.

1.2 SUBMITTALS

- A. Product Data: Provide complete list of products to be used, with the following information for each:
1. Manufacturer's name, product name and/or catalog number, and general product category (e.g., "alkyd enamel").
 2. MPI product number (e.g., MPI #47).
 3. Cross-reference to specified paint system(s) product is to be used in; include description of each system.
- B. Samples: Submit 3 paper "draw down" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.
1. Where sheen is specified, submit samples in only that sheen.

2. Where sheen is not specified, discuss sheen options with Architect before preparing samples, to eliminate sheens definitely not required.

PART 2 - PRODUCTS

2.1 PAINTS AND FINISHES - GENERAL

- A. Paints and Finishes: Ready mixed, unless required to be a field-catalyzed paint.
 1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 2. Supply each paint material in quantity required to complete entire Project's work from a single production run.
 3. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.
- B. Colors: To be selected from manufacturer's full range of available colors.

2.2 PRIMERS

- A. Primers: Provide the following unless other primer is required or recommended by manufacturer of topcoats.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the Project conditions.

3.2 APPLICATION

- A. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
- B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

END OF SECTION 099113

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.
1. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
 2. Elevator pit ladders.
 3. Surfaces inside cabinets.
 4. Paint all exposed items above decorative plane within bar/lounge - Black.
 5. Prime surfaces to receive all wallcoverings.
 6. Mechanical and Electrical: In finished areas, paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment, unless otherwise indicated.
- B. Do Not Paint or Finish the Following Items:
1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
 2. Items indicated to receive other finishes.
 3. Items indicated to remain unfinished.
 4. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
 5. Floors, unless specifically indicated.
 6. Ceramic and other tiles.
 7. Glass.
 8. Acoustical materials, unless specifically indicated.
 9. Concealed pipes, ducts, and conduits.

1.2 SUBMITTALS

- A. Product Data: Provide complete list of products to be used, with the following information for each:
1. Manufacturer's name, product name and/or catalog number, and general product category (e.g., "alkyd enamel").
 2. MPI product number (e.g., MPI #47).
 3. Cross-reference to specified paint system(s) product is to be used in; include description of each system.
- B. Samples: Submit 4 paper "draw down" samples, 8-1/2 by 11 inches in size, illustrating range of colors available for each finishing product specified.

1. Where sheen is specified, submit samples in only that sheen.
2. Where sheen is not specified, discuss sheen options with Architect before preparing samples, to eliminate sheens definitely not required.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Provide paints and finishes from the same manufacturer to the greatest extent possible.

2.2 PAINTS AND FINISHES - GENERAL

- A. Paints and Finishes: Ready mixed, unless intended to be a field-catalyzed paint.
 1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 2. Supply each paint material in quantity required to complete entire Project's work from a single production run.
 3. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.
- B. Colors: As indicated on Drawings.
 1. In finished areas, finish pipes, ducts, conduit, and equipment the same color as the wall/ceiling they are mounted on/under.

2.3 PAINT SYSTEMS - INTERIOR

- A. Paint I-OP - Interior Surfaces to be Painted, Unless Otherwise Indicated: Including gypsum board, concrete, concrete masonry units, wood, plaster, uncoated steel, shop primed steel, and aluminum.
 1. Two topcoats and 1 coat primer.
 2. Topcoat(s): Interior Latex; MPI #43, 44, 52, 53, 54, or 114.
 3. Topcoat Sheen:
 - a. Flat: MPI Gloss Level 1; use this sheen for ceilings and other overhead surfaces.
 - b. Satin: MPI Gloss Level 4; use this sheen for items subject to frequent touching by occupants, including door frames and railings.
 - c. Semigloss: MPI Gloss Level 5; use this sheen at all locations.
 - d. Gloss: MPI Gloss Level 6; use this sheen at all locations.
 4. Primer: As recommended by topcoat manufacturer for specific substrate.

- B. Paint I-OP-MD-DT - Medium-Duty Door/Trim: For surfaces subject to frequent contact by occupants, including metals and wood:
 - 1. One topcoat and 1 coat primer.
 - 2. Topcoat(s): Interior Alkyd, Water Based; MPI #167, 168, or 169.
 - 3. Topcoat Sheen:
 - a. Satin: MPI Gloss Level 3; use this sheen at all locations.
 - b. Semigloss: MPI Gloss Level 5; use this sheen at all locations.
 - 4. Primer: As recommended by topcoat manufacturer for specific substrate.
- C. Paint I-TR-C - Transparent Finish on Concrete Floors.
 - 1. One coat stain.
 - 2. Stain: Semi-Transparent Stain for Concrete Floors; MPI #58.
 - 3. Sealer: Water-Based Sealer for Concrete Floors; MPI #99.
 - 4. Sealer Sheen:
 - a. Eggshell: MPI Gloss Level 3; use this sheen at all locations.
 - b. Gloss: MPI Gloss Level 6; use this sheen at all locations.
- D. Paint CI-OP-2L - Concrete/Masonry, Opaque, Latex, 2 Coat:
 - 1. One coat of block filler.
 - 2. Semigloss: One coat of latex enamel.
 - 3. Satin: One coat of latex enamel; use this sheen at all locations.

2.4 PRIMERS

- A. Primers: Provide the following unless other primer is required or recommended by manufacturer of topcoats.
 - 1. Interior Institutional Low-Odor/VOC Primer Sealer; MPI #149.
 - 2. Interior/Exterior Latex Block Filler; MPI #4.
 - 3. Interior Latex Primer Sealer; MPI #50.
 - 4. Interior Drywall Primer Sealer.
 - 5. Interior Alkyd Enamel Undercoat; MPI #46.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 - 1. Gypsum Wallboard: 12 percent.

2. Plaster and Stucco: 12 percent.
3. Masonry, Concrete, and Concrete Masonry Units: 12 percent.
4. Interior Wood: 15 percent, measured in accordance with ASTM D4442.
5. Concrete Floors and Traffic Surfaces: 8 percent.

3.2 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the Project conditions.

3.3 APPLICATION

- A. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
- B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

END OF SECTION 099123

SECTION 099600 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: Provide complete list of all products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g., "alkyd enamel").
 - 2. MPI product number (e.g., MPI #47).
 - 3. Cross-reference to specified coating system(s) product is to be used in; include description of each system.
- B. Samples: Submit 2 samples 8 by 8 inches in size illustrating colors available for selection.
- C. Manufacturer's Certificate: Certify that high-performance coatings comply with VOC limits specified.

1.2 WARRANTY

- A. Correct defective Work within a 5-year period after Date of Substantial Completion.
- B. Warranty: Include coverage for bond to substrate.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Only materials (primers, coatings, etc.) listed in the latest edition of the MPI Approved Product List (APL) are acceptable for use on this Project.
- B. High-Performance Coatings: Sherwin-Williams Company: www.protective.sherwin-williams.com/industries/#sle.

2.2 HIGH-PERFORMANCE COATINGS

- A. MPI Standards: Provide products that comply with MPI standards indicated and are listed in "MPI Approved Products List."

- B. Provide coating systems that meet the following minimum performance criteria, unless more stringent criteria are specified:

1. Surface Burning Characteristics: Flame-spread/smoke-developed index of 0/0, maximum, when tested in accordance with ASTM E84.
2. NFPA 101, Class A rated.

2.3 TOPCOAT MATERIALS

- A. Coatings - General: Provide complete multi-coat systems formulated and recommended by manufacturer for the applications indicated, in the thicknesses indicated; number of coats specified does not include primer or filler coat.

1. Lead Content: Not greater than 0.06 percent by weight of total nonvolatile content.
2. Volatile Organic Compound (VOC) Content:
 - a. Provide coatings that comply with the most stringent requirements specified in the following:
 - 1) 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
 - 2) Architectural coatings VOC limits of State in which the Project is located.
 - b. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at Project site; or other method acceptable to authorities having jurisdiction.
3. Colors: As indicated on Drawings.

- B. Latex Coating:

1. Number of Coats: Two.
2. Topcoat(s): Latex, Interior, High Performance Architectural; MPI #139.
 - a. Sheen: Eggshell.
 - b. Products:
 - 1) PPG Paints; Pitt-Glaze WB1 Pre-Catalyzed Water-Borne Acrylic Epoxy, 16-310 Series: www.ppgpaints.com/#sle.
 - 2) Sherwin-Williams; Pro Industrial Pre-Catalyzed Water-based Epoxy; MPI #139, 141: www.protective.sherwin-williams.com/#sle.
 - 3) Substitutions: Section 016000 "Product Requirements."
3. Primer: As recommended by coating manufacturer for specific substrate.

- C. Epoxy Coating:

1. Number of Coats: Two.

2. Topcoat(s): Polyamide Epoxy; MPI #77.
 - a. Sheen: Gloss.
 - b. Products:
 - 1) PPG Paints; H&C Epoxy, High Gloss, 95-501 Series: www.ppgpaints.com/#sle.
 - 2) Sherwin-Williams; Macropoxy 646 Fast Cure Epoxy; MPI #177: www.protective.sherwin-williams.com/#sle.
 - 3) Substitutions: Section 016000 "Product Requirements."
 3. Topcoat(s): High-Performance Institutional, 2-Component, Water-Based Epoxy Coating; MPI #254.
 - a. Sheen: Refer to Finish Schedule.
 - b. Products:
 - 1) PPG Paints; Pitt-Glaze WB Water-Borne Acrylic Epoxy 16-598 Series, Gloss/16-599 Series, Semigloss: www.ppgpaints.com/#sle.
 - 2) Sherwin-Williams; Pro Industrial Water-Based Catalyzed Epoxy; MPI #254: www.protective.sherwin-williams.com/#sle.
 - 3) Substitutions: Section 016000 "Product Requirements."
- D. Aluminum Coating, Moderate-Heat-Resistant, for Ferrous Metal:
1. Number of Coats: Two.
 2. Topcoat(s) : Heat-Resistant Coating, Up to 402 degrees F, Solvent Based; MPI #21.
 - a. Sheen: Refer to Finish Schedule.
 - b. Products:
 - 1) PPG Paints; PSX-892HS High-Temperature Polysiloxane: www.ppgpaints.com/#sle.
 - 2) Substitutions: Section 016000 - Product Requirements.
 3. Primer: As recommended by coating manufacturer for specific substrate.

E. Shellac: Pure, white type.

2.4 PRIMERS

A. Primers: Provide the following unless other primer is required or recommended by coating manufacturer.

1. Primer Sealer, Latex, Interior; MPI #50.

2.5 ACCESSORY MATERIALS

A. Accessory Materials: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of coated surfaces.

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean surfaces of loose foreign matter.
- B. Remove substances that would bleed through finished coatings. If unremovable, seal surface with shellac.
- C. Remove finish hardware, fixture covers, and accessories and store.

3.2 PRIMING

- A. Apply primer to all surfaces, unless specifically not required by coating manufacturer. Apply in accordance with coating manufacturer's instructions.

3.3 COATING APPLICATION

- A. Apply coatings in accordance with manufacturer's written instructions, to thicknesses specified and recommendations in "MPI Architectural Painting and Specification Manual."
- B. Apply in uniform thickness coats, without runs, drips, pinholes, brush marks, or variations in color, texture, or finish. Finish edges, crevices, corners, and other changes in dimension with full coating thickness.

END OF SECTION 099600

SECTION 099723 - CONCRETE AND MASONRY COATINGS

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: Provide data indicating coating materials and surface preparation.
- B. Samples: Submit 2 samples 6 by 6 inches in size illustrating colors available for selection.

1.2 WARRANTY

- A. Correct defective Work within a 5-year period after Date of Substantial Completion.
- B. Warranty: Include coverage for bond to substrate.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Coatings - General: Provide complete systems formulated and recommended by manufacturer for the applications indicated, in the thicknesses indicated.

PART 3 - EXECUTION

3.1 PRIMING

- A. Apply primer to all surfaces, unless specifically not required by coating manufacturer. Apply in accordance with coating manufacturer's instructions.

3.2 COATING APPLICATION

- A. Apply coatings in accordance with manufacturer's instructions, to thicknesses specified.
- B. Apply in uniform thickness coats, without runs, drips, pinholes, brush marks, or variations in color, texture, or finish. Finish edges, crevices, corners, and other changes in dimension with full coating thickness.

END OF SECTION 099723

SECTION 101400 - SIGNAGE

PART 1 - GENERAL - FF&E ITEM

1.1 SUBMITTALS

- A. Product Data: Manufacturer's printed product literature for each type of sign, indicating sign styles, font, foreground and background colors, locations, overall dimensions of each sign.
- B. Signage Schedule: Provide information sufficient to completely define each sign for fabrication, including room number, room name, other text to be applied, sign and letter sizes, fonts, and colors.
- C. Verification Samples: Submit samples showing colors specified.

PART 2 - PRODUCTS

2.1 SIGNAGE APPLICATIONS

- A. Accessibility Compliance: Signs are required to comply with ADA Standards and ICC A117.1, unless otherwise indicated; in the event of conflicting requirements, comply with the most comprehensive and specific requirements.
- B. Emergency Evacuation Maps:
 - 1. Map content to be provided by Owner.
 - 2. Use clear plastic panel silk-screened on reverse, in brushed aluminum frame, screw-mounted.
- C. Building Identification Signs:
 - 1. Use individual metal letters.
 - 2. Mount on outside wall in location indicated on Drawings.

2.2 SIGN TYPES

- A. Flat Signs: Signage media without frame.
- B. Color and Font: Unless otherwise indicated:
 - 1. Character Font: Helvetica, Arial, or other sans serif font.
 - 2. Character Case: Upper case only.
 - 3. Background Color: Clear.
 - 4. Character Color: Contrasting color.

2.3 NON-TACTILE SIGNAGE MEDIA

- A. Silk Screened Plastic Panels: Letters and graphics silk screened onto reverse side of plastic surface:
- B. Sand-Blasted Plastic Panels: High-gloss acrylic plastic; letters sand blasted to dull sheen.

2.4 DIMENSIONAL LETTERS

- A. Metal Letters:
 - 1. Letter Height: 12 inches.
 - 2. Text and Typeface:
 - 3. Mounting: Tape adhesive.

2.5 ACCESSORIES

- A. Concealed Screws: Stainless steel, galvanized steel, chrome plated, or other non-corroding metal.
- B. Exposed Screws: Chrome plated.
- C. Tape Adhesive: Double-sided tape, permanent adhesive.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide all required blocking for installation. Coordinate with vendor provided shop drawings on exact requirements.
- C. Install neatly, with horizontal edges level.

END OF SECTION 101400

SECTION 101419 - DIMENSIONAL LETTER SIGNAGE

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: Manufacturer's product literature for each type of dimensional letter sign, indicating style, font, colors, locations, and overall dimensions of each sign.
- B. Shop Drawings:
 - 1. Include dimensions, locations, elevations, materials, text and graphic layout, and attachment details.
 - 2. Show locations of electrical service connections.
 - 3. Include diagrams for power, signal, and control wiring.
- C. Selection Samples: Where materials, colors, and finishes are not specified, submit 2 sets of selection charts or chips.
- D. Verification Samples: Submit samples showing colors and finishes specified.
- E. Manufacturer's Installation Instructions: Include installation templates and attachment devices.

PART 2 - PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Accessibility Requirements: Comply with ADA Standards and ICC A117.1 and applicable building codes, unless otherwise indicated; in the event of conflicting requirements, comply with the most restrictive requirements.

2.2 DIMENSIONAL LETTERS

- A. Applications: Building identification.
 - 1. Mounting Location: Exterior as indicated on Drawings.
- B. Metal Letters:
 - 1. Material: Stainless-steel sheet fabricated reverse channel.
 - 2. Thickness: 1/8-inch minimum.
 - 3. Letter Height: 18 inches.
 - 4. Text and Typeface:
 - a. Character Font: Helvetica, Arial, or other sans serif font.
 - b. Character Case: Upper case only.

5. Finish: Brushed, satin.
6. Color: As selected.
7. Mounting: Concealed screws.
8. Illumination System: Halo-lit reverse channel letters.

2.3 ACCESSORIES

- A. Concealed Screws: Noncorroding metal; stainless steel, galvanized steel, chrome plated, or other.
- B. Electrical Components and Devices: Listed and labeled as defined in NFPA 70 by a qualified testing agency.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install with horizontal edges level.
- C. Locate dimensional letter signs and mount at heights indicated on Drawings and in accordance with ADA Standards and ICC A117.1.
- D. Protect from damage until 06/01/2025; repair or replace damaged items.

END OF SECTION 101419

SECTION 102113.19 - PLASTIC TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: Provide data on panel construction, hardware, and accessories.
- B. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall supports, door swings.
- C. Samples: Submit 2 samples of partition panels, 2 inches by 2 inches in size, illustrating panel finish, color, and sheen.

PART 2 - PRODUCTS

2.1 PLASTIC TOILET COMPARTMENTS

- A. Solid Plastic Toilet Compartments: Factory-fabricated doors, pilasters, and divider panels made of solid molded, high-density polyethylene (HDPE), tested in accordance with NFPA 286; ceiling-hung.
 - 1. Color: Single color as selected.
 - 2. Doors:
 - a. Thickness: 1 inch.
 - b. Width: 24 inches.
 - c. Width for Handicapped Use: 36 inches, out-swinging.
 - d. Height: 55 inches.
 - 3. Panels:
 - a. Thickness: 1 inch.
 - b. Height: 55 inches.
 - c. Depth: As indicated on Drawings.
 - 4. Pilasters:
 - a. Thickness: 1 inch.
 - b. Width: As required to fit space; minimum 3 inches.
 - 5. Screens: Without doors; to match compartments; mounted to wall with 2 panel brackets with vertical support/bracing same as compartments.

2.2 ACCESSORIES

- A. Head Rails: Extruded aluminum, anti-grip profile.
- B. Wall and Pilaster Brackets: Stainless steel; manufacturer's standard type for conditions indicated on Drawings.
- C. Attachments, Screws, and Bolts: Stainless steel, tamper-proof type.
- D. Hinges: Continuous aluminum, manufacturer's standard finish.
- E. Door Hardware: Anodized aluminum, manufacturer's standard finish.
- F. Coat Hook: One per compartment, mounted on door.

PART 3 - EXECUTION

3.1 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.

3.2 TOLERANCES

- A. Maximum Variation From True Position: 1/4-inch.
- B. Maximum Variation From Plumb: 1/8-inch.

END OF SECTION 102113.19

SECTION 102600 - WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: Indicate physical dimensions, features, wall mounting brackets with mounted measurements, anchorage details, and rough-in measurements.
- B. Shop Drawings: Include plans, elevation, sections, and attachment details. Show design and spacing of supports for protective corridor handrails, required to withstand structural loads.
- C. Samples: Submit samples illustrating component design, configurations, joinery, color and finish.
 - 1. Submit 2 sections of corner guards, bumper rails, and protective corridor handrails, 24 inches long.
 - 2. Submit 2 samples of protective wallcovering and door surface protection, 6 by 6 inches square.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of Project:
 - 1. See Section 016000 "Product Requirements," for additional provisions.
 - 2. Extra Stock Materials: One package of minimum 96-inch-long unit of each kind of cover for corner guards, bumper rails, and protective corridor handrails.

1.2 WARRANTY

- A. Provide 5-year manufacturer and installer warranty for metal crash rails.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, internal connection failures, and/or detachment of rail system from substrates.
 - b. Deterioration of materials beyond that expected of normal use, as intended by manufacturer.

PART 2 - PRODUCTS

2.1 PERFORMANCE CRITERIA

- A. Impact Strength: Unless otherwise noted, provide protection products and assemblies that have been successfully tested for conformance to applicable provisions of ASTM D256 and/or ASTM F476.

- B. Chemical and Stain Resistance: Unless otherwise noted, provide protection products and assemblies with chemical and stain resistance conforming to applicable provisions of ASTM D543.
- C. Fungal Resistance: Unless otherwise noted, provide protection products and assemblies which pass ASTM G21 testing.

2.2 PRODUCT TYPES

A. Corner Guards - Surface Mounted:

- 1. Corner guards fabricated from rolled section or bent plate are specified in Section 055000.
- 2. Material: High-impact vinyl and stainless as indicated on Finish Legend.
- 3. Material: Type 304 stainless steel, No. 4 finish, 16 gauge, 0.06-inch thick.
- 4. Width of Wings: As indicated on Finish Legend.
- 5. Corner: Square.
- 6. Color: As indicated on Finish Legend.

B. Protective Wallcovering:

- 1. As indicated on Finish Legend.
- 2. Material: High-impact acrylic-modified vinyl.
- 3. Material: Polyethylene terephthalate (PET or PETG); PVC and PBTs-free.
- 4. Thickness: 0.040-inch.
- 5. Color: As selected from manufacturer's standard colors.
- 6. Pattern: None.
- 7. Texture: Suede, Pebble.
- 8. Accessories: Provide manufacturer's standard color-matched trim and moldings.
- 9. Mounting: Adhesive.

C. Doorway Protection:

- 1. See Section 087100 "Door Hardware" for standard protective plates and trim.
- 2. Hardware Knob/Lever Protection: Plastic vacuum-formed shapes; manufacturer's standard size and projection.

D. Adhesives and Primers: As recommended by manufacturer.

2.3 FABRICATION

- A. Fabricate components with tight joints, corners and seams.
- B. Pre-drill holes for attachment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to supporting construction.
- B. Position protective wallcovering no less than 1 inch above finished floor to allow for floor level variation.

END OF SECTION 102600

SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
- B. Stainless Steel Sheet: ASTM A666, Type 304.
- C. Stainless-Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.
- D. Mirror Glass: Annealed float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.

2.2 FINISHES

- A. Stainless Steel: Satin finish, unless otherwise noted.
- B. Chrome/Nickel Plating: ASTM B456, SC 2, polished finish, unless otherwise noted.

2.3 COMMERCIAL TOILET ACCESSORIES

- A. Toilet Paper Dispenser: Single roll, surface-mounted bracket type, stainless-steel, spindle-less type for tension spring delivery designed to prevent theft of tissue roll.
- B. Soap Dispenser: Liquid soap dispenser, deck-mounted on vanity, with polyethylene container concealed below deck; piston and 4-inch spout of stainless steel with bright polished finish; chrome-plated deck escutcheon.
- C. Mirrors: Framed, 1/4-inch-thick annealed float glass; ASTM C1036.
- D. Grab Bars: Stainless steel, smooth surface.
 - 1. Heavy-Duty Grab Bars: Floor supports are not acceptable.
 - a. Push/Pull Point Load: Minimum 1,000 pound-force, minimum.
 - b. Dimensions: 1-1/2-inch outside diameter, minimum 0.125-inch wall thickness, exposed flange mounting, 1-1/2-inch clearance between wall and inside of grab bar.

c. Length and Configuration: As indicated on Drawings.

- E. Sanitary Napkin Disposal Unit: Stainless-steel, surface-mounted, self-closing door, locking bottom panel with full-length stainless-steel piano-type hinge, removable receptacle.

2.4 ELECTRIC HAND/HAIR DRYERS

- A. Electric Hand Dryers: Deck-mounted on vanity, with downward fixed nozzle.

1. Operation: Automatic, sensor-operated on and off.
2. Mounting: Surface mounted.

2.5 DIAPER CHANGING STATIONS

- A. Diaper Changing Station: Wall-mounted folding diaper changing station for use in commercial toilet facilities, meeting or exceeding ASTM F2285.

1. Material: Polyethylene.
2. Mounting: Surface.
3. Color: As selected.
4. Minimum Rated Load: 250 pounds.

2.6 UTILITY ROOM ACCESSORIES

- A. Combination Utility Shelf/Mop and Broom Holder: 0.05-inch-thick stainless steel, Type 304, with 1/2-inch returned edges, 0.06-inch steel wall brackets.

1. Drying rod: Stainless steel, 1/4-inch diameter.
2. Hooks: Two 0.06-inch stainless-steel rag hooks at shelf front.
3. Mop/Broom Holders: Three spring-loaded rubber cam holders at shelf front.
4. Length: 36 inches.
5. Length: Manufacturer's standard length for number of holders/hooks.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions in locations indicated on Drawings.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.

END OF SECTION 102800

SECTION 104400 - FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 FIELD CONDITIONS

- A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 - PRODUCTS

2.1 FIRE EXTINGUISHERS

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
- B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
 - 1. Class: A:B:C type.
 - 2. Size: 10 pound.
 - 3. Finish: Baked polyester powder coat, color as selected.
 - 4. Temperature range: Minus 40 degrees F to 120 degrees F.
- C. Dry Chemical Type Fire Extinguishers: Stainless-steel tank, with pressure gauge.
 - 1. Class: K type.
 - 2. Size 10 pound and classification as required or scheduled.
 - 3. Finish: Polished stainless steel.
 - 4. Temperature range: Minus 20 degrees F to 120 degrees F.

2.2 FIRE EXTINGUISHER CABINETS

- A. Fire Rating: Listed and labeled in accordance with ASTM E814 requirements for fire-resistance rating of walls where being installed.
- B. Cabinet Construction: Non-fire rated.
 - 1. Formed stainless-steel sheet; 0.036-inch-thick base metal.
- C. Fire Rated Cabinet Construction: One-hour fire rated.
 - 1. Steel; double wall or outer and inner boxes with 5/8-inch-thick fire barrier material.
- D. Cabinet Configuration: Recessed type.
 - 1. Trimless type.

- E. Door: 0.036-inch metal thickness, reinforced for flatness and rigidity with nylon catch. Hinge doors for 180-degree opening with 2 butt hinges.
- F. Door Glazing: Acrylic plastic, clear, 1/8-inch-thick, flat shape and set in resilient channel glazing gasket.
- G. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.
- H. Finish of Cabinet Exterior Trim and Door: No. 4, brushed stainless steel.
- I. Finish of Cabinet Interior: White colored enamel.

2.3 ACCESSORIES

- A. Extinguisher Brackets: Formed steel, chrome-plated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure rigidly in place.

END OF SECTION 104400

SECTION 124813 - ENTRANCE FLOOR MATS AND FRAMES

PART 1 - GENERAL

2.1 SUBMITTALS

- A. Shop Drawings: Indicate dimensions and details for recessed frame.
 - 1. For recessed frames located within a dimensionally restricted area, show dimensions of space within which the frame will be installed.
- B. Samples: Submit 2 samples, 6 by 6 inches in size illustrating pattern, color, finish, edging.

PART 2 - PRODUCTS

3.1 ENTRANCE FLOOR RECESSED MAT

- A. Entrance Floor Mats (Recessed): Ultra Entry heat-welded, flexible, extruded PVC assembly with nominal 15/16-inch-wide tread strips running perpendicular to traffic flow, slots between treads, and perimeter frame forming sides of recess; mats are loose lay-in recessed subfloor for access to recess.
 - 1. Depth: 5/16-inch.
 - 2. Tread Surfaces: Alternating nylon carpet and deeply etched, textured, flexible, extruded PVC.
 - 3. Colors: As indicated on Drawings.
 - 4. Length in Direction of Traffic Flow: 96 inches minimum or as indicated on Drawings.
 - 5. Width Perpendicular to Traffic Flow: Full width of entrance door opening or as indicated on drawings.
 - 6. Frame: Perimeter "J" or "R" Frames and "T" Dividers as recommended by manufacturer for embedding in concrete; minimal exposed trim; plastic and stainless-steel counter-sunk screw as required by manufacturer.
- B. Mounting: Top of non-resilient members level with adjacent floor.
- C. Structural Capacity: Capable of supporting a rolling load of 1,500 pounds without permanent deformation or noticeable deflection.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install frames to achieve flush plane with finished floor surface.
- B. Install walk-off surface after cleaning of finish flooring.

END OF SECTION 124813

DOCUMENT 210010 - GENERAL FIRE SUPPRESSION REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.
- B. Division 21 of the Specifications and Drawings numbered with prefixes FP generally describe these systems, but the scope of the Fire Suppression work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Fire Suppression, Mechanical, Plumbing, Fire Alarm and Electrical Drawings and Specifications; and Addenda.
- C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general location and arrangement of the equipment, piping, etc. without showing all the exact details as to elevations, offsets, pipe routing, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.
- D. This system has been designed by a registered Fire Protection Engineer, licensed in the State of Missouri. Design documents have been submitted to the Local State Fire Marshal's Office and the Owner.
- E. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 7 Section "Penetration Firestopping" for material and methods for firestopping systems.
 - 2. Division 21 Section 210500 "Common Work Results for Fire Suppression," for materials and methods for wall and floor penetrations.
 - 3. Division 21 Section 210515 "Basic Fire Suppression Piping Material and Methods," for general piping and fitting materials and methods.
 - 4. Division 21 Section 210553 "Identification for Fire Suppression Piping and Equipment" for labeling and identification of installed fire suppression equipment.
 - 5. Division 21 Section 211100 "Fire Suppression Water Service Piping" for fire suppression piping starting 5 feet outside the building to within the building.
 - 6. Division 21 Section 211313 "Water-based Fire Suppression Systems" for fire suppression sprinkler systems inside the building.

1.2 QUALITY ASSURANCE

- A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.
- B. All work shall be installed in strict conformance with manufacturer's requirements and recommendations. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.
- C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.
- D. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Threaded joints shall conform to ASME B1.20.1, Pipe Threads, General Purpose and the Pipe Fitters Handbook.
- G. Regulatory Requirements: Comply with all standards listed in Section 1.2 and all applicable local requirements.
- H. All electrical equipment provided and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section, Division 26 and Division 28.
- I. Through and Membrane Penetration Firestopping Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

1.3 CODES, REFERENCES AND STANDARDS

- A. Execute Work in accordance with the National Fire Protection Association Standards and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.
- B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the submission of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.

- C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.
- D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes.
 - 1. NFPA (National Fire Protection Association) 13, "Installation of Sprinkler Systems", 2016 Edition.
 - 2.
 - 3. NFPA 24, "Private Fire Service Mains and their Appurtenances", 2016 Edition.
 - 4. NFPA 25, "Inspection, Testing and Maintenance of Water-Based Fire Protection Systems", 2017 Edition.
 - 5. Underwriters Laboratories, "Fire Protection Equipment Directory", Latest Edition.
 - 6. Factory Mutual Systems, "Approval Guide", Latest Edition.
 - 7. International Building Code (IBC), 2018 Edition with local amendments.
 - 8. International Fire Code (IFC), 2018 Edition with local amendments.
 - 9. NFPA 1 "Fire Code" 2015 Edition with local amendments.
 - 10. NFPA 5000 "Building Construction and Safety Code" 2015 Edition with local amendments.
- E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.
- F. All Fire Suppression work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the Fire Suppression work shall be provided by the Contractor.

1.4 DEFINITIONS

- A. General:
 - 1. Furnish: The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations."
 - 2. Install: The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."
 - 3. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use." When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.

4. **Furnished by Owner or Furnished by Others:** The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.
 5. **Engineer:** Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".
 6. **AHJ:** The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
 7. **NRTL:** Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.
 8. **Substitution:** Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.
 - a. **Substitutions for Cause:** Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - b. **Substitutions for Convenience:** Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.
 9. **Value Engineering:** A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.
- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.
- C. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).
- D. Other definitions for fire protection systems are listed in NFPA Standards 13, 14, 20 and 24.

- E. Working Plans, also referred to as Fire Protection Drawings as used in this Section means those documents (including drawings and calculations) prepared pursuant to the requirements contained in NFPA 13 for obtaining approval of the Authority Having Jurisdiction.
- F. The following definitions apply to excavation operations:
 - 1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
 - 2. Sub-base: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.
 - 3. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.
 - 4. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.

1.5 COORDINATION

- A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.
- B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping in the manner anticipated in the design.
- C. The Contractor shall maintain a foreman on the jobsite at all times to coordinate his work with other contractors and subcontractors so that various components of the Fire Suppression systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the work in such a manner that the work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.
- D. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and his subcontractors and as approved by the Architect/Engineer. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.
- E. The contractor shall coordinate work in this section with all related trades. Work and/or equipment provided in other sections and related to the fire protection system shall include, but not be limited to:

1. Sprinkler monitoring equipment (water flow switches, valve tamperers, etc) shall be provided by the fire sprinkler installer, but wired and connected by Division 28.

F. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and described within the specification sections.

1.6 MEASUREMENTS AND LAYOUTS

A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.7 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.

1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
6. Indicate required installation sequence to minimize conflicts between entities.
7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.

- B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of electrical equipment locations within electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.
 - 1. Clearly identify all required working clearances and access provisions required for installation and maintenance.
 - 2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.
 - 3. Indicate path to allow for the future removal of each large piece of equipment (up to and including generators and unit sub-station transformers) without removal of non-related equipment or architectural elements.
 - 4. Include work provided by others routed through the equipment rooms.
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
 - 1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
 - 2. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.
 - a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.
 - 3. Where the Engineer's digital data files are provided to the Contractor for use in preparing coordination digital data files, the Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.
 - 4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.

1.8 SUBMITTALS

- A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.
- B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.
- C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, username and password information

needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives. Contractor shall allow for the Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

- D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time or time specified in the Engineer's Agreement with the Client,] plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.
- E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.
- F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.
- H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.
- I. Refer to individual Sections for additional submittal requirements.
- J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- K. Submittals shall contain the following information:
 - 1. The project name.
 - 2. The applicable specification section and paragraph.
 - 3. Equipment identification acronym as used on the drawings.
 - 4. The submittal date.

5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
 6. Submittals not so identified will be returned to the Contractor without action.
- L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Contract Administrator prior to implementing any deviation.
- M. Provide shop drawings prepared in accordance with referenced standards identified as "Working Plans", including hydraulic calculations where applicable. Shop drawings shall be developed by minimum NICET Level III technician. Submit copies of the certification for the designer with submittal. Shop drawings consisting of the following shall be furnished at a minimum. Refer to NFPA 13 for additional requirements.
1. Scaled site plan indicating underground piping with sizes and hydrants utilized for flow test in relation to the building.
 2. Layout drawings of complete fire sprinkler system indicating relationship to all other trades. This shall include all equipment, piping and a reflected ceiling plan indicating sprinkler locations.
 3. Complete details and sections as required to clearly define and clarify the design indicated.
 4. Shop drawings shall be to a standard scale and not less than $3/32" = 1'-0"$.
 5. Shop drawings shall be produced using computer-aided design. Hand drawn documents will not be reviewed or approved.
 6. Hydraulic calculations shall be based on a water flow test conducted at the site within twelve (12) months of the submittal of plans for approval. The contractor shall be responsible for obtaining the flow test if existing data is not provided in contract documents. Flow test information shall be documented on shop drawings with an accompanying site plan to scale. Contractor shall verify with AHJ any minimum safety factor requirements. Demand shall not be less than 5 psi- below the supply at the demand point.
 - a. Hydrant testing shall be in accordance with NFPA 13 and 291 requirements.
 7. Contractor shall prepare installation drawings (working shop drawings) based upon this design. Requests for deviations from the approved design shall be submitted in writing to the Engineer of Record for approval. Shop drawings showing deviations from the design without prior approval will not be approved.
- N. Provide Test Reports and Certificates including:

1. "Contractor's Material & Test Certificate for Aboveground Piping"
2. "Contractor's Material & Test Certificate for Underground Piping" as described in NFPA
 - a. Underground piping test certificate shall be obtained prior to connection of the aboveground system.

O. Provide welders' qualification certificates.

1.9 ELECTRONIC DRAWING FILES

- A. Contractor may request an electronic version of the contract drawing set in AutoCAD format from the Engineer for a fee of \$250. Contact the Architect for written authorization. Contact the Engineer for the release agreement form and specify the shipping method and drawing format. Allow up to ten (10) working days for electronic file delivery after authorization and release agreements are completed and delivered to the Engineer.

1.10 SUBSTITUTIONS

- A. Refer to Division 1 and General Conditions for substitutions in addition to requirements specified herein.
- B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.
- D. Request for Substitution:
 1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
 2. The burden of proof of the merit of the proposed substitution is upon the proposer.
 3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:
 - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
 - b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
 - c. Proposed substitution has received necessary approvals of authorities having jurisdiction.
 - d. Same warranty will be furnished for proposed substitution as for specified Work.

- e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
- f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

- 1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
- 2. No substitutions will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.
- 3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
- 4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 1 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.
- B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.
- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Prior to Substantial Completion for the project, furnish to the Architect, for Engineer's review, and for Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.
- E. Include the following sections with the appropriate information for each section:
 - 1. Typewritten Index.
 - 2. Qualifications. Provide designer and installer qualification.
 - 3. Bill of Materials. Provide complete nomenclature, model number and vendor information for all parts.

4. Operating Instructions. Complete instructions detailing operation and maintenance of all equipment installed.
5. Product Data: Provide product cut-sheets for all equipment utilized and installed.
6. Guarantee. Copy of all guarantees and warranties issued.
7. Testing/Certification: Provide all completed testing and certification forms as required per NFPA 13 and 25.
8. Contact list with minimum three service representative phone numbers.

F. Refer to Division 1 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives.

1.12 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections in Division 21 specifications.

1.13 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.
- B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.
- C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.
- D. The fire shop drawings and all information contained therein shall be utilized as the basis for the Record Drawings.

1.14 TRAINING

- A. Provide training as indicated in each specific section. Schedule training with the Owner at least 7 days in advance. Video tape the training sessions in a format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

1.15 PAINTING

- A. Exposed ferrous surfaces, including pipe, pipe hangers, equipment stands and supports shall be painted by the Fire Suppression Contractor using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.
- B. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.
- C. Where factory finishes are provided and no additional field painting is specified, marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish.

1.16 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 1 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.
- B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.
- D. The Contractor shall be responsible for the safe storage of his own tools, material and equipment.

1.17 GUARANTEES AND WARRANTIES

- A. Refer to Division 1 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.
- B. Furnish service and maintenance of fire protection system for one year from date of substantial completion.
- C. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.
- D. The following additional items shall be guaranteed:
 - 1. Piping shall be free from obstructions, holes or breaks of any nature.

2. Proper sloping of pipe to drain in each piping system per NFPA 13.
- E. The above guarantees shall include labor (including travel expenses), troubleshooting and material; and repairs or replacements shall be made without additional cost to the Owner.
- F. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.
- G. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed and stating the commencement date and term.

1.18 PROJECT CONDITIONS

A. Conditions Affecting Work In Existing Buildings:

1. The Drawings describe the general nature of remodeling to the existing building. However, the Contractor shall visit the site prior to submitting their bid to determine the nature and extent of work involved.
2. Work in the existing building shall be scheduled with the Owner.
3. Certain demolition work must be performed prior to the remodeling. The Fire Suppression Contractor shall perform the demolition which involves Fire Suppression and Fire Suppression systems, equipment, piping, equipment supports or foundations and materials.
4. Fire Suppression Contractor shall remove articles which are not required for the new work. Unless otherwise indicated, each item removed by the Fire Suppression Contractor during this demolition shall be removed by the Fire Suppression Contractor from the premises and disposed of in accordance with applicable federal, state and local regulations.
5. Fire Suppression Contractor shall relocate and reconnect Fire Suppression equipment that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where Fire Suppression equipment or materials are removed, the Fire Suppression Contractor shall cap unused piping beyond the floor line or wall line to facilitate restoration of finish.
6. General Contractor shall install finish material.
7. Obtain permission from the Architect for channeling of floors or walls not specifically noted on the Drawings.
8. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
9. Locate, identify, and protect Fire Suppression services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.

B. Conditions Affecting Excavations: The following project conditions apply:

1. Maintain and protect existing building services which transit the area affected by selective demolition.
 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
 3. Use of explosives is not permitted.
- C. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Electrical Contractors shall provide all motors, starters, disconnects, wire, conduit, etc. as specified in the Construction Documents. If, however, the Fire Suppression Contractor furnishes a piece of equipment requiring a different motor, starter, disconnect, wire size, etc. than what is shown and/or intended on the Construction Documents, the Fire Suppression Contractor shall coordinate the requirements with any other Contractor and shall be responsible for any additional cost incurred by any other Contractor that is associated with installing the different equipment and related accessories for proper working condition.
- B. Refer to Division 26, "Common Work Results for Electrical" for specification of motor connections.
- C. Refer to Division 26, "Enclosed Switches and Circuit Breakers" for specification of disconnect switches.
- D. Refer to Division 28, "Fire Detection and Alarm" for specification of sprinkler monitoring equipment connections.
- E. All fire protection equipment shall be UL listed and FM approved (FM Insureds only) for its intended use and in conformance with the applicable NFPA codes.
- F. System Pressures: All system components shall be listed for the actual designed system pressures.
 1. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
 2. High-Pressure Piping System Component: Listed for 250-psig minimum working pressure.

2.2 SOIL MATERIALS

- A. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, or natural or crushed sand.
- B. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2-inch sieve, and not more than 5 percent passing a No. 4 sieve.

- C. Backfill and Fill Materials: Materials complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW, and SP; free of clay, rock, or gravel larger than 2 inches in any dimension; debris; waste; frozen materials; and vegetable and other deleterious matter.

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall install, and test all new equipment identified in this contract and revise existing equipment as noted.
- B. Installation shall be in accordance with NFPA requirements and the Contractor shall have employed or enlist the design services of at least one minimum NICET Level II certified technician.
- C. Installer: Company specializing in the products indicated in this section with minimum three years documented experience. Shall be bondable and licensed contractor and employ full-time factory-trained and certified installers and technicians. Installers shall provide with the fire sprinkler submittal proof of factory training for each installer.
- D. The Contractor shall provide all required equipment, sprinklers and piping for a complete and operational fire protection system. All components shall be installed in accordance with the guidelines of these specifications and documents as well as the NFPA codes and standards listed in these specifications.
- E. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Engineer.

3.2 PERMITS

- A. Secure and pay for permits required in connection with the installation of the Fire Suppression Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.3 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Section.
- B. Report test results promptly and in writing.

3.4 EXISTING UTILITIES

- A. Schedule and coordinate with the Utility Company, Owner and with the Engineer connection to, or relocation of, or discontinuation of normal utility services from existing utility lines. Premium time required for any such work shall be included in the bid.

- B. Existing utilities damaged due to the operations of utility work for this project shall be repaired to the satisfaction of the Owner or Utility Company without additional cost.
- C. Utilities shall not be left disconnected at the end of a work day or over a weekend unless authorized by representatives of the Owner or Engineer.
- D. Repairs and restoration of utilities shall be made before workmen leave the project at the end of the workday in which the interruption takes place.
- E. Contractor shall include in his bid the cost of furnishing temporary facilities to provide services during interruption of normal utility service.

3.5 SELECTIVE DEMOLITION

- A. General: Demolish, remove, demount, and disconnect abandoned Fire Suppression materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- B. Materials and equipment to be salvaged: Remove, demount, and disconnect existing Fire Suppression materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
- C. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.
- D. Fire Suppression Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
 - 1. Inactive and obsolete piping, fittings, specialties, equipment and controls.
 - a. Piping embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove exposed materials and materials above accessible ceilings. Drain and cap piping allowed to remain.
 - b. Perform cutting and patching required for demolition in accordance with Division 1, General Conditions and "Cutting and Patching" portion of this Section in Division 21.

3.6 EXCAVATION AND BACKFILLING

- A. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this Division. Excavation shall be in conformance with applicable Division and section of the General Specifications.
- B. Roads, alleys, streets and sidewalks damaged during this work shall be restored to the satisfaction of Authorities Having Jurisdiction.
- C. Trenches close to walks or columns shall not be excavated without prior consultation with the Architect.
- D. The Contractor shall erect barricades around excavations, for safety, and shall place an adequate number of amber lights on or near the work and shall keep them burning from dusk to dawn. The

Contractor shall be held responsible for any damage that any parties may sustain in consequence of neglecting the necessary precautions in prosecuting the work.

- E. Slope sides of excavations to comply with local, state and federal codes and ordinances. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
 - 1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.
- F. Install sediment and erosion control measures in accordance with local codes and ordinances.
- G. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
 - 1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
 - 2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.
- H. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.
 - 1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
 - 2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.
- I. Excavation for Underground Tanks, Basins, and Fire Suppression Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.
 - 1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.
 - 2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- J. Trenching: Excavate trenches for Fire Suppression installations as follows:
 - 1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of pipe and equipment.

2. Excavate trenches to depth indicated or required for piping to establish indicated slope and invert elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.
 3. Limit the length of open trench to that in which pipe can be installed, tested, and the trench backfilled within the same day.
 4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of pipe. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and pipe.
 5. Excavate trenches for piping and equipment with bottoms of trench to accurate elevations for support of pipe and equipment on undisturbed soil.
 - a. For pipes or equipment 6 inches or larger in nominal size, shape bottom of trench to fit bottom 1/4 of the circumference. Fill unevenness with tamped sand backfill. At each pipe joint over-excavate to relieve the bell or pipe joint of the pipe of loads, and to ensure continuous bearing of the pipe barrel on the bearing surface.
- K. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35°F.
- L. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.
1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
 2. Under building slabs, use drainage fill materials.
 3. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
 4. For piping less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support. After installation and testing of piping, provide a 4-inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.
 5. Other areas, use excavated or borrowed materials.
- M. Backfill excavations as promptly as work permits, but not until completion of the following:
1. Inspection, testing, approval, and locations of underground utilities have been recorded.
 2. Removal of concrete formwork.
 3. Removal of shoring and bracing, and backfilling of voids.
 4. Removal of trash and debris.

- N. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- O. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- P. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of piping and equipment by carrying material uniformly around them to approximately same elevation in each lift.
- Q. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.
 - 1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).
 - a. Areas under structures, building slabs, steps, and pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - b. Areas under walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - c. Other areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.
 - 2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.
- R. Subsidence: Where subsidence occurs at Fire Suppression installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.7 CUTTING AND PATCHING

- A. The Contractor shall do necessary cutting of walls, floors, ceilings and roofs.
- B. No structural member shall be cut without permission from Architect and Structural Engineer.

- C. Patch around openings to match adjacent construction.
- D. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.

3.8 CLEANING

- A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Fire Suppression Contractor shall cooperate in maintaining reasonably clean premises at all times.
- B. Immediately prior to the final inspection, the Fire Suppression Contractor shall clean material and equipment installed under the Fire Suppression Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.9 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:
 - 1. Submit complete Operation and Maintenance Manuals.
 - 2. Submit complete Record Drawings.
 - 3. Perform special inspections.
 - 4. Start-up testing of systems.
 - 5. Removal of temporary facilities from the site.
 - 6. Comply with requirements for Substantial Completion in the "General Conditions".
- B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.
- C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, they shall reimburse the Architect/Engineer for time and expenses incurred for the visit.
- F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.
- G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

- H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. He shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF DOCUMENT 210010

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER

Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

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

Reason for not providing specified item: _____

Similar Installation:

Project: _____ Architect: _____

Address: _____ Owner: _____

Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

- ▲ A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
- B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
- C. Proposed substitution does not affect dimensions and functional clearances.
- D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
- E. Same warranty will be furnished for proposed substitution as for specified Work.
- F. Same maintenance service and source of replacement parts, as applicable, is available.
- G. Proposed substitution will not adversely affect other trades or delay construction schedule.
- H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

_____ Submitting Contractor	_____ Date	_____ Company
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Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

_____ Manufacturer's Representative	_____ Date	_____ Company
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Engineer Review and Recommendation Section

Recommend Acceptance	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Additional Comments:	<input type="checkbox"/> Attached	<input type="checkbox"/> None

Acceptance Section:

_____ Contractor Acceptance Signature	_____ Date	_____ Company
_____ Owner Acceptance Signature	_____ Date	_____ Company
_____ Architect Acceptance Signature	_____ Date	_____ Company
_____ Engineer Acceptance Signature	_____ Date	_____ Company

DOCUMENT 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes limited scope general construction materials and methods for application with Fire Suppression installations as follows:
1. Access panels and doors in walls, ceilings, and floors for access to Fire Suppression materials and equipment.
 2. Concrete for bases and housekeeping pads.
 3. Non-shrink grout for equipment installations.
 4. Miscellaneous metals for support of Fire Suppression materials and equipment.
 5. Wood grounds, nailers, blocking, fasteners, and anchorage for support of Fire Suppression materials and equipment.
 6. Joint sealers for sealing around Fire Suppression materials and equipment.
- B. Related Sections: The following sections contain requirements that relate to this Section:
1. Division 7 Section "Penetration Firestopping" for material and methods for firestopping systems.
 2. Division 21 Section 210010 "General Fire Suppression Requirements" for requirements for hydraulic calculations, obtaining electronic drawings files, shop drawings and record drawings.
 3. Division 21 Section 210515 "Basic Fire Suppression Piping Material and Methods," for general piping and fitting materials and methods.
 4. Division 21 Section 210553 "Identification for Fire Suppression Piping and Equipment" for labeling and identification of installed fire suppression equipment.
 5. Division 21 Section 211100 "Fire Suppression Water Service Piping" for fire suppression piping starting 5 feet outside the building to within the building.
 6. Division 21 Section 211313 "Water-based Fire Suppression Systems" for fire suppression sprinkler systems inside the building.

1.2 SUBMITTALS

- A. General: Submit the following in accordance with Division 1 and Division 21 Section "General Fire Suppression Requirements".
1. Product data for the following products:

- a. Access panels and doors.
 - b. Through and membrane-penetration firestopping systems.
2. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
 - a. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 1 Section "Summary of Work."

1.3 QUALITY ASSURANCE

- A. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.

1. Provide UL Label on each fire-rated access door.

PART 2 - PRODUCTS

2.1 ACCESS TO EQUIPMENT

- A. Acceptable Manufacturers:

1. Bar-Co., Inc.
 2. Elmdor Stoneman.
 3. JL Industries
 4. Jay R. Smith Mfg. Co.
 5. Karp Associates, Inc.
 6. Milcor
 7. Nystrom Building Products
 8. Wade
 9. Zurn
 10. <Insert manufacturer's name>

- B. Access Doors:

1. Provide access doors for all concealed equipment, except where above lay-in ceilings. Refer to Section "Identification for Fire Suppression Piping and Equipment" for labeling of access doors.

2. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
3. Access doors must be of the proper construction for type of construction where installed.
4. The exact location of all access doors shall be verified with the Architect prior to installation.
5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
 - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.
 - b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.
 - c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.
7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
 - a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
8. Locking Devices: Flush, screwdriver-operated cam locks.
9. Locking Devices: Where indicated on the drawings or where access panels are installed in locations accessible to the public, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

2.2 FIRE SUPPRESSION EQUIPMENT NAMEPLATE DATA

- A. For each piece of power operated Fire Suppression equipment, provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance's, and similar essential data. Locate nameplates in an accessible location.

2.3 CONCRETE EQUIPMENT BASES/HOUSEKEEPING PADS

- A. Provide concrete equipment bases and housekeeping pads for various pieces of floor mounted Fire Suppression equipment. Concrete equipment bases/housekeeping pads shall generally conform to the shape of the piece of equipment it serves with a minimum 4" margin around the equipment and supports.

- B. Form concrete equipment bases and housekeeping pads using framing lumber or steel channel with form release agent. Chamfer top edges and corners. Trowel tops and sides of each base/pad to a smooth finish, equal to that of the floors.
- C. Concrete equipment bases and housekeeping pads shall be made of a minimum 28 day, 4000 psi concrete conforming to American Concrete Institute Standard Building Code for Reinforced Concrete (ACI 318-99) and the latest applicable recommendations of the ACI standard practice manual. Concrete shall be composed of cement conforming to ASTM C 150 Type I, aggregate conforming to ASTM C33, and potable water. All exposed exterior concrete shall contain 5 to 7 percent air entrainment.
- D. Unless otherwise specified or shown on the structural drawings, reinforce equipment bases and housekeeping pads with No. 4 reinforcing bars conforming to ASTM A 615 or 6x6 – W2.9 x W2.9 welded wire mesh conforming to ASTM A185. Reinforcing bars shall be placed 24" on center with a minimum of two bars each direction.
- E. Provide galvanized anchor bolts for all equipment placed on concrete equipment bases and housekeeping pads or on concrete slabs. Anchor bolts size, number and placement shall be as recommended by the Manufacturer of the equipment.
- F. Concrete equipment bases and housekeeping pads shall have minimum heights in accordance with the following table:

Equipment	Minimum Height
Pumps and Equipment Less than or equal to 20 tons and Other Equipment Not Listed – Note 1	3-1/2"
Pumps 30 HP to 75 HP (See Note 1)	7-1/4"
Pumps greater than 75 HP (See Note 1)	11-1/4"

NOTES:

- 1. Height of equipment bases applies to equipment installed on slab-on-grade. For equipment installed on floors above grade and/or roof, reference the drawings.

2.4 GROUT

- A. Provide nonshrink, nonmetallic grout conforming to ASTM C 1107, Grade B, in premixed and factory-packaged containers.
- B. Grout shall have post-hardening, volume-adjusting, dry, non-staining, non-corrosive, non-gaseous, hydraulic-cement characteristics and shall be as recommended by manufacturer for interior and exterior applications.
- C. Grout shall have 5,000 psi, 28-day compressive strength design mix.

2.5 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
- B. Cold-Formed Steel Tubing: ASTM A 500.

- C. Hot-Rolled Steel Tubing: ASTM A 501.
- D. Steel Pipe: ASTM A 53, Schedule 40, welded.
- E. Fasteners: Zinc-coated, type, grade, and class as required.

2.6 MISCELLANEOUS LUMBER

- A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPB rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.
 - 1. Framing materials shall be fire resistant treated for use in Type I and II buildings.
- B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 15/32 inches.
 - 1. Framing materials shall be fire resistant treated for use in Type I and II buildings.

2.7 JOINT SEALERS

- A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- B. Colors: As selected by the Architect from manufacturer's standard colors.
- C. Elastomeric Joint Sealers: Provide the following types:
 - 1. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer. Provide one of the following:
 - a. "Dow Corning 790," Dow Corning Corp.
 - b. "Silglaze II SCS 2801," General Electric Co.
 - c. "Silpruf SCS 2000," General Electric Co.
 - d. "864," Pecora Corp.
 - e. "Rhodia 5C," Rhone-Poulenc, Inc.
 - f. "Spectrem 1," Tremco, Inc.
 - g. "Spectrem 2," Tremco, Inc.
 - h. "Dow Corning 795," Dow Corning Corp.
 - i. "Rhodia 7B," Rhone-Poulenc, Inc.
 - j. "Rhodia 7S," Rhone-Poulenc, Inc.

- k. "Omniseal," Sonneborn Building Products Div.
 - 2. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide one of the following:
 - a. "Dow Corning 786," Dow Corning Corp.
 - b. "Sanitary 1700," General Electric Co.
 - c. "898 Silicone Sanitary Sealant," Pecora Corp.
 - d. "OmniPlus," Sonneborn Building Products Div.
 - D. Acrylic-Emulsion Sealants: One-part, nonsag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Chem-Calk 600," Bostik Construction Products Div.
 - b. "AC-20," Pecora Corp.
 - c. "Sonolac," Sonneborn Building Products Div.
 - d. "Tremflex 834," Tremco, Inc.
- 2.8 ACOUSTICAL SEALANTS
- A. General: Penetrations by pipes through surfaces that are around and between noise critical spaces shall be sleeved, packed and sealed airtight with foam rod, non-hardening sealant and/or packing material as described herein.
 - B. Foam Rod: Foam backer rod shall be closed cell polyethylene suitable for use as a backing for non-hardening sealant.
 - C. Non-Hardening Sealant: Sealant for penetrations shall be non-hardening polysulphide type. Permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.
 - D. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 pcf (40 kg/m³).

PART 3 - EXECUTION

3.1 INSTALLATION OF ACCESS DOORS

- A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- B. Adjust hardware and panels after installation for proper operation.

3.2 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor Fire Suppression materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.3 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor Fire Suppression materials and equipment.
- B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.4 PREPARATION FOR JOINT SEALERS

- A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
- B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.5 APPLICATION OF JOINT SEALERS

- A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - 1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
 - 2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.
- B. Tooling: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.6 PENETRATIONS:

A. New Construction:

1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support piping penetrations.

B. Construction in Existing Facilities:

1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.

C. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.

D. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.

E. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.

F. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.

G. Cut sleeves to length for mounting flush with both surfaces of walls.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

I. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.

J. All openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 21 Section "Basic Fire Suppression Piping Materials and Methods

END OF DOCUMENT 210500

DOCUMENT 210515 - BASIC FIRE SUPPRESSION PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies piping materials and installation methods common to more than one Section of Division 21 and includes piping, joining materials, piping specialties and basic piping installation instructions.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 21 Section 210010 "General Fire Suppression Requirements" for requirements for hydraulic calculations, obtaining electronic drawings files, shop drawings and record drawings.
 - 2. Division 21 Section 210500 "Common Work Results for Fire Suppression," for materials and methods for wall and floor penetrations.
 - 3. Division 21 Section 210553 "Identification for Fire Suppression Piping and Equipment" for labeling and identification of installed fire suppression equipment.
 - 4. Division 21 Section 211100 "Fire Suppression Water Service Piping" for fire suppression piping starting 5 feet outside the building to within the building.
 - 5. Division 21 Section 211313 "Water-based Fire Suppression Systems" for fire-suppression sprinkler systems inside the building.

1.2 SUBMITTALS

- A. Refer to Division 1 and Division 21 "General Fire Suppression Requirements" for administrative and procedural requirements for submittals.
- B. Product Data: Submit product data on the following items:
 - 1. Piping and Fittings
 - 2. Escutcheons
 - 3. Dielectric Unions and Fittings
 - 4. Sleeves and Mechanical Sleeve Seals
 - 5. Wall Pipes

1.3 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- B. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Plumbing Refrigeration.

- C. Threaded joints shall conform to ASME B1.20.1, Pipe Threads, General Purpose and the Pipe Fitters Handbook.
- D. UL and FM Compliance: Fire protection system materials and components shall be Underwriter's Laboratories listed and labeled, and Factory Mutual approved (FM Insureds only) for fire service.
- E. Pipe, piping specialties and fittings shall be manufactured in plants located in the United States.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. All fire suppression system materials and components essential to successful system operation shall be listed for their intended purpose.
- B. For FM Global insured projects – All fire Suppression system materials and components shall be FM approved.
- C. General: Refer to the individual piping system specification sections in Division 21 for specifications on piping and fittings relative to that particular system.

2.2 STEEL PIPE AND FITTINGS

- A. All piping 2-inch and smaller:
 - 1. With the use of welded or roll grooved fittings: ASTM A135 or 795, Grade A, Schedule 10 or 40, seamless or ERW, black steel pipe.
 - 2. With the use of threaded fittings: ASTM A135 or 795, Grade A, Schedule 40, seamless or ERW, black steel pipe.
- B. All piping 2-1/2" and larger: ASTM A135 or 795, Grade A, Schedule 10, ERW, black steel pipe, roll grooved ends.
- C. Piping used in dry pipe and preaction sprinkler systems shall be ASTM A135 or 795, Type E, Grade A, Schedule 40, black steel pipe, threaded or roll grooved ends.
- D. All piping on the exterior of the building shall be externally galvanized or painted.
- E. Acceptable alternatives to Schedule 40 and Schedule 10 pipe shall be manufactured to standards recognized by NFPA 13. Threaded pipe shall have a corrosion resistance rating (CRR) of 1.0 or greater. Crimp type couplings shall not be used. Threadable thinwall pipe with CRR less than 1.0 not permitted.
- F. Cast-Iron Threaded Fittings: ANSI B16.4, Class 125, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.
- G. Black Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- H. Steel Couplings: ASTM A 865, threaded

- I. Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- J. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.
- K. Malleable- or Ductile-Iron Unions: UL 860.
- L. Cast-Iron Flanges: ASME 16.1, Class 125.
- M. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- N. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- O. Grooved-Joint, Steel-Pipe Appurtenances
 - 1. Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
 - 2. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
 - 3. Grooved mechanical couplings including gaskets used on dry-pipe systems shall be listed for dry-pipe service.

2.3 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
 - 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
 - 2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
 - 1. Valves shall be UL listed or FM approved.
 - 2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.
 - 3. Minimum Pressure Rating for High-Pressure Piping: 250 psig.

B. Check Valves:

1. Description: Swing-check type, rubber-face checks unless otherwise indicated, and ends matching piping.
2. Standard: UL 312.
3. Pressure Rating: 250 psig minimum.
4. Type: Swing check.
5. Body Material: Cast iron.
6. End Connections: Flanged or grooved.

C. Bronze OS&Y Gate Valves:

1. Description: Bronze body and bonnet and bronze stem.
2. Standard: UL 262.
3. Pressure Rating: 175 psig.
4. Body Material: Bronze.
5. End Connections: Threaded or grooved.

D. Iron OS&Y Gate Valves:

1. Description: Iron body and bonnet and bronze seating material.
2. Standard: UL 262.
3. Pressure Rating: 250 psig minimum.
4. Body Material: Cast or ductile iron.
5. End Connections: Flanged or grooved.

E. Indicating-Type Butterfly Valves:

1. Standard: UL 1091.
2. Pressure Rating: 175 psig minimum.
3. Valves NPS 2 and Smaller:
 - a. Valve Type: Ball or butterfly.
 - b. Body Material: Bronze.

- c. End Connections: Threaded or grooved.
- 4. Valves NPS 2-1/2 and Larger:
 - a. Valve Type: Butterfly.
 - b. Body Material: Cast or ductile iron.
 - c. End Connections: Flanged or grooved.
- 5. Valve Operation: Integral, prewired supervisory switch and visual indicating device.

2.5 TRIM AND DRAIN VALVES

A. General Requirements:

- 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing (FM insureds only).
- 2. Pressure Rating: 175 psig minimum.

B. Automatic (Ball Drip) Drain Valves:

- 1. Standard: UL 1726.
- 2. Pressure Rating: 175 psig minimum.
- 3. Type: Automatic draining, ball check.
- 4. Size: NPS 3/4.
- 5. End Connections: Threaded.

2.6 AUTOMATIC AIR RELEASE VALVE

A. Standard: UL 2573

B. Pressure Rating: 175 psig minimum.

2.7 FIRE-DEPARTMENT CONNECTIONS

A. Exposed-Type, Fire-Department Connection:

- 1. Standard: UL 405.
- 2. Type: Exposed, projecting, for wall mounting.
- 3. Pressure Rating: 175 psig minimum.
- 4. Body Material: Corrosion-resistant metal.

5. Inlets: NPS 2-1/2 brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
6. Caps: Locking type.
7. Escutcheon Plate: Round, brass, wall type.
8. Outlet: Back, with pipe threads, NPS 4"
9. Number of Inlets: Two.
10. Escutcheon Plate Marking: Similar to "AUTO SPKR."
11. Finish: Rough brass or bronze.

B. Storz-Type, Fire-Department Connection:

1. Pressure Rating: 175 psig minimum.
2. Body Material: Aluminum Alloy.
3. Inlets: 5" Storz type.
4. Caps: Locking type.
5. Escutcheon Plate: Rectangular, brass, wall type.
6. Outlet: NPS 4".
7. Escutcheon Plate Marking: Similar to "AUTO SPKR."
8. Include 30 degree downturn elbow.
9. Finish: Anodized aluminum and/or Powder coated red as required.

2.8 PIPING SPECIALTIES

- A. Escutcheons: Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.
1. One-Piece, Cast-Brass Type: With rough-brass finish and setscrew fastener.
 2. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
 3. Split-Casting Brass Type: With rough-brass finish and with concealed hinge and setscrew.
 4. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

- B. Floor Plates: Inside diameter shall closely fit pipe outside diameter. Outside diameter shall completely cover the opening in floors, walls, or ceilings.
 - 1. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
 - 2. Split-Casting Floor Plates: Cast brass with concealed hinge.
- C. Unions: Malleable-iron, Class 150 for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.
- D. Dielectric Unions and Fittings: Provide factory-fabricated dielectric unions and fittings with appropriate end connections for the pipe materials in which installed (screwed, soldered, or flanged), which effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.
- E. Pressure Gauges
 - 1. Standard: UL 393.
 - 2. Dial Size: 3-1/2- to 4-1/2-inch diameter.
 - 3. Pressure Gage Range: 0 to 300 psig.
 - 4. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.
 - 5. Air System Piping Gage: Include "AIR" or "AIR/WATER" label on dial face.

2.9 PENETRATIONS

- A. Sleeves:
 - 1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.
 - 2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.
 - 3. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.
 - 4. Box Frames: Frames for rectangular openings shall be of welded 12 gauge steel attached to forms and of a maximum dimension established by the Architect. Contractor shall notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

B. Wall Pipes

1. Cast-iron sleeve with integral clamping flange with clamping ring, bolts, and nuts for membrane flashing.

- a. Underdeck Clamp: Clamping ring with setscrews.

- C. Mechanical Sleeve Seals: Modular Plumbing type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

- a. Pressure Plates: Carbon steel or stainless steel.

- b. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, or Stainless steel of length required to secure pressure plates to sealing elements.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.2 PIPING INSTALLATIONS

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.
- B. Coordinate installation of horizontal piping with other components. Allow sufficient space above removable ceiling panels to allow for panel removal (minimum 6" clearance).
- C. Install system such that all piping is rigidly secured and supported. All ductwork, lights, structural members and main runs of piping shall take precedence over sprinkler piping. Cutting of structural members for passage of sprinkler pipes or hangers shall not be permitted. All horizontal piping in ceiling space shall be at an elevation above the top of light fixtures and air outlets to allow for access to light fixtures and air outlets without removing horizontal piping. Route all sprinkler piping and provide all offsets, bends, and elbows around all mechanical, electrical, and structural members as required.

- D. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated otherwise. In areas with ceilings, piping shall be routed concealed, above ceiling. In areas without ceilings, piping shall extend as high as possible.
- E. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.
- F. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.
- G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- H. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.
- I. Install sprinkler piping to provide for system drainage in accordance with NFPA 13. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple and cap.
- J. Coordinate pipe routing near electrical equipment in accordance with NFPA 70.
- K. Verify final equipment locations for roughing in.
- L. Deviations from approved "Working Plans" for sprinkler piping require written approval of the Authority Having Jurisdiction. Written approval shall be on file with the Engineer prior to deviating from the approved "Working Plans."
- M. Install escutcheons for exposed piping penetrations of walls, ceilings, and floors.

3.3 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Use approved fittings to make all changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- C. Install unions in pipes NPS 2 and smaller, adjacent to each valve. Unions are not required on flanged devices or in piping installations using grooved mechanical couplings.
- D. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- E. Install dielectric unions to connect piping materials of dissimilar metals in dry piping systems.
- F. Non-ferrous Pipe Joints:

1. Brazed and Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.9 - Standard Code for Building Services Piping.
 2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.
- G. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- a. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- H. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads and Pipe Fitter's Handbook. Join pipe, fittings, and valves as follows:
1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 2. Align threads at point of assembly.
 3. Apply appropriate tape or thread compound to the external pipe threads.
 4. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.
 5. Damaged Threads: Do not use pipe with threads that are corroded, or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.
- I. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9. Align flanged surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.
- J. Mechanical Grooved Joints: Roll grooves on pipe ends dimensionally compatible with the couplings. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- K. Joints for other piping materials are specified within the respective piping system sections.
- 3.4 FIRE DEPARTMENT CONNECTION INSTALLATION
- A. Install wall-type, fire department connection.
 - B. Install connections between 18- and 36-inches above finished grade and as indicated on the Drawings.
 - C. Grout or caulk pipe penetration in exterior wall.
 - D. Provide minimum 36-inch working clearance around connection for fire department access.

- E. Install automatic (ball drip) drain valve at each check valve for fire department connection. The drain line shall discharge to the exterior.

3.5 ALARM DEVICE INSTALLATION

- A. General: Comply with NFPA 24 for devices and methods of valve supervision.
- B. Supervisory Switches: Supervise valves in open position unless noted otherwise.
 - 1. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
 - 2. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.
- C. Locking and Sealing: Secure unsupervised valves as follows:
 - 1. Valves: Install chain and padlock on open OS&Y gate valve.
 - 2. Post Indicators: Install padlock on wrench on indicator post.
- D. Water-Flow Indicators: Install in fire suppression piping where indicated. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.
- E. Connect alarm devices to building's fire-alarm system. Wiring and fire-alarm devices are specified in Division 28 Sections.

3.6 PIPING PROTECTION

- A. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at the end of each day or whenever work stops.

3.7 PENETRATIONS

- A. Fire suppression penetrations occur when piping penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies.
- B. Above Grade Concrete or Masonry Penetrations
 - 1. Provide sleeves for pipes passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:
 - a. Provide schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.
 - b. Provide galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 10 gauge (0.1382 inches).

- c. Provide welded galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:
 - 1) For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 18 gauge (0.052 inches).
 - 2) For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 10 gauge (0.1382 inches).
 - d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.
 - 2. Seal elevated floor, exterior wall and roof penetrations watertight and weathertight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of ½" of sealant.
- C. Underground, Exterior-Wall Penetrations: Install cast-iron wall pipes for sleeves. Size sleeves to allow for 1-inch (or larger, if required by the mechanical sleeve manufacturer) annular clear space between pipe and sleeve. Provide mechanical sleeve seal.
- 1. Use type and number of sealing elements recommended by manufacturer for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
 - 2. Inspect installed sleeve and sleeve-seal installations for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade to seal against hydrostatic pressure.
- D. Elevated Floor Penetrations of Waterproof Membrane:
- 1. Provide cast-iron wall pipes for sleeves, extend top of wall pipe minimum 1" above finish floor. Size wall pipe for minimum ½" annular space between pipe and wall pipe.
 - 2. Extend pipe insulation for insulated pipe through wall pipe. The vapor barrier shall be maintained. Size wall pipe for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.
 - 3. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.
 - 4. Secure waterproof membrane flashing between clamping flange and clamping ring. Comply with requirements for flashing specified in Division 7 Section "Sheet Metal Flashing and Trim."
 - 5. Extend bottom of wall pipe below floor slab as required and secure underdeck clamp to hold wall pipe rigidly in place.

- E. Interior Foundation Penetrations: Provide sleeves for horizontal pipe passing through or under foundation. Sleeves shall be cast iron soil pipe two nominal pipe sizes larger than the pipe served.
- F. Concrete Slab on Grade Penetrations:
 - 1. Provide schedule 40 PVC pipe sleeves for vertical pressure pipe passing through concrete slab on grade. Sleeves shall be one nominal pipe size larger than the pipe served and two pipe sizes larger than pipe served for ductile iron pipes with restraining rods. Seal water-tight with silicone caulk.
 - 2. Provide 1/2-inch thick cellular foam insulation around perimeter of non-pressure pipe passing thru concrete slab on grade. Insulation shall extend to 2-inch above and below the concrete slab.
- G. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2-inch of sealant. Refer to Division 21 Section "Common Work Results for Fire Suppression" for materials and installation.
 - 1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1-inch annular clear space between inside of sleeve and outside of insulation.
- H. Exterior Wall Penetrations: Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2-inch of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.
 - 1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1-inch annular clear space between inside of sleeve and outside of insulation.
- I. Fire / Smoke Rated Floor and Wall Assemblies: Seal around penetrations of fire rated assemblies to maintain fire resistance rating of assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer's UL listing. Refer to Division 21 Section "Common Work Results for Fire Suppression" for firestopping and materials.

3.8 ACOUSTICAL PENETRATIONS

- A. General: There shall be no direct contact of piping with shaft walls, floor slabs and/or partition. All openings around pipes in the structure surrounding the Fire Suppression equipment and surrounding noise-critical spaces shall be sealed, packed with caulking for the full depth of the penetration, as described herein. This includes all slab penetrations and penetrations of noise critical walls.
- B. Fire Sprinkler Piping
 - 1. Where a pipe passes through a wall, ceiling or floor slab of a noise critical space, a steel sleeve shall be cast or grouted into the structure. The internal diameter of the sleeve shall be 2 inches larger than the external diameter of the pipe passing through it. After all of the

piping is installed in that area, the Contractor shall check the clearance and correct it, if necessary, to within 1/2 inch. Pack the void full depth with packing material sealed at both ends, 1 inch deep, with non-hardening sealant backed by foam rod.

3.9 PIPE FIELD QUALITY CONTROL

- A. Testing: Refer to individual piping system specification sections.

END OF DOCUMENT 210515

DOCUMENT 210553 - IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Extent of Fire Suppression work to be identified as required by this Section is indicated on drawings and/or specified in other Division 21 Sections.
- B. Types of identification devices specified in this Section include the following:
 - 1. Equipment labels.
 - 2. Valve tags.
 - 3. Hydraulic placards.
 - 4. Pipe labels.
 - 5. Stencils.
- C. Related Sections
 - 1. Division 21 Section 210010 "General Fire Suppression Requirements" for requirements for hydraulic calculations, fire flow test data, obtaining electronic drawings files, shop drawings and record drawings.
 - 2. Division 21 Section 210500 "Common Work Results for Fire Suppression," for materials and methods for wall and floor penetrations.
 - 3. Division 21 Section 210515 "Basic Fire Suppression Piping Material and Methods," for general piping and fitting materials and methods.
 - 4. Division 21 Section 210533 "Heat Tracing for Fire-Suppression Piping" for heat tracing requirements.
 - 5. Division 21 Section 210548 "Seismic Controls for Fire Protection" for seismic bracing requirements.
 - 6. Division 21 Section 211100 "Fire Suppression Water Service Piping," for fire suppression piping starting 5 feet outside the building to within the building.
 - 7. Division 21 Section 211200 "Fire-Suppression Standpipes" for fire-suppression standpipes inside the building.
 - 8. Division 21 Section 211313 "Water-based Fire Suppression Systems" for fire-suppression sprinkler systems inside the building.
 - 9. Division 21 Section 213113 "Electric-Drive Fire Pumps" for fire pumps.

1.2 CODES AND STANDARDS:

- A. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.
- B. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- B. Maintenance Data: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, aluminum, or anodized aluminum, 0.032 inch thick, with predrilled holes for attachment hardware.
 - 2. Background/Letter Color: Red/White or Bare Metal/Black.
 - 3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 4. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 5. Fasteners: Stainless-steel rivets or self-tapping screws.
 - 6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
 - 2. Background/Letter Color: Red/White
 - 3. Maximum Temperature: Able to withstand temperatures 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 3/4 inch
 - 5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for

greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

6. Fasteners: Stainless-steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number,

2.2 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping-system abbreviation and 1/2-inch (13-mm) numbers.

1. Tag Material: Brass, stainless steel, aluminum or anodized aluminum, 0.032 inch thick, with predrilled holes for attachment hardware.
2. Fasteners: Brass wire-link chain, beaded chain or S-hook.
3. Valve-Tag Color: Red.
4. Letter Color: White.

2.3 HYDRAULIC PLACARDS

A. Provide hydraulic calculation placard attached to each riser in accordance with NFPA 13. Placard shall include location of design area or areas, discharge densities over the design area or areas, required flow and pressures at the base of riser, occupancy classification and maximum permitted storage height and configuration, hose stream allowance included in addition to the sprinkler demand and name of installing contractor. Information shall be permanently and clearly displayed on placard.

2.4 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction.
- B. Pretensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; pipe size; and an arrow indicating flow direction.
- E. Lettering Size: At least 1-1/2 inches high.
- F. Pipe-Label Colors:
 1. Background Color: Red.
 2. Letter Color: White.

2.5 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
 - 1. Stencil Material: Fiberboard or metal.
 - 2. Stencil Paint: Exterior, gloss, alkyd enamel or acrylic enamel, black unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, alkyd enamel or acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT IDENTIFICATION

- A. General: Install metal or plastic equipment marker on or near each major item of fire protection equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
 - 1. Pumps
 - 2. Tanks and pressure vessels
 - 3. Backflow Preventers

3.3 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in fire suppression systems

3.4 LABEL INSTALLATION

- 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 or permanently fasten labels on each major piece of equipment.
- D. Locate equipment labels where accessible and visible.
- E. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting."

- F. 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. Near each valve and control device.
 2. Near each branch connection excluding short takeoffs. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 3. At access doors, manholes, and similar access points that permit view of concealed piping.
 4. Near major equipment items and other points of origination and termination.
 5. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 6. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

END OF DOCUMENT 210553

DOCUMENT 211100 - FIRE SUPPRESSION WATER SERVICE PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. The extent of this fire suppression water service piping shall be as specified herein. Contractor shall be responsible for preparation of design drawings, fabrication and installation for complete fire suppression water service piping for the building.
- B. This section specifies:
 - 1. Materials and equipment for fire suppression water service piping and related components starting 5-feet outside the building and the following:
 - a. Service entrance piping through floor into the building.
- C. This section includes:
 - 1. Pipe and fittings
 - 2. Valves
 - 3. Post indicating valves
 - 4. Backflow preventers
 - 5. Fire department connection
 - 6. Alarm devices
 - 7. Accessories
- D. Provide facility fire suppression water service piping during construction in accordance with code.
- E. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 21 Specifications Sections, apply to this section.
- F. Related Sections:
 - 1. Division 31 Section "Earthwork," for trenching and backfilling materials and methods for underground piping installations.
 - 2. Division 33 Section "Water Service Systems," for water service piping beginning from 5'-0" outside the building and extending to the water service line.
 - 3. Division 21 Section 210010 "General Fire Suppression Requirements" for requirements for hydraulic calculations, fire flow test data, obtaining electronic drawings files, shop drawings and record drawings.

4. Division 21 Section 210500 "Common Work Results for Fire Suppression," for materials and methods for wall and floor penetrations.
5. Division 21 Section 210533 "Heat Tracing for Fire-Suppression Piping" for heat tracing requirements.
6. Division 21 Section 210548 "Seismic Controls for Fire Protection" for seismic bracing requirements.
7. Division 21 Section 210553 "Identification for Fire Suppression Piping and Equipment" for labeling and identification of installed fire suppression equipment.
8. Division 21 Section 211313 "Water-based Fire Suppression Systems" for fire suppression sprinkler systems inside the building.

1.2 SUBMITTALS

- A. Submit shop drawings prepared in accordance with Division 21 Section 210010 "General Fire Suppression Requirements."
- B. Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

1.3 QUALITY ASSURANCE

- A. Contractor shall be responsible for all permits and fees associated with preparation and approval of Drawings and the installation and approval of the Facility Fire Suppression Water Service Piping.
- B. Regulatory Requirements:
 1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
 2. Comply with standards of authorities having jurisdiction for fire suppression water service piping, including materials, hose threads, installation, and testing.
- C. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- D. NFPA 24, "Private Fire Service Mains and their Appurtenances", Latest Edition. Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire suppression water service piping.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves according to the following:
 1. Ensure that valves are dry and internally protected against rust and corrosion.
 2. Protect valves against damage to threaded ends and flange faces.
 3. Set valves in best position for handling.

- B. During Storage: Use precautions for valves, including fire hydrants, according to the following:
 - 1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
 - 2. Protect from weather. Store indoors and maintain temperature higher than ambient dew point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
- C. Handling: Use sling to handle valves if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use hand wheels or stems as lifting or rigging points.
- D. 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.
- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Protect flanges, fittings, and specialties from moisture and dirt.
- G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.5 PROJECT CONDITIONS

- A. Interruption of Existing Fire Suppression Water Service Piping: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water distribution service according to requirements indicated:
 - 1. Notify Architect, Construction Manager, and Owner no fewer than seven days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Architect's, Construction Manager's, and Owner's written permission.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Refer to Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods" for general piping fittings and piping specialty requirements.

2.2 DUCTILE-IRON PIPE AND FITTINGS.

- A. Mechanical-Joint, Cement Lined Ductile-Iron Pipe: AWWA C151/C104, with mechanical-joint bell and plain spigot end.
- B. Mechanical-Joint, Cement Lined Ductile-Iron Fittings: AWWA C110/C104, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 1. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Flanges: ASME B16.1, Class 125, cast iron.

D. Ductile-Iron Deflection Fittings:

1. Description: Compound, ductile-iron coupling fitting with sleeve and one or two flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
2. Pressure Rating: 250 psig minimum.

2.3 SERVICE ENTRANCE ASSEMBLY

A. At Contractor's option, the service entrance is permitted to utilize a one-piece riser assembly to enter the building.

1. Assembly shall be Ames Fire and Waterworks Series IBR or approved equivalent. In-Building Riser shall be composed of a single extended 90 degree fitting of fabricated 304 stainless steel tubing, maximum working pressure 200 psi. The fitting shall have a grooved-end connection on the outlet (building) side and a CIPS coupler on the inlet (underground) side. The grooved end shall include a coupler and cap to facilitate testing of the underground piping.

2.4 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105.
- B. Material: Linear low-density PE film of 0.008-inch (0.20-mm) or High-density, cross-laminated PE film of 0.004-inch (0.10-mm) minimum thickness.
- C. Form: Sheet or tube.

2.5 CURB VALVES

- A. Curb Valves: Comply with AWWA C800 for high pressure service line valves. Valve has bronze body, ground-key plug or ball, wide tee head, and inlet and outlet matching service piping material.
- B. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches in diameter.
1. Shutoff Rods: Steel; with tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

C. Meter Valves: Comply with AWWA C800 for high pressure service line valves. Include angle- or straight-through-pattern bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.

2.6 GATE VALVES

A. UL Listed or FM Approved Gate Valves:

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FIRE SUPPRESSION WATER SERVICE PIPING

1. UL listed or FM approved, Iron, Non-rising Stem Gate Valves:
 - a. Description: Iron body and bonnet, bronze seating material, and inside screw.
 - b. Standards: UL 262 listing and "Approval Guide," published by FM Global, approval.
 - c. Pressure Rating: 175 psig minimum.
 - d. End Connections: Mechanical or push-on joint.
 - e. Indicator-Post Flange: Include on valves used with indicator posts.
2. UL-Listed or FM-Approved, Iron, OS&Y, Gate Valves:
 - a. Description: Iron body and bonnet and bronze seating material.
 - b. Standards: UL 262 listing and "Approval Guide," published by FM Global, approval.
 - c. Pressure Rating: 175 psig minimum.
 - d. End Connections: Flanged or grooved.

2.7 GATE VALVE ACCESSORIES AND SPECIALTIES

- A. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5-inches (125 mm) in diameter.
 1. Operating Wrenches: Steel; with tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.
- B. Indicator Posts:
 1. Description: Vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.
 2. Standards: UL 789 listing and "Approval Guide," published by FM Global, approval.

2.8 CHECK VALVES

- A. UL listed or FM approved Check Valves:
 1. Description: Swing-check type with pressure rating, rubber-face checks unless otherwise indicated, and ends matching piping.
 2. Standards: UL 312 listing and "Approval Guide," published by FM Global, approval.
 3. Pressure Rating: 175 psig minimum.

2.9 DETECTOR CHECK VALVES

- A. Description: Galvanized cast-iron body, bolted cover with air bleed device for access to internal parts, and flanged ends. Include one-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.
 - 1. Standards: UL 312 listing and "Approval Guide," published by FM Global, approval.
 - 2. Pressure Rating: 175 psig minimum.
- B. Water Meter: AWWA C700, disc type, at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.

2.10 BACKFLOW PREVENTERS

- A. Double Check Backflow Preventer Assembly:
 - 1. Standard: ASSE 1015.
 - 2. Operation: Continuous-pressure applications unless otherwise indicated.
 - 3. Body Material: Cast iron with fused epoxy coating or stainless steel.
 - 4. End Connections: Threaded, flanged or grooved.
 - 5. Accessories: Supervised butterfly or OS&Y gate valves. Backflow preventer and valves shall be listed as an assembly.
- B. Double Check Detector Backflow Preventer Assembly:
 - 1. Standards: ASSE 1048 and UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, approval.
 - 2. Operation: Continuous-pressure applications.
 - 3. Body Material: Cast iron with interior lining complying with AWWA C550 or that is FDA approved; Steel with interior lining complying with AWWA C550 or that is FDA approved; or Stainless steel.
 - 4. End Connections: Threaded, flanged or grooved.
 - 5. Accessories:
 - a. Supervised butterfly or OS&Y gate valves. Backflow preventer and valves shall be listed as an assembly.
 - b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

- C. Reduced Pressure Zone (RPZ) Backflow Preventer Assembly:

1. Standard: ASSE 1013 and UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, approval.
2. Operation: Continuous-pressure applications.
3. Body Material: Cast iron with fused epoxy coating or stainless steel.
4. End Connections: Threaded, flanged or grooved.
5. Accessories:
 - a. Supervised butterfly or OS&Y gate valves. Backflow preventer and valves shall be listed as an assembly.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.

D. Reduced Pressure Zone (RPZ) Detector Backflow Preventer Assembly:

1. Standards: ASSE 1047 and UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, approval.
2. Operation: Continuous-pressure applications.
3. Body Material: Cast iron with interior lining complying with AWWA C550 or that is FDA approved; Steel with interior lining complying with AWWA C550 or that is FDA approved; or Stainless steel.
4. End Connections: Threaded, flanged or grooved.
5. Accessories:
 - a. Supervised butterfly or OS&Y gate valves. Backflow preventer and valves shall be listed as an assembly.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
 - c. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

2.11 CONCRETE VAULTS

- A. Description: Precast, reinforced concrete vault, designed for A-16 load designation according to ASTM C 857, and made according to ASTM C 858.
- B. Ladder: ASTM A 36/A 36M, steel ladder; or PE-encased steel steps.
- C. Manhole: ASTM A 536, Grade 60-40-18, ductile-iron traffic frame and cover.
 1. Dimension: 24-inch (610-mm) minimum diameter unless otherwise indicated.

- D. Drain: ASME A112.6.3, cast-iron floor drain with outlet of size indicated. Include body anchor flange, light-duty cast-iron grate, bottom outlet, and integral or field-installed bronze ball or clapper-type backwater valve.

2.12 FIRE DEPARTMENT CONNECTION

- A. Description: Wall mounted type with cast-bronze body, thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded back outlet. Include locking caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose connection inlet; and round escutcheon plate.

- 1. Standard: UL 405.
- 2. Connections: Two NPS 2-1/2 inlets and one NPS 4" outlet.
- 3. Inlet Alignment: Horizontal.
- 4. Finish Including Sleeve-Rough bronze-.
- 5. Caps: Locking type.
- 6. Escutcheon Plate Marking: "-AUTO SPKR >" as applicable.

- B. Description: Wall mounted, Storz-type with aluminum body, threaded back outlet. Include locking caps, gaskets, and chains; and round escutcheon plate.

- 1. Standard: UL 405.
- 2. Pressure Rating: 175 psig (minimum).
- 3. Body Material: Corrosion-resistant metal
- 4. Finish: Anodized aluminum.
- 5. Caps: Locking type, with gasket and chain.
- 6. Outlet: 30° elbow.
- 7. Size: 5" Storz x 4" NPS.
- 8. Check valve: Sized per NFPA 13 with 3/4" ball drip drain piped to the exterior of the building.
- 9. Escutcheon Plate Marking: "AUTO SPKR" as applicable."

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with excavating, trenching, and backfilling requirements in Section 312000 "Earth Moving."

3.2 PREPARATION FOUNDATION FOR BELOW GROUND WATER DISTRIBUTION PIPE AND FITTINGS

- A. Grade trench bottoms to provide a smooth, firm, and stable foundation, free from rock, throughout the length of the pipe.
- B. Remove unstable, soft, and unsuitable materials at the surface upon which pipes are to be laid and backfill with clean sand or pea gravel to indicated elevation.
- C. Pipe Beds:
 - 1. Ductile Iron Pipe: Shape bottom of trench to fit bottom of pipe for 90-degrees (bottom 1/4 of the circumference). Fill unevenness with tamped sand backfill. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation. Provide first layer of pea gravel backfill 6-inch above pipe, tamp backfill with mechanical tamper to 85% to 95% compaction. For piping with rock trench bottoms, provide sand pipe bed 6-inch underneath and around sides of pipe up to middle half of the pipe, including fittings.
- D. Provide backfill above top of pipe bed as required for field conditions. Refer to Division 21 Section 210010 "General Fire Suppression Requirements" for materials and methods for backfill.

3.3 PIPE APPLICATIONS

- A. Piping below grade: Provide cement lined ductile iron pipe and fittings with mechanical joints.

3.4 PIPING INSTALLATION

- A. Comply with NFPA 24 for fire service main piping materials and installation.
- B. Water main connection: Arrange with water utility company for tap of size and in location indicated in water main or tap water main according to the requirements of the water utility company.
- C. Install ductile-iron, water service piping according to AWWA C600 and AWWA M41.
 - 1. Install encasement for piping according to ASTM A 674 or AWWA C105.
- D. Bury piping with depth of cover over top of piping at least 30-inches, with top at least 12-inches below level of maximum frost penetration, and according to the following:
 - 1. Under Driveways: With at least 36-inches of cover over top.
 - 2. Under Railroad Tracks: With at least 48-inches of cover over top.
- E. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.
- F. Extend fire suppression water service piping and connect to water supply source and building fire suppression water service piping systems at locations and pipe sizes indicated.

1. Terminate fire suppression water service piping at 12" above building floor slab until building water piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building's fire suppression water service piping systems when those systems are installed.
- G. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.
- H. Comply with requirements in Section 211313 "Water-Based Fire Suppression Systems," for fire suppression water piping inside the building.
- I. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210515 "Basic Fire Suppression Piping Materials and Methods."
- J. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210515 "Basic Fire Suppression Piping Materials and Methods."
- K. Make connections between underground and aboveground piping using an approved transition piece strapped or fastened to prevent separation.

3.5 JOINT CONSTRUCTION

- A. See Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods" for general joint construction requirements.
- B. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure rating same as or higher than systems pressure rating for aboveground applications unless otherwise indicated.
- C. Remove scale, slag, dirt, and debris from outside and inside of pipes, tubes, and fittings before assembly.
- D. Ductile-Iron Piping, Gasketed-Joints for Fire Service Main Piping: UL 194.
- E. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with bolts according to ASME B31.9.

3.6 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
 1. Locking mechanical joints.
 2. Bolted flanged joints.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches in fire suppression water service piping according to NFPA 24 and the following:
 1. Gasketed-Joint, Ductile-Iron, Water Service Piping: According to AWWA C600.

- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.7 VALVE INSTALLATION

- A. See Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods" for general valve installation requirements.
- B. UL-Listed or FM-Approved Gate Valves: Comply with NFPA 24. Install each underground valve(s) in vaults with stem pointing up
- C. UL-Listed or FM-Approved Valves Other Than Gate Valves: Comply with NFPA 24.
- D. Support valves and piping, not direct buried, on concrete piers. Comply with requirements for concrete piers in Division 03.

3.8 ROUGHING-IN FOR WATER METERS

- A. Rough-in piping and specialties for water meter installation according to utility company's written instructions

3.9 BACKFLOW PREVENTER INSTALLATIONS

- A. Install backflow preventer at each fire protection entry in compliance with the plumbing code and Authority Having Jurisdiction. Locate in an accessible and testable location.
 - 1. Install air gap fitting and pipe relief outlet drain without valves to nearest floor drain or exterior.
- B. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks.
- C. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.
- D. Do not install bypass piping around backflow preventers.
- E. Support NPS 2-1/2 and larger backflow preventers with pipe supports attached to the floor with anchor bolts where indicated on the drawings.
- F. Test backflow preventer per requirements of plumbing or division of cross connection control official.
 - 1. Reports: Prepare backflow preventer test reports signed by the plumbing or division of cross connection control official and turn over to the Architect upon completion of the project.

3.10 FIRE DEPARTMENT CONNECTION INSTALLATIONS

- A. Install automatic (ball drip) drain valve at each check valve for fire department connection, to drain piping between fire department connection and check valve. Install drain piping to and discharge to outside building.

- B. Install connections between 18- and 36-inches above finished grade and as indicated on the Drawings.
- C. Install mechanical sleeve seal at pipe penetration in outside walls.
- D. Provide minimum 36-inch working clearance around connection for fire department access.
- E. Install protective pipe bollards on two sides of each fire department connection. Pipe bollards are specified in Section 055000 "Metal Fabrications."

3.11 FIELD QUALITY CONTROL

- A. Flush, test, and inspect in accordance with NFPA 24.
- B. Leave uncovered and unconcealed all new, altered, extended, or replaced water distribution piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.
- C. Replace piping system components that do not pass the test procedures specified, and retest repaired portion of the system.

3.12 IDENTIFICATION

- A. Install continuous underground detectable warning tape during backfilling of trench for underground fire suppression water service piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."

3.13 CLEANING

- A. Clean fire suppression water service piping as follows:
 - 1. Flush new piping systems and parts of existing systems that have been altered, extended, or repaired before use.
 - 2. Use flushing procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
- B. Prepare reports of flushing activities.

END OF DOCUMENT 211100

DOCUMENT 211313 - WATER BASED FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. The extent of this fire sprinkler system shall be as specified herein. Contractor shall be responsible for preparation of design drawings, hydraulic calculations, fabrication and installation for complete fire sprinkler protection for the building.
- B. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Fire protection valves.
 - 3. Sprinkler pipe fittings.
 - 4. Sprinklers.
 - 5. Alarm devices.
 - 6. Control panels.
- C. Related Sections:
 - 1. Division 21 Section 210010 "General Fire Suppression Requirements" for requirements for hydraulic calculations, obtaining electronic drawings files, shop drawings and record drawings.
 - 2. Division 21 Section 210500 "Common Work Results for Fire Suppression," for materials and methods for wall and floor penetrations.
 - 3. Division 21 Section 210515 "Basic Fire Suppression Piping Material and Methods," for general piping and fitting materials and methods.
 - 4. Division 21 Section 210553 "Identification for Fire Suppression Piping and Equipment" for labeling and identification of installed fire suppression equipment.
 - 5. Division 21 Section 211100 "Fire Suppression Water Service Piping" for fire suppression piping starting 5 feet outside the building to within the building.

1.2 SYSTEM DESCRIPTION

- A. Fire protection system in the location or portion of the building is a Wet Pipe system.
 - 1. Wet Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to a water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts a fusible link or destroys a frangible device. Hose connections are included if indicated.

- B. Provide system(s) as specified herein and as shown on drawings. The sprinkler system shall be supplied by the underground system as shown on the Drawings.
- C. Provide dry pipe fire protection system for non-heated spaces and other areas of building subject to freezing including the loading docks and canopies, mansards, and balconies. Portions of systems subject to freezing or temperatures below 40° F shall be protected against freezing as required by NFPA 13. The Contractor shall be responsible for repairs and for all costs incurred from damage caused by freezing of the fire protection system.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design fire suppression system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Standard Pressure, Fire Suppression System Component: Listed for 175-psig minimum working pressure.
- C. High Pressure, Fire Suppression System Component: Listed for 250-psig minimum working pressure.
- D. Performance Criteria
 - 1. Protect entire building, unless noted otherwise, with a sprinkler system designed in accordance with NFPA 13 for Ordinary Hazard Group 2 requirements.
 - 2. Protect mechanical and electrical areas/rooms with a sprinkler system designed in accordance with NFPA 13 for Ordinary Hazard Group 1 requirements.
 - 3. Protect storage areas/back of house areas with a sprinkler system designed in accordance with NFPA 13 for Ordinary Hazard Group 2 requirement.
 - 4. Other Occupancy Hazard Classifications.
 - a. Building Service Areas: Ordinary Hazard Group 1.
 - b. Restrooms and Public Areas: Light Hazard.
 - c. Restaurant Service Areas: Ordinary Hazard, Group 1.
 - 5. Design Criteria for Automatic-Sprinkler Piping Design:
 - a. Light Hazard Occupancy:
 - 1) Minimum Design Density: 0.10 gpm over 1,500 sq.ft. area.
 - 2) Maximum protection area per sprinkler: 225 sq.ft.
 - 3) Minimum Combined Hose Stream Demand Requirement: 100 gpm for 30 minutes.

b. Ordinary Hazard Group 1 Occupancy:

- 1) Minimum Design Density: 0.15 gpm over 1,500 sq.ft. area.
- 2) Maximum area per sprinkler: 130 sq.ft..
- 3) Minimum Combined Hose Stream Demand: 250 gpm for 60 to 90 minutes.

c. Ordinary Hazard Group 2 Occupancy:

- 1) Minimum Design Density: 0.20 gpm over 1,500 sq.ft. area.
- 2) Maximum protection area per sprinkler: 130 sq.ft.
- 3) Minimum Combined Hose Stream Demand: 250 gpm for 60 to 90 minutes.

E. The criteria listed herein shall not preclude the use of extended coverage or special application fire sprinklers designed and installed in accordance with their listing and manufacturer's instructions.

F. The hydraulic area of operation may not be reduced as allowed by NFPA 13 for areas utilizing quick response sprinklers in unfinished shell spaces. For all other areas, the hydraulic area of operation shall not be reduced as allowed by NFPA 13 for areas utilizing quick response sprinklers unless specifically approved by the Engineer via a formally submitted RFI.

G. Sprinkler spacing shall conform to NFPA 13 and shall not exceed 256 SF per sprinkler in unfinished shell spaces.

H. The hydraulic area of operation shall be increased by 30% without revising the density for areas with sloped ceilings with a pitch exceeding 1 in 6 (16.7% slope) in accordance with NFPA 13.

1.4 SUBMITTALS

A. Submit shop drawings prepared in accordance with NFPA 13 as specified in Division 21 Section 210010 "General Fire Suppression Requirements."

1.5 QUALITY ASSURANCE

A. Contractor shall be responsible for all permits and fees associated with preparation and approval of Drawings and the installation and approval of a fire sprinkler system.

B. Tests and Inspections: Arrange, test, and pay for all tests required by code and authorities having jurisdiction.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Fire Sprinkler Protection: Do not interrupt fire sprinkler system protection to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire sprinkler protection according to requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than seven days in advance of proposed interruption of fire-sprinkler protection.
2. Do not proceed with interruption of fire sprinkler protection without Architect's, Construction Manager's, and Owner's written permission.

1.7 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.8 EXTRA MATERIALS

- A. Sprinkler Wrenches: Furnish to Owner, 2 sprinkler wrenches for each type of sprinkler installed.
- B. Sprinklers: Furnish extra sprinklers of each style, type and finish included in the project as required by NFPA 13.
- C. Sprinkler Cabinet and Wrench: Provide a finished steel cabinet(s), suitable for wall mounting, with hinged cover and space for the quantity of spare sprinklers provided plus sprinkler wrench(es).
- D. Provide hydraulic calculation placard attached to each riser.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. All fire protection equipment shall be UL listed and FM approved (FM Insureds only) for its intended use and in conformance with the applicable NFPA documents.

2.2 PIPE AND FITTING MATERIALS

- A. Refer to Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods" for specifications on piping and fittings.

2.3 HANGERS

- A. Shall be UL listed and shall meet requirements of NFPA 13 for type, dimension and location.

2.4 GENERAL DUTY VALVES

- A. Refer to Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods" for specifications on general duty valves.

2.5 SPECIALTY VALVES

- A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by Factory Mutual, approval.
2. Pressure Rating:

- a. Standard Pressure Piping Specialty Valves: 175-psig minimum.
 - b. High Pressure Piping Specialty Valves: 250-psig minimum.
3. Body Material: Cast- or ductile- iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.
- B. Alarm Valves:
 1. Standard: UL 193.
 2. Design: For horizontal or vertical installation.
 3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gauges, retarding chamber, and fill-line attachment with strainer.
 4. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
 5. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
 - a. Motor Horsepower: Fractional.
 - b. Power: 120-V ac, 60 Hz, single phase, hard wired per NEC and manufacturer's requirements.
 - c. Provide combination fused disconnect switch and magnetic starter.
 - a. Type: Oil-less, air-cooled
 - b. Standard: UL's "Fire Protection Equipment Directory" listing.
 - c. Motor Horsepower: Fractional.
 - d. Power: 120-V ac, 60 Hz, single phase, hard wired per NEC and manufacturer's requirements.
 - e. Provide combination fused disconnect switch and magnetic starter.
- C. Air Release Valve:
 1. Provide for all wet pipe sprinkler systems utilizing metallic piping in accordance with one of the following options:
 - a. Manual ball valve with a minimum size of ½ inch (15 mm).
 - b. Listed and/or Factory Mutual Approved automatic valve.

2.6 PIPE FITTINGS

A. Branch Outlet Fittings:

1. Standard: UL 213.
2. Pressure Rating: 175-psig minimum.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-T and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, welded or threaded.

B. Flow Detection and Test Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, approval.
2. Pressure Rating: 175-psig minimum.
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Grooved or threaded.

C. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, approval.
2. Pressure Rating: 175-psig minimum.
3. Body Material: Cast- or ductile-iron housing with sight glass.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

D. Flexible Piping Systems:

1. At Contractor's option, UL listed and FM approved flexible piping connections to sprinklers may be used for both acoustical panel and gypsum board ceilings when suitable

for their intended use. Piping shall be seismically qualified per ICC-ES AC-156 where required.

2. Description: Connections shall include a leak-tested sprinkler drop with a minimum internal corrugated hose diameter of 1 inch.
3. Flexible piping lengths shall not exceed 6 feet.
4. Installation shall not exceed the minimum bend radius and maximum allowable bends as specified by the manufacturer.
5. Change in direction shall be gradual enough to allow flexible piping to bend without crimping, distorting or reducing internal diameter.

2.7 AUTOMATIC SPRINKLERS

- A. Sprinklers: type and style as indicated or required by application. Sprinkler operating temperatures to comply with NFPA 13. Sprinklers in Light Hazard areas shall be quick response type.
- B. General Requirements:
 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, approval.
 2. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
 3. Pressure Rating for High-Pressure Automatic Sprinklers: 250-psig minimum.
- C. Automatic Sprinklers with Heat-Responsive Element:
 1. Early-Suppression, Fast-Response Applications: UL 1767.
 2. Nonresidential Applications: UL 199.
 3. Residential Applications: UL 1626.
 4. Characteristics: Nominal 1/2-inch orifice with discharge coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- D. Use sprinkler types below for the following applications:
 1. Rooms without Ceilings: Upright sprinklers.
 2. Rooms with Suspended Ceilings: Concealed sprinklers.
 3. Rooms with Gypsum Board Ceilings: Concealed sprinklers.
 4. Spaces Subject to Freezing: Dry pendent or dry sidewall sprinklers as indicated on drawings.

E. Provide sprinkler types below with finishes indicated.

1. Finished Areas:

- a. Concealed Sprinklers: Rough brass, with factory-painted white cover plate in gwb and lay-in ceiling areas. Coordinate cover plate finish in wood plank ceiling areas with architect.
- b. Unfinished Areas: Rough bronze in unfinished spaces exposed to view.

F. Coordinate sprinkler temperature ratings near heat-producing sources in accordance with NFPA 13.

G. Sprinkler Guards: Provide sprinkler guard where sprinklers are less than 7-feet above finished floor; where subject to physical damage, and/or where indicated on drawings. Guard shall be UL 199 listed, wire cage type with fastening device for attaching to sprinkler.

H. Sprinkler Cabinet and Wrench: Provide a finished steel cabinet, suitable for wall mounting, with hinged cover and space for the appropriate quantity of spare sprinklers plus sprinkler wrench(es).

2.8 ALARM DEVICES

A. General: Alarm device types shall match piping and equipment connections.

B. Electrically Operated Alarm Bell:

1. Standard: UL 464.
2. Type: Vibrating, metal alarm bell.
3. Size: 6-inch minimum diameter.
4. Finish: Red-enamel factory finish, suitable for outdoor use.
5. Provide engraved lamacoid plate under bell lettered "Building Fire Sprinkler System."

C. Audible/Visual Alarm Notification Appliances (Horn/Strobe):

1. Standard: UL 1971 combination horn and strobe appliance.
2. Horn: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn.
3. Strobes: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch (25-mm) high letters on the lens.
4. Audible/visual notification appliance shall be exterior, weatherproof with weatherproof backbox.

D. Water Flow Indicators:

1. Standard: UL 346.
2. Water-Flow Detector: Electrically supervised.
3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory set, field-adjustable retard element to prevent false signals and tamperproof cover.
4. Type: Paddle operated.
5. Pressure Rating: 250 psig.
6. Design Installation: Horizontal or vertical.

E. Valve Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts and tamperproof cover.
4. Design: Signals that controlled valve is in other than fully open position.

F. Indicator Post Supervisory Switches:

1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts and tamperproof cover.
4. Design: Signals that controlled indicator post valve is in other than fully open position.

2.9 SPRINKLER WATERFLOW AND SUPERVISORY SYSTEM

A. Provide a Sprinkler Waterflow and Supervisory System control panel in accordance with NFPA 13 and NFPA 72.

1. UL listed, microprocessor based fire alarm control/communicator that provides addressable point monitoring or supports a minimum of 5 zones providing supervising station service. Microprocessor shall be capable of continuously monitoring and reporting system status of AC, standby battery, inputs and telephone line connections. In the event of a fault condition a local audible sound shall be activated and reported to supervising station.

2. Shall have one notification appliance circuit for connection of the exterior bell or horn/strobe.
3. A keypad shall be provided and mounted adjacent to the fire sprinkler remote dialer.
4. Power requirements: primary power, 20-V ac, 60 Hz, 600 mA max; secondary rated 18-V ac, 40 VA. Backup battery: 12-V dc, 7 AH min to 14 AH max, lead acid (gel type).
5. Provide two telephone lines for off site system monitoring in accordance with NFPA 72. Other monitoring methods permitted by NFPA 72 may be used subject to Engineer approval.

B. Supervisory System Wire and Cable

1. Power Branch Circuits: Building wire as specified in Division 26.
2. Fire alarm Wire and Cable: NRTL listed and labeled as complying with NFPA 70 (NEC) Article 760. All wiring, including wiring to existing modified devices and appliances shall be new.
3. Signaling Line, Initiating Device and Notification Appliance Circuits: Power limited fire protective signaling cable, solid copper conductor, 300 volts insulation, suitable for temperature, conditions and location installed. Minimum wire size for initiating device circuits, control circuits and notification appliance circuits shall be determined by calculations and manufacturer's requirements or recommendations. Wire and cable shall be twisted and shielded if recommended by the system manufacturer.
4. The type of cable chosen should be based on fire alarm system requirements, specification requirements and applicable code requirements. Consideration should also be given to the length of cable runs and potential interference.
5. Initiating, notification, and control circuits shall be sized based on 20% additional power consuming devices.
6. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 PREPARATION

- A. Perform fire hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

3.3 WATER SUPPLY CONNECTION

- A. Connect sprinkler piping to water service piping for service entrance to building. Do not connect to underground supply until provided with written documentation that piping has been flushed

and pressure tested in accordance with NFPA 13. Comply with requirements for exterior piping in Division 21 Section 211100 "Fire Suppression Water Service Piping."

- B. Connect sprinkler piping to building's interior water distribution piping. Comply with requirements in Division 22 Section 221116 "Domestic Water Piping" for interior piping.
- C. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Division 21 Section 211100 "Fire Suppression Water Service Piping."
- D. Wet pipe systems shall be equipped with a listed relief valve not less than ½-inch in size and set to operate at 175 psi or 10 psi in excess of the maximum system pressure, whichever is greater.

3.4 PIPE APPLICATIONS

- A. Piping Below Grade: Refer to Division 21 Section 211100 "Fire Suppression Water Service Piping."
- B. Piping Above Grade: Refer to Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods."

3.5 PIPING INSTALLATIONS

- A. Refer to Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods" for general fire suppression piping installation requirements.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Hangers and Supports: Comply with the requirements of NFPA 13. Hanger and support spacing and locations for piping joined with grooved mechanical couplings shall be in accordance with the grooved mechanical coupling manufacturer's written instructions, for rigid systems. Provide protection from damage where subject to earthquake if required by the applicable building code, designed in accordance with NFPA 13. Locate hangers at or directly adjacent to the joist panel points. Provide two nuts on threaded supports to securely fasten the support.
- D. Install test connections sized and located in accordance with NFPA 13 complete with shutoff valve. Test connections may also serve as drain pipes.
- E. Install pressure gauge on the riser or feed main at or near each test connection. Provide pressure gauge with a connection not less than 1/4 inch and having a soft metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they will not be subject to freezing.
- F. Install automatic (ball drip) drain valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.
- G. Drain dry-type sprinkler system piping.
- H. Fill wet-type sprinkler system piping with water.

- I. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods"
- J. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods."

3.6 PIPE JOINT CONSTRUCTION

- A. Refer to Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods" for general pipe joint construction requirements.

3.7 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable water supply sources.
- D. Specialty Valves:
 - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 - 2. Alarm Valves: Include bypass check valve and retarding chamber drain line connection.

3.8 SPRINKLER INSTALLATIONS

- A. Use proper tools to prevent damage during installations.
- B. Areas with ceilings: Install sprinklers not less than 6-inches from the edge of a ceiling tile in areas with suspended ceilings, in a symmetrical pattern with lights and outlets.
- C. Install sprinklers in suspended ceilings in center of acoustical ceiling panels, in a symmetrical pattern with lights and outlets.
- D. Install sprinklers in a symmetrical pattern with lights and outlets in all other areas with ceilings.
- E. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.
- F. Do not install more than one sprinkler on a one inch outlet unless hydraulic calculations are included to verify performance.

3.9 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and Division 21 Section 210553 "Identification for Fire Suppression Piping and Equipment."
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.10 FIELD QUALITY CONTROL

- A. Perform required tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Start and run air compressors.
 - 6. Coordinate with fire alarm tests. Operate as required.
 - 7. Verify that equipment hose threads are same as local fire department equipment.
- C. Replace piping system components that do not pass the test procedures specified, and retest repaired portion of the system.

3.11 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.12 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.13 COMMISSIONING

- A. Sprinkler Systems: Test per NFPA 13, NFPA 25 and local authorities requirements. Submit Contractor's Material & Test Certificates for Above Ground Piping. Submit certificates of completion to Authority Having Jurisdiction and Owner.
 - 1. After completion of all installation, tests, etc., and prior to the opening date, the Sprinkler Subcontractor shall instruct the building personnel in the operation of the sprinkler system. Special care shall be taken to make sure the building personnel:

- a. Will immediately recognize whether the system control valves are in an 'Open' position or a 'Closed' position.
 - b. Will know how to drain the system.
 - c. Will know how to test the flow switches, tamper switches and alarm system.
 - d. Will know how to test the dry pipe/preaction valve.
 - e. Will know how to make complete weekly inspection.
 - f. Will know how to perform periodic maintenance of the Fire Sprinkler System.
- B. Fire Alarm Equipment: Test per NFPA 25, NFPA 72 and local authorities requirements in the presence of the Owner. Submit certificates of completion to authority having jurisdiction and Owner.

END OF DOCUMENT 211313

DOCUMENT 220010 - GENERAL PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.
- B. Division 22 of the Specifications and Drawings numbered with prefixes P, MP and EP, or MEP generally describe these systems, but the scope of the Plumbing work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.
- C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, piping, etc. without showing all the exact details as to elevations, offsets, control lines, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

1.2 QUALITY ASSURANCE

- A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.
- B. All work shall be installed in strict conformance with manufacturer's requirements, recommendations, and installation instructions. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.
- C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.
- D. Unless specified otherwise, manufactured items shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this project.

1.3 CODES, REFERENCES AND STANDARDS

- A. Execute Work in accordance with the National Fire Protection Association and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of

the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.

- B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.
- C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.
- D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes:

IBC	International Building Code – 2018 with Amendments
IMC	International Mechanical Code – 2018 with Amendments
IPC	International Plumbing Code – 2018 with Amendments
IFGC	International Fuel Gas Code – 2018
NEC	National Electrical Code – 2017
ADA	American Disabilities Act
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
AHRI	Airc Conditioning, Heating and Refrigeration Institute
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
ETL	Electrical Testing Laboratories
HI	Hydraulic Institute
MSS	Manufacturer's Standardization Society of the Valve and Fitting Industry
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code
NFPA	National Fire Protection Association
NEMA	National Electrical Manufactures' Association
OSHA	Occupational Safety and Health Act
PDI	Plumbing and Drainage Institute
UL	Underwriter's Laboratories

- E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.
- F. All Plumbing work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the Plumbing work shall be provided by the Contractor.

1.4 DEFINITIONS

- A. General:

1. **Furnish:** When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.
2. **Install:** The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."
3. **Provide:** The term "provide" means "to furnish and install, complete and ready for the intended use." When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.
4. **Furnished by Owner or Furnished by Others:** The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.
5. **Engineer:** Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".
6. **AHJ:** The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
7. **NRTL:** Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.
8. **Substitution:** Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.
 - a. **Substitutions for Cause:** Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - b. **Substitutions for Convenience:** Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.
9. **Value Engineering:** A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal

of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.
- C. The following definitions apply to excavation operations:
 - 1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
 - 2. Bedding: as used in this Section refers to the compacted sand or pea gravel installed in the bottom of a pipe trench to immediately support a pipe and cover a pipe.
 - 3. Subbase: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.
 - 4. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.
 - 5. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.
 - 6. Drainage Fill: as used in this Section refers to gravel installed to assist in the removal of underslab groundwater.
 - 7. Building Fill: as used in this section refers to borrowed fill material of rock 1" and larger used to fill foundation excavations.

1.5 COORDINATION

- A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.
- B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping and ductwork in the manner anticipated in the design.
- C. The Contractor shall confirm and coordinate the final location and routing of all mechanical, electrical, plumbing, fire protection, control and audio-visual systems with all architectural features, structural components, and other trades. The contractor shall locate equipment, components, ductwork, piping, conduit, and related accessories to maintain the desired ceiling

heights as indicated on the architectural drawings. The contractor shall inform the architect of any areas where conflicts may prevent the indicated ceiling height from being maintained. The contractor shall not proceed with any installation in such areas until the architect has given written approval to proceed or has provided modified contract drawings or written instructions to resolve the apparent conflict.

- D. The Contractor shall provide materials with trim which will fit properly the types of ceiling, wall, or floor finishes actually installed.
- E. The Contractor shall maintain a foreman on the jobsite at all times to coordinate his work with other contractors and subcontractors so that various components of the Plumbing systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the Work in such a manner that the Work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.
- F. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and his subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

1.6 MEASUREMENTS AND LAYOUTS

- A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.7 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.
 - 1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
 - 2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
 - 3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
 - 4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.

5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
 6. Indicate required installation sequence to minimize conflicts between entities.
 7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
 8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.
- B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of electrical equipment locations within electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.
1. Clearly identify all required working clearances and access provisions required for installation and maintenance.
 2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.
 3. Indicate path to allow for the future removal of each large piece of equipment (up to and including generators and unit sub-station transformers) without removal of non-related equipment or architectural elements.
 4. Include work provided by others routed through the equipment rooms.
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
 2. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.
 - a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.
 3. Where the Engineer's digital data files are provided to the Contractor for use in preparing coordination digital data files, the Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.

4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.

1.8 SUBMITTALS

- A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.
- B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.
- C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives. Contractor shall allow for the Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.
- D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.
- E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.
- F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.
- H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.
- I. Refer to individual Sections for additional submittal requirements.

- J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
 - K. Submittals shall contain the following information:
 - 1. The project name.
 - 2. The applicable specification section and paragraph.
 - 3. Equipment identification acronym as used on the drawings.
 - 4. The submittal date.
 - 5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
 - 6. Submittals not so identified will be returned to the Contractor without action.
 - L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Contract Administrator prior to implementing any deviation.
 - M. Provide welders' qualification certificates.
 - N. BIM Incorporation: Develop and incorporate Shop Drawing files into BIM established for Project.
- 1.9 ELECTRONIC DRAWING FILES
- A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.
- 1.10 SUBSTITUTIONS
- A. Refer to Division 01 and General Conditions for substitutions in addition to requirements specified herein.

- B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.
- D. Request for Substitution:
 - 1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
 - 2. The burden of proof of the merit of the proposed substitution is upon the proposer.
 - 3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:
 - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
 - b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
 - c. Proposed substitution has received necessary approvals of authorities having jurisdiction.
 - d. Same warranty will be furnished for proposed substitution as for specified Work.
 - e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
 - f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.
- E. Substitution Consideration:
 - 1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
 - 2. No substitution will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.
 - 3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
 - 4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.
- B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.
- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Prior to Substantial Completion of the project, furnish to the Architect, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.
- E. Each manual shall contain data listed in Table 5.
- F. Refer to Division 01 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives.

1.12 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections in Division 22 of this specification. Refer to Table 2 at the end of this section for a list of specification sections in Division 22 that contain spare parts requirements.
- B. Owner or Owner's representative shall initial and date each section line in Table 2 when the specified spare parts for that section are received and shall sign at the bottom when all spare parts have been received.

1.13 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.
- B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension, from column lines.

- C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.

1.14 TRAINING

- A. Provide training as indicated in each specific section. Schedule training with the Owner at least 7 days in advance. Video tape the training sessions in format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

1.15 PAINTING

- A. Exposed ferrous surfaces, including pipe, pipe hangers, equipment stands and supports and exposed insulated piping shall be painted by the Plumbing Contractor using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.
- B. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.
- C. Where factory finishes are provided and no additional field painting is specified, marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish.

1.16 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.
- B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.
- D. The Contractor shall be responsible for the safe storage of his own tools, material and equipment.

1.17 GUARANTEES AND WARRANTIES

- A. Refer to Division 01 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.
- B. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific

items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.

- C. The following additional items shall be guaranteed:
 - 1. Piping shall be free from obstructions, holes or breaks of any nature.
 - 2. Insulation shall be effective.
 - 3. Proper circulation of fluid in each piping system.
- D. The above guarantees shall include both labor and material; and repairs or replacements shall be made without additional cost to the Owner.
- E. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.
- F. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed to the Owner and stating the commencement date and term. Refer to Table 3 at the end of this section for a list of specification sections in Division 22 that contain special warranties.

1.18 PROJECT CONDITIONS

- A. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Provide clean sand, pea gravel or flowable fill material (per the geotechnical engineer's or structural engineer's recommendations).
- B. Subbase Material: Where applicable, provide natural soils with 10% by volume of rocks less than 2" diameter or artificially crushed aggregate. Corrosive fill materials shall not be utilized. When CL clay, rock, or gravel is used, it shall not be larger than 2 inches in any dimension and be free of debris, waste, frozen materials, vegetable and other deleterious matter.
- C. Drainage Fill: Provide washed, evenly graded mixture of ¾" open graded aggregate stone or gravel, around drainage pipes to a level above pipe as detailed by Architect. Provide open graded aggregate, crushed stone, crushed or uncrushed gravel with 100 percent passing a 1-1/2-inch sieve, and not more than 5 percent passing a No. 4 sieve for drainage fill to subgrade or around equipment structures.
- D. Filter Fabric: Flat needle punched PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. (4,480 to 13,440 L/min. per sq. m) when tested according to ASTM D 4491.

PART 3 - EXECUTION

3.1 PERMITS

- A. Secure and pay for permits required in connection with the installation of the Plumbing Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.2 ACCEPTANCE TESTING REQUIREMENTS

- A. Perform acceptance test procedures in accordance with the specifications listed in the Reference Joint Appendices for the Building Energy Efficiency Standards of California. Reference the Non-Residential Certificate of Compliance (NRCC) forms on the drawings for the systems which shall be tested.
- B. Submit Non-Residential Certificate of Acceptance (NRCA) forms for each system for which the CMATT is responsible.

3.3 EXISTING UTILITIES

- A. Schedule and coordinate with the Utility Company, Owner and with the Engineer connection to, or relocation of, or discontinuation of normal utility services from existing utility lines. Premium time required for any such work shall be included in the bid.
- B. Existing utilities damaged due to the operations of utility work for this project shall be repaired to the satisfaction of the Owner or Utility Company without additional cost.
- C. Utilities shall not be left disconnected at the end of a work day or over a weekend unless authorized by representatives of the Owner or Engineer.
- D. Repairs and restoration of utilities shall be made before workmen leave the project at the end of the workday in which the interruption takes place.
- E. Contractor shall include in his bid the cost of furnishing temporary facilities to provide services during interruption of normal utility service.

3.4 EXCAVATION AND BACKFILLING

- A. Refer to Division 01, Division 02, and Division 31, Geotechnical Soils Report and General Conditions for Excavation and Backfilling in addition to the requirements specified herein.
- B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this Division. Excavation shall be in conformance with applicable Division and section of the General Specifications.
- C. Roads, alleys, streets and sidewalks damaged during this work shall be restored to the satisfaction of Authorities Having Jurisdiction.
- D. Trenches close to walks or columns shall not be excavated without prior consultation with the Architect.

- E. Erect barricades around excavations. Provide an adequate number of amber lights on or near the work and keep them burning from dusk to dawn. The Contractor shall be held responsible for any damage that any parties may sustain due to neglecting the necessary precautions when performing the work.
- F. Slope sides of excavations to comply with local, state and federal codes and ordinances. Shore and brace as required for stability of excavation.
- G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
 - 1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.
- H. Install sediment and erosion control measures in accordance with local codes and ordinances.
- I. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and trenches.
 - 1. Do not allow water to accumulate in excavations and trenches. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
 - 2. Establish and maintain temporary drainage ditches and other diversions outside excavation and trench limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.
- J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.
 - 1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
 - 2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.
- K. Excavation for Underground Tanks, Basins, and Plumbing Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.
 - 1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.
 - 2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.

L. Trenching: Excavate trenches for Plumbing installations as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of pipe and equipment.
2. Excavate trenches to depth indicated or required for piping to establish indicated slope and invert elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.
3. Limit the length of open trench to that in which pipe can be installed, tested, and the trench backfilled within the same day.
4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of pipe. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and pipe.
5. Excavate trenches for piping and equipment with bottoms of trench to accurate elevations for support of pipe and equipment on undisturbed soil.

M. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35°F.

N. Bedding:

1. Fill bottom of pipe trench and fill unevenness with compacted bedding material to ensure continuous bearing of the pipe barrel on the bearing surface. Additional bedding installation requirements are in the following piping specifications. Compact bedding as described below:
2. Fill bottom of equipment trench and fill unevenness with compacted sand backfill to ensure continuous bearing of the equipment on the bearing surface. Compact bedding as described below.

O. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
2. Under building slabs, use drainage fill materials.
3. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
4. For piping less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support after installation and testing of piping and prior to backfilling and placement of roadway subbase. Coordinate with AHJ for colored concrete requirements.
5. Other areas, use excavated or borrowed materials.

P. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval, and locations of underground utilities have been recorded.
 2. Removal of concrete formwork.
 3. Removal of shoring and bracing, and backfilling of voids.
 4. Removal of trash and debris.
- Q. Drainage Fill: Where building fill is used in lieu of natural soils, provide drainage fill as subbase material. Provide filter fabric material to line the trench to support the bedding material and subbase materials to ensure that backfill materials will not segregate within the trench nor create voids and sags within the pipe trench.
- R. Placement and Compaction: Place subgrade backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- S. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- T. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of piping and equipment by carrying material uniformly around them to approximately same elevation in each lift.
- U. Compaction: Place bedding backfill materials in maximum layers of not more than 6 inches loose depth for material compacted by hand-operated tampers. Place subbase backfill materials in maximum layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers. Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.
1. Use of pneumatic backhoe as compaction method is not allowed as an acceptable process for compaction of excavations or trenches.
 2. For vertical and/or diagonal pipe installations greater than ½" rise/lf, thoroughly support pipes from permanent concrete structures or undisturbed earth at no less than 10-foot intervals, while placing backfill materials, so that pipes are not deflected, crushed, broken, or otherwise damaged by the backfill placement or settlement.
 3. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
 4. Place backfill and/or drainage fill materials evenly adjacent to structures, piping, and equipment to required elevations. Coordinate with Architect and/or Civil Engineer backfill

requirements prior to installation. Prevent displacement of pipes and equipment by carrying material uniformly around them to approximately same elevation in each layer or lift.

5. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 or ASTM D 698 and not less than the following percentages of relative density, determined in accordance with ASTM D 4253, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).
 - a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - c. Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.
 - V. Subsidence: Where subsidence occurs at Plumbing installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.
 - W. Additional Excavation: Where additional excavation may be required due to unsuitable bearing materials encountered, notify the architect immediately for resolution.
- 3.5 CUTTING AND PATCHING
- A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.
 - B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.
 - C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.
 - D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.
 - E. Patch around openings to match adjacent construction, including fire ratings, if applicable.
 - F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

- G. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.

3.6 CLEANING

- A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Plumbing Contractor shall cooperate in maintaining reasonably clean premises at all times.
- B. Immediately prior to the final inspection, the Plumbing Contractor shall clean material and equipment installed under the Plumbing Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.7 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:
 - 1. Submit complete Operation and Maintenance Manuals.
 - 2. Submit complete Record Drawings.
 - 3. Perform special inspections. Refer to Table 4 at the end of this section for a list of specification sections in Division 22 that contain special inspection requirements.
 - 4. Start-up testing of systems.
 - 5. Removal of temporary facilities from the site.
 - 6. Comply with requirements for Substantial Completion in the "General Conditions".
- B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.
- C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, He shall reimburse the Architect/Engineer for time and expenses incurred for the visit.
- F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.
- G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

- H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. He shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF DOCUMENT 220010

TABLE 1: PLUMBING SPECIFICATION SHOP DRAWING SUBMITTAL REQUIREMENTS

SPECIFICATION NUMBER/TITLE		CODE DESIGNATION
220010	General Plumbing Requirements	NONE
220015	Coordination	NONE
220500	Common Work Results For Plumbing	A, B, G, M
220513	Common Motor Requirements For Plumbing Equipment	B
220515	Basic Piping Materials And Methods	B, G
220519	Meters And Gauges For Plumbing Piping	B, H
220523	General-Duty Valves For Plumbing Piping	B
220529	Hangers And Supports For Plumbing Piping	B, F, G, H
220553	Identification For Plumbing Piping & Equipment	B, L, M
220700	Plumbing Insulation	B, M
221100	Water Distribution Piping & Specialties	B, G, H
221111	Mechanically Joined Plumbing Piping Systems	B, G, H
221123	Domestic Water Pumps	A, B, C, E
221300	Sanitary Drainage & Vent Piping & Specialties	B
221400	Storm Drainage Piping & Specialties	B
223400	Fuel Fired Domestic Water Heaters	B, C, E, F, H, K
224000	Plumbing Fixtures	B, E, N
227000	Natural Gas Systems	A, B, C, D, F, G
227010	Mechanically Joined Natural Gas Piping Systems	B, F, H, N

CODED LEGEND

A	Shop Drawings
B	Product Data and equipment weights
C	Performance Data, Curves, Certificates and Test Data
D	Coordination Drawings
E	Wiring Diagrams and short circuit current ratings
F	Installation Instructions
G	Welder's Certificates
H	Certificates
I	Calculations
J	Special Inspections
K	Special Warranties
L	Material Samples
M	Schedules
N	Recommended Spare Parts List

TABLE 2: SPARE PARTS REQUIREMENTS FOR PLUMBING EQUIPMENT

SECTION NUMBER		RECEIVED/DATE/INITIAL
220553	Identification For Plumbing Piping & Equipment	_____
221100	Water Distribution Piping & Specialties	_____
221111	Mechanically Joined Plumbing Piping Systems	_____
221123	Domestic Water Pumps	_____
224000	Plumbing Fixtures	_____
227000	Natural Gas Systems	_____

Owner's Signature

TABLE 3: SPECIAL WARRANTY REQUIREMENTS FOR PLUMBING EQUIPMENT

<u>SECTION NUMBER</u>	<u>RECEIVED/DATE/INITIAL</u>
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223400 Fuel Fired Domestic Water Heaters	_____
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TABLE 4: SPECIAL INSPECTION REQUIREMENTS FOR PLUMBING EQUIPMENT

<u>SECTION NUMBER</u>	<u>COMPLETED/DATE/INITIAL</u>
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TABLE 5: PLUMBING SPECIFICATION OPERATION AND MAINTENANCE SUBMITTAL REQUIREMENTS

SPECIFICATION NUMBER/TITLE		CODE DESIGNATION
220500	Common Work Results For Plumbing	B
220513	Common Motor Requirements For Plumbing Equipment	B
220515	Basic Piping Materials And Methods	B
220519	Meters And Gauges For Plumbing Piping	B, G, I
220523	General-Duty Valves For Plumbing Piping	B, H, I
220529	Hangers And Supports For Plumbing Piping	B
220553	Identification For Plumbing Piping & Equipment	B
220700	Plumbing Insulation	B
221100	Water Distribution Piping & Specialties	A, B, F, H, I
221111	Mechanically Joined Plumbing Piping Systems	A, B, F, H, I
221123	Domestic Water Pumps	B, C, D, E, G, H, I
221300	Sanitary Drainage & Vent Piping & Specialties	A, B, F
221400	Storm Drainage Piping & Specialties	A, B, F
223400	Fuel Fired Domestic Water Heaters	B, C, D, E, G, H, I
224000	Plumbing Fixtures	B, E, H, I
227000	Natural Gas Systems	A, B, C, H
227010	Mechanically Joined Natural Gas Piping Systems	B, F, H

CODED LEGEND

A	As-Built Drawings
B	Product Data
C	Performance Data, Capacities, Curves and Certificates
D	Wiring Diagrams
E	Operating Instructions
F	Test Reports
G	Warranties
H	Recommended Spare Parts List
I	Service and Maintenance Instructions

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER

Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

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

Reason for not providing specified item: _____

Similar Installation:

Project: _____ Architect: _____

Address: _____ Owner: _____

Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

- ▲ A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
- B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
- C. Proposed substitution does not affect dimensions and functional clearances.
- D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
- E. Same warranty will be furnished for proposed substitution as for specified Work.
- F. Same maintenance service and source of replacement parts, as applicable, is available.
- G. Proposed substitution will not adversely affect other trades or delay construction schedule.
- H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

_____ Submitting Contractor	_____ Date	_____ Company
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Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

_____ Manufacturer's Representative	_____ Date	_____ Company
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Engineer Review and Recommendation Section

Recommend Acceptance	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Additional Comments:	<input type="checkbox"/> Attached	<input type="checkbox"/> None	

Acceptance Section:

_____ Contractor Acceptance Signature	_____ Date	_____ Company
_____ Owner Acceptance Signature	_____ Date	_____ Company
_____ Architect Acceptance Signature	_____ Date	_____ Company
_____ Engineer Acceptance Signature	_____ Date	_____ Company

DOCUMENT 220015 - COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies the basic requirements for electrical components which are an integral part of packaged plumbing equipment. These components include, but are not limited to factory furnished motors, starters, and disconnect switches furnished as an integral part of packaged plumbing equipment.
- B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for plumbing equipment are scheduled on the Drawings.
- C. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.2 SUBMITTALS

- A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification Sections.

1.3 QUALITY ASSURANCE

- A. Electrical components and materials shall be UL labeled.
- B. All electrical equipment provided and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section and Division 26.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The Contractors shall provide all motors, starters, disconnects, wire, conduit, etc. as specified in the Construction Documents. If, however, the Plumbing Contractor furnishes a piece of equipment requiring a different motor, starter, disconnect, wire size, etc. than what is shown and/or intended on the Construction Documents, the Plumbing Contractor shall coordinate the requirements with any other Contractor and shall be responsible for any additional cost incurred by any other Contractor that is associated with installing the different equipment and related accessories for proper working condition.
- B. Refer to Division 26, "Common Work Results for Electrical" for specification of motor connections
- C. Refer to Division 26, "Enclosed Switches and Circuit Breakers" for specification of disconnect switches.

PART 3 - EXECUTION

3.1 CONTRACTOR COORDINATION

- A. Unless otherwise indicated, all motors, equipment, controls, etc. shall be furnished, set in place and wired in accordance with Table 1. Any items not listed but shown on the drawings shall be considered part of the Contract Documents and brought to the attention of the Architect.
- B. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Engineer.

TABLE 1: ELECTRICAL REQUIREMENTS FOR PLUMBING EQUIPMENT

ITEM	FURN BY	SET BY	POWER WIRING	CONTROL WIRING
Equipment motors	DIV 22	DIV 22	DIV 26	---
Loose motor starters, disconnect switches, thermal overloads and heaters.	DIV 26	DIV 26	DIV 26	DIV 23
Thermostats (line voltage)	DIV 22	DIV 22	DIV 26	---
Time switches	DIV 22	DIV 22	DIV 26	DIV 23
Motor and solenoid operated valves	DIV 22	DIV 22	DIV 23	DIV 23

DIV 22 = Plumbing Contractor

DIV 26 = Electrical Contractor

DIV 23 = Building Automation System Contractor, refer to Division 23 Section "Direct-Digital Control for HVAC".

END OF DOCUMENT 220015

DOCUMENT 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes limited scope general construction materials and methods for application with Plumbing installations as follows:
1. Access panels and doors in walls, ceilings, and floors for access to Plumbing materials and equipment.
 2. Plumbing equipment nameplate data.
 3. Concrete for bases and housekeeping pads.
 4. Non-shrink grout for equipment installations.
 5. Sleeves for Plumbing penetrations.
 6. Miscellaneous metals for support of Plumbing materials and equipment.
 7. Wood grounds, nailers, blocking, fasteners, and anchorage for support of Plumbing materials and equipment.
 8. Joint sealers for sealing around Plumbing materials and equipment.
 9. Plenum insulation for enclosure of combustible items located within fire-rated return air plenums.
- B. Related Sections: The following sections contain requirements that relate to this Section:
1. Division 7 Section "Penetration Firestopping" for material and methods for firestopping systems.
 2. Division 22 Section "Basic Piping Materials and Methods" for materials and methods for mechanical sleeve seals.
 3. Division 22 Section "Sanitary Drainage and Vent Piping and Specialties" for indirect drain piping and installation requirements.
 4. Division 23 Section "Direct Digital Controls for HVAC" for integration with building automation system of leak detection system "Water Present" alarm.
 5. Division 26 Section "Common Work Results for Electrical" required electrical devices.
 6. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.2 SUBMITTALS

- A. General: Submit the following in accordance with Division 1 and Division 22 Section "General Plumbing Requirements".
 - 1. Product data for the following products:
 - a. Access panels and doors.
 - b. Through and membrane-penetration firestopping systems.
 - c. Joint sealers.
 - 2. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for Plumbing materials and equipment.
 - 3. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.
 - 4. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
 - a. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 1 Section "Summary of Work."
 - 5. Through and Membrane Penetration Firestopping Systems Product Schedule: Submit a schedule for each piping system penetration that includes UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.
 - a. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.3 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel".
 - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- B. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.
 - 1. Provide UL Label on each fire-rated access door.

- C. Through and Membrane Penetration Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

PART 2 - PRODUCTS

2.1 ACCESS TO EQUIPMENT

A. Manufacturer:

1. Bar-Co., Inc.
2. Elmdor Stoneman.
3. JL Industries
4. Jay R. Smith Mfg. Co.
5. Karp Associates, Inc.
6. Milcor
7. Nystrom Building Products
8. Wade
9. Zurn

B. Access Doors:

1. Provide access doors for all concealed equipment, except where above lay-in ceilings. Refer to Section "Identification for Plumbing Piping" for labeling of access doors.
2. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
3. Access doors must be of the proper construction for type of construction where installed.
4. The exact location of all access doors shall be verified with the Architect prior to installation.
5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.

6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
 - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.
 - b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.
 - c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.
7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
 - a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
8. Locking Devices: Flush, screwdriver-operated cam locks.
9. Locking Devices: Where indicated on the drawings or where access panels are installed in locations accessible to the public, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

2.2 PLUMBING EQUIPMENT NAMEPLATE DATA

- A. For each piece of power operated Plumbing equipment, provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance's, and similar essential data. Locate nameplates in an accessible location.

2.3 CONCRETE EQUIPMENT BASES/HOUSEKEEPING PADS

- A. Provide concrete equipment bases and housekeeping pads for various pieces of floor mounted Plumbing equipment.. Concrete equipment bases/housekeeping pads shall generally conform to the shape of the piece of equipment it serves with a minimum 4" margin around the equipment and supports.
- B. Form concrete equipment bases and housekeeping pads using framing lumber or steel channel with form release agent. Chamfer top edges and corners. Trowel tops and sides of each base/pad to a smooth finish, equal to that of the floors.
- C. Concrete equipment bases and housekeeping pads shall be made of a minimum 28 day, 4000 psi concrete conforming to American Concrete Institute Standard Building Code for Reinforced Concrete (ACI 318-99) and the latest applicable recommendations of the ACI standard practice manual. Concrete shall be composed of cement conforming to ASTM C 150 Type I, aggregate conforming to ASTM C33, and potable water. All exposed exterior concrete shall contain 5 to 7 percent air entrainment.
- D. Unless otherwise specified or shown on the structural drawings, reinforce equipment bases and housekeeping pads with No. 4 reinforcing bars conforming to ASTM A 615 or 6x6 – W2.9 x

W2.9 welded wire mesh conforming to ASTM A185. Reinforcing bars shall be placed 24" on center with a minimum of two bars each direction.

- E. Provide galvanized anchor bolts for all equipment placed on concrete equipment bases and housekeeping pads or on concrete slabs. Anchor bolts size, number and placement shall be as recommended by the Manufacturer of the equipment.
- F. Concrete equipment bases and housekeeping pads shall have minimum heights in accordance with the following table:

Equipment	Minimum Height
Water Heaters, Water Softeners and Equipment Less than or equal to 20 tons and Other Equipment Not Listed – Note 1	3-1/2"

NOTES:

- 1. Height of equipment bases applies to equipment installed on slab-on-grade. For equipment installed on floors above grade and/or roof, reference the drawings.

2.4 GROUT

- A. Provide nonshrink, nonmetallic grout conforming to ASTM C 1107, Grade B, in premixed and factory-packaged containers.
- B. Grout shall have post-hardening, volume-adjusting, dry, non-staining, non-corrosive, non-gaseous, hydraulic-cement characteristics and shall be as recommended by manufacturer for interior and exterior applications.
- C. Grout shall have 5,000 psi, 28-day compressive strength design mix.

2.5 PENETRATIONS

- A. Sleeves:
 - 1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.
 - 2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.
- B. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.
- C. Box Frames: Frames for rectangular openings shall be of welded 12 gauge steel attached to forms and of a maximum dimension established by the Architect. Contractor shall notify the General

Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

2.6 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
- B. Cold-Formed Steel Tubing: ASTM A 500.
- C. Hot-Rolled Steel Tubing: ASTM A 501.
- D. Steel Pipe: ASTM A 53, Schedule 40, welded.
- E. Fasteners: Zinc-coated, type, grade, and class as required.

2.7 MISCELLANEOUS LUMBER

- A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPB rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.
- B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 15/32 inches.

2.8 JOINT SEALERS

- A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- B. Colors: As selected by the Architect from manufacturer's standard colors.
- C. Elastomeric Joint Sealers: Provide the following types:
 - 1. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer. Provide one of the following:
 - a. "Dow Corning 790," Dow Corning Corp.
 - b. "Silglaze II SCS 2801," General Electric Co.
 - c. "Silpruf SCS 2000," General Electric Co.
 - d. "864," Pecora Corp.
 - e. "Rhodia 5C," Rhone-Poulenc, Inc.
 - f. "Spectrem 1," Tremco, Inc.
 - g. "Spectrem 2," Tremco, Inc.

- h. "Dow Corning 795," Dow Corning Corp.
 - i. "Rhodia 7B," Rhone-Poulenc, Inc.
 - j. "Rhodia 7S," Rhone-Poulenc, Inc.
 - k. "Omniseal," Sonneborn Building Products Div.
- 2. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, metal or porcelain plumbing fixtures and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide one of the following:
 - a. "Dow Corning 786," Dow Corning Corp.
 - b. "Sanitary 1700," General Electric Co.
 - c. "898 Silicone Sanitary Sealant," Pecora Corp.
- D. Acrylic-Emulsion Sealants: One-part, nonsag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent. Provide one of the following:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. "Chem-Calk 600," Bostik Construction Products Div.
 - b. "AC-20," Pecora Corp.
 - c. "Sonolac," Sonneborn Building Products Div.
 - d. "Tremflex 834," Tremco, Inc.

2.9 PLENUM INSULATION

- A. General: Combustible materials including, but not limited to, plastic pipe and plastic-coated cables that do not meet the minimum combustibility requirements of the applicable building codes may be installed in fire-rated return air plenums when enclosed within high-temperature insulation blanket where approved by the authority having jurisdiction.
- B. Material: FyreWrap 0.5 Plenum Insulation, ETS Schaefer Plenumshield Blanket, or equivalent utilizing light weight, high temperature blanket enhanced for biosolubility. The encapsulating material shall be aluminum foil with fiberglass reinforcing scrim covering.
- C. Certification: Plenum insulation shall have an encapsulated flame spread rating less than 25 and a smoke developed rating of less than 50. The product shall be UL 1887 (Modified) listed, certified by ASTM E-136 for Non-combustibility and ASTM E-84/UL 723 for Surface Burning Characteristics.

- D. Physical Properties: Plenum insulation shall be single ½" layer with a density of 6 to 8 pounds per cubic foot.

2.10 FIRESTOPPING

- A. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, or other NRTL acceptable to AHJ. Manufactured by:
 - 1. 3M Corp., Fire Barrier Sealant
 - 2. Hilti
 - 3. Owens Corning, Firestopping Insulation.
 - 4. Pecora, AC-20 FTR
 - 5. RectorSeal
 - 6. Specified Technologies Inc.,
 - 7. United States Gypsum Company SHEETROCK Firecode Compound
 - 8. Tremco, Tremstop Fyre-Sil.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install plenum insulation, access doors and sealants in accordance with manufacturer's installation instructions.

3.2 INSTALLATION OF ACCESS DOORS

- A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- B. Adjust hardware and panels after installation for proper operation.

3.3 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor Plumbing materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.4 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor Plumbing materials and equipment.

- B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

- C. Attach to substrates as required to support applied loads.

3.5 PREPARATION FOR JOINT SEALERS

- A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
- B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.6 APPLICATION OF JOINT SEALERS

- A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - 1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
 - 2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.
- B. Tooling: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.7 PENETRATIONS:

- A. New Construction:
 - 1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support piping or ductwork penetrations.
- B. Construction in Existing Facilities:
 - 1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.
- C. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.
- D. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.

- E. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.
- F. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.
- G. Cut sleeves to length for mounting flush with both surfaces of walls.
- H. Extend sleeves installed in floors 2 inches above finished floor level.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
- J. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.
- K. All openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 22 Section "Basic Piping Materials and Methods".

3.8 PLENUM INSULATION

- A. General: Plenum insulation shall be installed as a single layer encapsulation applied directly on the surface of combustible items within fire-rated return air plenums where permitted by the local authority having jurisdiction
- B. Overlap: Provide a minimum 1" perimeter and longitudinal overlap at all seams and joints. Seal all cut edges with aluminum foil tape. There shall be no exposed fiber.
- C. Secure Attachment: Securely attach insulation using stainless steel tie wire or banding at locations and intervals as recommended by the manufacturer. The entire installation shall comply with the manufacturer's written installation instructions.
- D. Approval: Plenum insulation shall not be installed where not allowed by local authority having jurisdiction. Do not install combustible material within fire-rated return air plenums where the use of plenum insulation is not approved.

END OF DOCUMENT 220500

DOCUMENT 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:

1. Single phase electric motors.

1.2 SUBMITTALS

- A. General: Submit the following in accordance with conditions of contract and Division 1 specification Sections.

1. Product Data: Show nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, and grounding lug; and coatings.

1.3 QUALITY ASSURANCE

- A. All motors shall be UL listed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Century
- B. General Electric
- C. Westinghouse
- D. Baldor
- E. Gould

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Motors Less Than 250 Watts, for Intermittent Service: Provide equipment manufacturer's standard. Motor's need not conform to these specifications.
- B. Electrical Service: All motors shall be supplied in accordance with the following voltage and phase unless noted otherwise on the Drawings.
 - 1. Motors 1/2 HP and Smaller: 120 volts, single phase, 60 Hz.
- C. Type:
 - 1. Open drip-proof except where noted otherwise.
 - 2. Motors: Design for continuous operation in 40 degrees C environment.

3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 4. Motors with frame sizes 254T and larger: Energy Efficient Type.
- D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- E. Wiring Terminations:
1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 2. For fractional horsepower motors, provide flexible conduit connection in end frame. Maximum length of flexible conduit shall be five feet.
- 2.3 SINGLE PHASE POWER - SPLIT PHASE MOTORS
- A. Starting Torque: Less than 150 percent of full load torque.
 - B. Starting Current: Up to seven times full load current.
 - C. Breakdown Torque: Approximately 200 percent of full load torque.
 - D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
 - E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.
- 2.4 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS
- A. Starting Torque: Exceeding one fourth of full load torque.
 - B. Starting Current: Up to six times full load current.
 - C. Multiple Speed: Through tapped windings.
 - D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.
- 2.5 SINGLE PHASE POWER - CAPACITOR START MOTORS
- A. Starting Torque: Three times full load torque.
 - B. Starting Current: Less than five times full load current.
 - C. Pull-up Torque: Up to 350 percent of full load torque.
 - D. Breakdown Torque: Approximately 250 percent of full load torque.

- E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated ball bearings.
- G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.6 CAPACITORS

- A. Furnish capacitors for power factor correction as specified herein on motors furnished under Division 22 that are not connected to variable frequency drives. KVAR size shall be as required to correct motor power factor to 90 percent or better and shall be installed on all motors 1 horsepower and larger, that have an uncorrected power factor of less than 85 percent at rated load.
- B. Features:
 - 1. Individual unit cells.
 - 2. All welded steel housing.
 - 3. Each capacitor internally fused.
 - 4. Non-flammable synthetic liquid impregnated.
 - 5. Craft tissue insulation.
 - 6. Aluminum foil electrodes.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Single phase motors for pumps and air compressors: Capacitor start type.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation.
- C. Check line voltage and phase and ensure agreement with nameplate.

3.3 NEMA OPEN MOTOR SERVICE FACTOR SCHEDULE

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6-1/3	1.35	1.35	1.35	1.35

END OF DOCUMENT 220513

DOCUMENT 220515 - BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies piping materials and installation methods common to more than one Section of Division 22 and includes joining materials, piping specialties and basic piping installation instructions.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 22 Section "Common Work Results for Plumbing," for materials and methods for sleeve materials.

1.2 DEFINITIONS

- A. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content $\leq 0.25\%$ per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.3 SUBMITTALS

- A. Refer to Division 1 and Division 22 Section "General Plumbing Requirements" for administrative and procedural requirements for submittals.
- B. Product Data: Submit product data on the following items:
 - 1. Escutcheons
 - 2. Dielectric Unions
 - 3. Dielectric Waterway Fittings
 - 4. Dielectric Flanges and Flange Kits
 - 5. Strainers
- C. Quality Control Submittals:
 - 1. Submit welders' certificates specified in Quality Assurance below.
- D. Submit certification that specialties and fittings for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.
- E. Submit a schedule of dissimilar metal joints and dielectric waterway fittings, unions, flanges or flange kits. Include joint type materials, connection method and proposed dielectric waterway fittings, unions and flanges to isolate dissimilar metals. Include minimum and maximum torque requirements for flange connections to valves. Refer to the individual piping system specification sections in Division 22 for specifications for piping materials and fittings relative to that particular system and additional requirements.

- F. Submit certification that fittings and specialties are manufactured in plants located in the United States or certified that they comply with applicable ANSI and ASTM standards.

1.4 QUALITY ASSURANCE

- A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
- B. Welding procedures and testing shall comply with ANSI Standard B31.9 - Standard Code for Building Services Piping and The American Welding Society, Welding Handbook.
- C. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Plumbing Refrigeration.
- D. Pipe specialties and fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.
- E. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide piping materials and specialties from one of the following:
 - 1. Pipe Escutcheons:
 - a. AWI Manufacturing.
 - b. Keeney Manufacturing Company
 - c. Wal-Rich Corp.
 - d. Jones Stephens Corp.
 - 2. Dielectric Waterway Fittings:
 - a. Elster Perfection Corporation..
 - b. Grinnell Mechanical Products; Tyco Fire Products LP
 - c. Precision Plumbing Products, Inc.
 - 3. Dielectric Unions:
 - a. JOMAR International
 - b. Smith Cooper International

- c. Watts Regulator Co.
 - d. Zurn Industries
- 4. Dielectric Flanges and Flange Kits:
 - a. Advance Products & Systems
 - b. Calpico, Inc.
 - c. FMC Technologies
 - d. Pipeline Seal & Insulator, Inc.
 - e. Tampa Rubber and Gasket Co., inc.
 - f. Watts Industries Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
- 5. Strainers – 2" and smaller:
 - a. Apollo
 - b. Hammond
 - c. Milwaukee
 - d. NIBCO
- 6. Strainers – 2-1/2" and larger:
 - a. Metraflex Co.
 - b. Watts Regulator Co.
 - c. Zurn Industries, Inc.; Wilkins Div.

2.2 PIPE AND FITTINGS

- A. Refer to the individual piping system specification sections in Division 22 for specifications on piping and fittings relative to that particular system.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 22 Piping Sections for special joining materials not listed below.
- B. Welding Materials: AWS D10.12; Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

- C. Brazing Materials: AWS A5.8; Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.
- D. Soldering Materials: ASTM B32; Refer to individual piping system specifications for solder appropriate for each respective system.
- E. Gaskets for Flanged Joints: ASME B16.21; Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select materials to suit the service of the piping system in which installed and which conform to their respective ANSI Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.4 PIPING SPECIALTIES

- A. Escutcheons: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated and of depth adequate to conceal protruding piping. Outside diameter shall completely cover the opening in floors, walls, or ceilings.
- B. Unions:
 - 1. Malleable-iron, Class 150 for low pressure service and class 300 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.
 - 2. Bronze, Class 125, with lead free cast bronze body meeting ASTM B584, for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; solder or female threaded ends.
- C. Dielectric Unions: Factory-fabricated with lead free cast bronze body meeting ASTM B584 and galvanized steel body with plastic dielectric gasket, class 125 for low pressure service and class 250 for high pressure service, and appropriate end connections for the pipe materials in which installed (screwed or soldered) to effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.
- D. Dielectric Waterway Fittings: Electroplated steel or brass nipple, with an inert and non-corrosive, thermoplastic lining.
- E. Dielectric Flanges and Flange Kits:
 - 1. Full faced gasket with same outside diameter and bolt hole arrangement as the flange. Pressure rating of 200psi for low pressure service and 400 psi for high pressure service at a continuous operating temperature of 180F.
 - 2. Steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.
 - 3. Lead free cast bronze meeting ASTM B584, class 125 solder type or cast iron class 125 threaded type for low pressure service and bronze class 250 solder type or cast iron class 250 threaded type for high pressure service.

- F. Y-Type Strainers: Provide strainers full line size of connecting piping, with ends matching piping system materials. Screens for 4" and smaller shall be Type 304 stainless steel mesh with 0.062" perforations and screens for 5" and larger shall be Type 304 stainless steel, with 0.125" perforations.
1. For low pressure applications, cast iron strainers shall have 125 psi working pressure rating and cast bronze strainers shall have 150 psi working pressure rating. For high pressure applications, cast iron strainers shall have 250 psi working pressure rating and cast bronze strainers shall have 300 psi working pressure rating.
 2. Solder Ends, 2" and Smaller: Lead free cast bronze body meeting ASTM B584, screwed screen retainer with centered blowdown fitted with pipe plug.
 3. Flanged Ends, 2-1/2" and Larger: Cast-iron body, with FDA fused epoxy coating, bolted screen retainer with off-center blowdown fitted with pipe plug.
- G. Sleeves:
1. Sleeve: Refer to Division 22 Section "Common Work Results for Plumbing" for sleeve materials.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's installation instructions.

3.2 PREPARATION

- A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.3 INSTALLATIONS

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.
- B. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated otherwise.
- C. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.
- D. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.

- E. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- F. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- G. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.
- H. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.
- I. Verify final equipment locations for roughing in.

3.4 PIPING PROTECTION

- A. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

3.5 PENETRATIONS

- A. Plumbing penetrations occur when piping penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies.
- B. Provide escutcheons for exposed pipe penetrations of interior floors, walls, ceilings and under cabinets and millwork. Use deep pattern escutcheons where required.
- C. Above Grade Concrete or Masonry Penetrations
 - 1. Provide sleeves for pipes passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:
 - a. Provide schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.
 - b. Provide galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 10 gauge (0.1382 inches).
 - c. Provide welded galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:
 - 1) For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 18 gauge (0.052 inches).
 - 2) For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 10 gauge (0.1382 inches).

- d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.
 - 2. Extend pipe insulation for insulated pipe through floor, wall and roof penetrations, including fire rated walls and floors. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.
 - 3. Seal elevated floor, exterior wall and roof penetrations watertight and weathertight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of ½" of sealant.
- D. Interior Foundation Penetrations: Provide sleeves for horizontal pipe passing through or under foundation. Sleeves shall be cast iron soil pipe two nominal pipe sizes larger than the pipe served.
- E. Concrete Slab on Grade Penetrations:
- 1. Provide schedule 40 PVC pipe sleeves for vertical pressure pipe passing through concrete slab on grade. Sleeves shall be one nominal pipe size larger than the pipe served and two pipe sizes larger than pipe served for ductile iron pipes with restraining rods. Seal watertight with silicone caulk.
 - 2. Provide ½" thick cellular foam insulation around perimeter of non-pressure pipe passing thru concrete slab on grade. Insulation shall extend to 2" above and below the concrete slab.
- F. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and pipe , using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- 1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.
- G. Exterior Wall Penetrations: Seal annular space between sleeve and pipe, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant. Cover exterior sealant with grout, minimum ½" thick and paint grout to match exterior color, with color selection by the architect. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- 1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.
- H. Fire / Smoke Rated Floor and Wall Assemblies: Seal around penetrations of fire rated assemblies to maintain fire resistance rating of fire-rated assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer's UL listing. Refer to Division 22 Section "Common Work Results for Plumbing" for firestoppings and materials.

3.6 FITTINGS AND SPECIALTIES

- A. Use fittings for all changes in direction and all branch connections.
- B. Remake leaking joints using new materials.
- C. Install components with pressure rating equal to or greater than system operating pressure.
- D. Install strainers on the supply side of each control valve, pressure reducing or regulating valve, solenoid valve, mixing valve, backflow preventer and elsewhere as indicated.
- E. Install unions at the final connection to each piece of equipment adjacent to each isolation valve or valve assembly for connections 2" and smaller. Install unions where indicated elsewhere on the drawings.
- F. Install flanges at the final connection to each piece of equipment, adjacent to each isolation valve or valve assembly in piping 2-1/2" and larger. Install flanges at each valve 2-1/2" and larger.
- G. Install dielectric unions for piping 2" and smaller to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum) for copper or brass connected to carbon steel, cast or ductile iron.
- H. Install dielectric flanges for piping 2-1/2" and larger to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum) for copper or brass connected to carbon steel, cast or ductile iron.
- I. Install dielectric unions for piping 2" and smaller to connect piping materials of dissimilar metals in wet piping systems (water) (except do not install dielectric unions in concealed spaces, instead, install dielectric waterway fittings) for copper or brass connected to carbon steel, cast or ductile iron.
- J. Install dielectric flanges for piping 2-1/2" and larger to connect piping materials of dissimilar metals in wet piping systems (water) (except do not install dielectric unions in concealed spaces, instead, install dielectric waterway fittings) for copper or brass connected to carbon steel, cast or ductile iron.
- K. Install dielectric waterway fittings for piping 2" and smaller for copper or brass pipe connections to carbon steel equipment connections.
- L. Install dielectric flanges for piping 2-1/2" and larger for copper or brass pipe connections to carbon steel equipment connections, steel, ductile iron or cast iron valves and fittings.
- M. Dielectric Flange Installation:
 - 1. Provide brass nipples between the equipment connection and dielectric flange for screwed connections. Provide an iron flange for the equipment side and a bronze flange for the copper or brass piping side of the joint.
 - 2. Provide a bronze flange for the copper or brass piping connection to a cast iron, ductile iron or steel flange.

3. Provide full face gasket with pressure rating equal to system served.
4. At each bolt provide, steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.

3.7 JOINTS

A. Steel Pipe Joints:

1. Pipe 2" and Smaller: Thread pipe with tapered pipe threads in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed.
2. Pipe Larger Than 2":
 - a. Weld pipe joints (except for exterior water service pipe) in accordance with ASME Code for Pressure Piping, B31.
 - b. Weld pipe joints of exterior water service pipe in accordance with AWWA C206.
 - c. Install flanges on all valves, apparatus, and equipment. Weld pipe flanges to pipe ends in accordance with ASME B31.9 Code for Building Services Piping. Clean flange faces and install gaskets. Tighten bolts to torque specified by manufacturer of flange and flange bolts, to provide uniform compression of gaskets.

B. Non-ferrous Pipe Joints:

1. Brazed And Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.9 - Standard Code for Building Services Piping and ANSI B9.1 - Standard Safety Code for Plumbing Refrigeration.
2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emory cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.

C. Joints for other piping materials are specified within the respective piping system Sections.

3.8 PIPE FIELD QUALITY CONTROL

- A. Testing: Refer to individual piping system specification sections.
- B. Inspection Report Form: Refer to the inspection report form at the end of this section for inspection data to be completed for each piping system. Submit completed forms to the Owner and Engineer.

END OF DOCUMENT 220515

PLUMBING & PLUMBING PIPING SYSTEMS
INSPECTION REPORT FORM

Project Name: _____
Project No: _____ Contractor Project No. _____
General Contractor: _____
Inspection Date: _____ Temperature: _____

System Inspected

Building: _____
Location/Description: _____
Service: _____

Inspection Results

Time of Inspection: _____
Approval to Insulate: Y N Approval to Cover in Wall: Y N
Approval to backfill Y N

Signatures

Witness: _____ Representing: _____
Witness: _____ Representing: _____
Witness: _____ Representing: _____

Remarks

Contractor Supervisor's signature: _____

DOCUMENT 220519 - METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following types of meters and gauges:

1. Temperature gauges and fittings.
2. Pressure gauges and fittings.

1.2 SUBMITTALS

- A. General: Submit the following in accordance with conditions of Contract and Division 1 Specification Sections.
1. Product data for each type of meter and gauge. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.
 2. Product certificates signed by manufacturers of meters and gauges certifying accuracy under specified operating conditions and products' compliance with specified requirements.
 3. Maintenance data for each type of meter and gauge for inclusion in Operating and Maintenance Manuals specified in Division 1 and Division 22 Section "General Plumbing Requirements."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Glass Tube Industrial Thermometers:
 - a. H. O. Trerice Co.
 - b. Marshalltown Instruments, Inc.
 - c. Miljoco Corporation
 - d. Weiss Instruments, Inc.
 - e. Weksler Instruments Corp.
 - f. Winters Instruments

2. Thermometer Wells: Same as for thermometers.
3. Pressure Gauges:
 - a. Ametek, U.S. Gauge Div.
 - b. Ashcroft Dresser Industries Instrument Div.
 - c. Ernst Gage Co.
 - d. H. O. Trerice Co.
 - e. Marsh Instrument Co., Unit of General Signal.
 - f. Marshalltown Instruments, Inc.
 - g. Miljoco Corporation
 - h. Weiss Instruments, Inc.
 - i. Weksler Instruments Corp.
 - j. WIKA Instruments Corp.
 - k. Winters Instruments
4. Pressure Gauge Accessories: Same manufacturers as for pressure gauges.

2.2 THERMOMETERS, GENERAL

- A. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.
- B. Scale range: Temperature ranges for services listed as follows:
 1. Domestic Hot Water: 30 to 240 deg with 2-degree scale divisions (0 to 115 deg C with 1-degree scale divisions).
 2. Domestic Cold Water: 0 to 100 deg F with 2-degree scale divisions (minus 18 to 38 deg C with 1-degree scale divisions).

2.3 GLASS TUBE INDUSTRIAL THERMOMETERS

- A. Case: Die cast, aluminum finished, in baked epoxy enamel, glass front, spring secured, 9 inches long.
- B. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.
- C. Tube: Non-red color reading, non-toxic organic spirit-filled glass tube, magnifying lens.

- D. Scale: Satin-faced, nonreflective aluminum, with permanently etched markings.
- E. Stem: Copper-plated steel, aluminum or brass, for separable socket, length to suit installation.

2.4 THERMOMETER WELLS

- A. Thermometer Wells: Brass or stainless steel, pressure rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

2.5 PRESSURE GAUGES

- A. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube type, bottom connection.
- B. Case: Cast aluminum or stainless steel case, glass lens, 4-1/2-inches diameter.
- C. Connector: Brass, 1/4-inch NPS.
- D. Scale: White coated aluminum, with permanently etched markings.
- E. Accuracy: Plus or minus 1 percent of range span.
- F. Range: Conform to the following:
 - 1. Vacuum: 30 inches Hg to 15 psi.
 - 2. All fluids: 2 times operating pressure.
- G. Liquid-Filled: Provide liquid filled gauges where specified in Part 3 of this section.

2.6 PRESSURE GAUGE ACCESSORIES

- A. Snubber: 1/4-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

PART 3 - EXECUTION

3.1 THERMOMETERS INSTALLATION

- A. Install in the following locations and elsewhere as indicated:
 - 1. At outlet of each domestic water heater.
- B. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

3.2 INSTALLATION OF PRESSURE GAUGES

- A. Install in the following locations, and elsewhere as indicated:
 - 1. Provide liquid-filled gauge at suction and discharge of each pump.

2. At discharge of each pressure-reducing valve.
 3. At building water service entrance.
- B. Pressure Gauge Needle Valves: Install in piping tee with snubber.

END OF DOCUMENT 220519

DOCUMENT 220523 - GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes general duty valves common to most plumbing water distribution piping systems.
 - 1. Special purpose valves are specified in individual piping system specifications.
- B. Contractors Option:
 - 1. The Division 22 contractor may provide mechanically joined plumbing piping systems to connect mechanical joints, couplings, fittings, valves and related components as an option in lieu of, in whole or in part, copper sweat, brazing, threaded or flanged piping methods. Mechanically joined plumbing piping systems to connect plumbing piping where used shall be provided in compliance with specification Section 221111 "Mechanically Joined Plumbing Piping Systems".

1.2 DEFINITIONS

- A. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content $\leq 0.25\%$ per Safe Drinking Water Act as amended January 4th, 2011 Section 1417.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
 - 1. Product data, including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions.
- B. Submit certification that valves for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.

1.4 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide products specified in this section from the same manufacturer where products are available and conform to the specification requirements.
- B. American Society of Mechanical Engineers (ASME) Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.
- C. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Compliance: Comply with the MSS Standard Practices below:
 - 1. MSS SP 67 "Butterfly Valves"
 - 2. MSS SP 70 "Gray Iron Gate Valves, Flanged and Threaded Ends"

3. MSS SP 71 "Gray Iron Swing Check Valves, Flanged and Threaded Ends"
 4. MSS SP 72 "Ball Valves with Flanged or Butt Welding Ends"
 5. MSS SP 80 "Bronze Gate, Globe, Angle and Check Valves"
 6. MSS SP 85 "Gray Iron Globe and Angle Valves, Flanged and Threaded Ends"
 7. MSS SP 110 "Ball Valves, Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends"
 8. MSS SP 125 "Check Valves: Gray Iron and Ductile Iron, In-Line, Spring Loaded, Center-Guided"
 9. MSS SP 139 "Copper Alloy Gate, Globe, Angle and Check Valves for Low Pressure/Low Temperature Plumbing Applications"
- D. Valves shall be manufactured in plants located in the United States or certified that they comply with applicable ANSI, ASTM and MSS standards.
- E. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of valves containing no more than 0.25% lead by weight compliance for valves for domestic water distribution.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide products from one of the manufacturers listed in valve schedule.

2.2 VALVE FEATURES, GENERAL

- A. Valve Design: Rising stem or rising outside screw and yoke stems.
1. Non-rising stem valves may be used where headroom prevents full extension of rising stems.
- B. Pressure and Temperature Ratings: As scheduled and required to suit system pressures and temperatures.
- C. Sizes: Same size as upstream pipe, unless otherwise indicated.
- D. Operators: Provide the following special operator features:
1. Handwheels, fastened to valve stem, for valves other than quarter turn.
 2. Lever handles, on quarter-turn valves 6-inch and smaller.
- E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

F. End Connections: As indicated in the valve specifications.

1. Threads: Comply with ANSI B1.20.1.
2. Flanges: Comply with ANSI B16.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze valves.
3. Solder-Joint: Comply with ANSI B16.18.
 - a. Caution: Where soldered end connections are used, use solder having a melting point below 840 deg F for gate, globe, and check valves; below 421 deg F for ball valves.

2.3 GATE VALVES

2.4 BALL VALVES

- A. Ball Valves, 2 Inch and Smaller: Meeting MSS SP 110, Class150, 600-psi CWP; two-piece construction; with ASTM B 584 cast lead free bronze, full port, blowout-proof stem and chrome-plated lead free brass ball, with replaceable "Teflon" or "TFE" seats and seals, solder ends and vinyl-covered steel handle.

2.5 BUTTERFLY VALVES

- A. Butterfly Valves, 2-1/2-Inch and Larger: Meeting MSS SP-67 and lead free; 200-psi CWP; lug-type body constructed of ductile iron conforming to ASTM A 536. Provide valves with field replaceable EPDM sleeve/seat, aluminum-bronze disc, 416 stainless steel stem, and EPDM O-ring stem seals. Provide lever operators, (10 position minimum), with lock and stops with locks for sizes 2-1/2 through 6 inches and gear operators with position indicator for sizes 8 inch and larger. Drill and tap valves on dead-end service or requiring additional body strength. Valves must be rated for dead end service at 150 psi with no downstream flange required.

2.6 CHECK VALVES

- A. Swing Check Valves, 2-Inch and Smaller: Meeting MSS SP-80; Class 125, 200-psi CWP, body and cap of ASTM B 584 cast lead free bronze; with horizontal swing, Y-pattern, disc and disc holder of ASTM B 283 alloy C46400 naval brass; solder ends. Provide valves capable of being reground while the valve remains in the line.
- B. Lift Check Valves, 2-Inch and Smaller: Meeting MSS SP-139; 250-psi CWP, body, disc holder and cap of ASTM B 584 cast lead free bronze; horizontal or angle pattern, lift-type valve, with stainless steel spring, renewable "Teflon" disc and solder ends. Provide valves capable of being refitted and ground while the valve remains in the line.

PART 3 - EXECUTION

3.1 INSTALLATIONS

- A. Install valves in accordance with manufacturer's installation instructions.
- B. Locate valves for easy access and provide separate support where necessary. Provide access doors and fire rated access doors as required.

- C. Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown. Unions are not required on flanged devices.
- D. Install three-valve bypass around each pressure reducing valve using throttling-type valves.
- E. Install valves in horizontal piping with stem at or above the center of the pipe.
- F. Install valves in a position to allow full stem movement.
- G. Installation of Check Valves: Install for proper direction of flow as follows:
- H. Swing Check Valves: Horizontal position with hinge pin level.
- I. Lift Check Valve: With stem upright and plumb.

3.2 VALVE ENDS SELECTION

- A. Select valves with the following ends or types of pipe/tube connections:
 - 1. Copper Tube Size, 2-Inch and Smaller: Solder ends.
 - 2. Copper Tube Sizes 2-1/2 Inch and Larger: flanged end.

3.3 VALVE PRESSURE/TEMPERATURE CLASSIFICATION SCHEDULES

- A. Domestic Hot and Cold Water Service

<u>VALVE TYPE</u>	<u>2" AND SMALLER</u>	<u>2-1/2" AND LARGER</u>
Ball	150	200
Butterfly	N/A	200
Check	125	N/A

3.4 VALVE SCHEDULE

- A. Ball Valves (full port) – 2 inch and smaller:

<u>MANUFACTURER</u>	<u>SOLDER ENDS</u>	<u>THREADED ENDS</u>
Apollo (Conbraco)	77C-LF-200	77C-LF-100
Hammond	UP8311A	UP8301A
Milwaukee	UPBA-450	UPBA-400
NIBCO	S-585-80-LF	T-585-80-LF

- B. Iron Body Ball Valves (full port) – 2-1/2" and larger:

<u>MANUFACTURER</u>	<u>FLANGED ENDS</u>
Apollo (Conbraco)	6PLF

Watts G4000-FDA

C. Butterfly Valves (aluminum-bronze disc) - 2-1/2 inch and larger:

<u>MANUFACTURER</u>	<u>LEVER</u>	<u>GEAR</u>
Apollo (Conbraco)	LD141 xx BE1*	LD141 xx BE2*
Hammond	6411-01	6411-03
NIBCO	LD-2000-3	LD-2000-5
Watts	XXBF-03-121-15	XBF-03-121-1G
* xx = Valve Size		

D. Swing Check Valves – 2 inch and smaller:

<u>MANUFACTURER</u>	<u>SOLDER ENDS</u>	<u>THREADED ENDS</u>
Apollo	161S-LF	161T-LF
Milwaukee	UP1509	UP509
NIBCO	S-413-Y-LF	T-413-Y-LF

E. Lift Check Valves – 2 inch and smaller:

<u>MANUFACTURER</u>	<u>SOLDER ENDS</u>	<u>THREADED ENDS</u>
Hammond	UP947	UP943
Milwaukee	UP1548T	UP548T
NIBCO	S-480-Y-LF	T-480-Y-LF

3.5 APPLICATION SCHEDULE

- A. General Application: Use gate, ball, and butterfly valves for shutoff duty; globe, ball, and butterfly for throttling duty. Refer to piping system Specification Sections for specific valve applications and arrangements.
- B. Domestic Water Systems: Use the following valve types:
1. Ball Valves, 2" and Smaller: Class 150, 600-psi CWP, with stem extension if installed in insulated pipe.
 2. Ball Valves, 2-1/2" and larger: 200-psi CWP cast iron body.
 3. Swing Check, 2-1/2" and smaller: Class 125, cast bronze, with rubber seat.

3.6 FIELD QUALITY CONTROL

- A. Tests: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leaks; replace valves if leak persists.

3.7 ADJUSTING AND CLEANING

- A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.
- B. Inspect valves for leaks after piping systems have been tested and put into service, but before final adjusting and balancing. Adjust or replace packing, as required, on valves with leaks. Replace valve if leak persists.

END OF DOCUMENT 220523

DOCUMENT 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Support and attachment components.
- B. Horizontal-piping hangers and supports.
- C. Shields
- D. Vertical piping clamps
- E. Pipe alignment guides.
- F. Pipe anchors.
- G. Pre-engineered roof supports
- H. Anchors and fasteners.
- I. Miscellaneous materials.
- J. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 22 Section "Plumbing Insulation", for high density insulation for protecting insulation vapor barrier and materials and methods for piping hanger installations.
 - 2. Division 22 "Water Distribution Piping and Specialties", for pipe hanger types and spacing for horizontal and vertical domestic water distribution and heat traced piping of sizes and materials indicated.
 - 3. Division 22 "Sanitary Drainage & Vent Piping and Specialties", for pipe hanger types and spacing for heat traced and cold sanitary piping of sizes and materials indicated.
 - 4. Division 22 "Storm Drainage & Piping and Specialties", for pipe hanger types and spacing for horizontal and vertical storm drainage piping of sizes and materials indicated.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.

4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.3 SUBMITTALS

- A. Product Data : Provide manufacturer's standard catalog pages and data sheets for each type of hanger and support. Include a hanger and support schedule showing manufacturer's figure number, size, location, and features for each hanger and support. Submit style and type to Structural Engineer for approval prior to installation.
- B. Product Certificates: Signed by the manufacturer of hangers and supports certifying the products meet the specified requirements.
- C. Welder Certificates: Signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.
- D. Maintenance Data: For inclusion in Operating and Maintenance manual specified in Division 01 and Division 22 Section "General Plumbing Requirements."
- E. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution. Include dimensions, weights, required clearances, and method of assembly.
 1. Application of protective inserts, and shields at pipe hangers for each type of insulation and hanger.
- F. Installer's Qualifications: Include evidence of compliance with specified requirements.
- G. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- H. Deferred Submittals: Submit signed and sealed drawings that indicate the design and installation requirements of pre-engineered roof supports can withstand the design criteria listed in this specification. Include installation requirements for anchoring to the roof structure. The Engineer is not responsible and will not provide the seal and signature. Deliver submittal to the local AHJ for approval prior to installation of the contractor provided, pre-engineered roof supports.

1.4 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Installer Qualifications for Field-Welding:

1. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
2. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
3. Qualify welding processes and welding operators in accordance with ASME BPVC Section IX, "Welding and Brazing Qualifications."

D. Flame/Smoke Ratings: Provide hangers and supports with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

F. Deferred Submittals: Signed and sealed by a professional engineer or National Institute for Certification in Engineering Technologies (NICET) stamp and signature. The professional engineer shall be licensed in the same state in which the project is located.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

1.6 DEFINITIONS

A. Terminology used in this Section is defined in MSS SP-90.

PART 2 - PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Comply with MSS SP-58.
2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of work.
3. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.

6. Materials: Products and materials listed in this specification are based on indoor, dry locations. Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Painted carbon steel, galvanized steel or zinc-plated steel. Where supports will be field painted in exposed locations, provide carbon steel.
 - b. Indoor Damp or Wet Locations: Galvanized steel or type 304 stainless steel.
 - c. Natatorium or other treated pool environments: Type 316 stainless steel.
 - d. Outdoor Locations: Galvanized steel or type 304 stainless steel.
 - e. Dielectrics Barriers: Provide dielectric barriers between metallic supports and metallic piping and associated items of dissimilar type. Acceptable barriers include rubber, or copper-plated coatings where attachments are in direct contact with copper.
 - f. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - g. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Metal Channel (Strut) Framing Systems:

1. Manufacturers:
 - a. Cooper B-Line.
 - b. Ferguson Enterprises/FNW.
 - c. PHD Manufacturing.
 - d. Thomas & Betts Corporation.
 - e. Unistrut, a brand of Atkore International Inc.
 - f. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
2. Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
3. Comply with MSS SP-69, Type 59, MSS SP-89, and . Welds shall comply with AWS D1.1.

4. Channel Material:

- a. Indoor Dry Locations: Galvanized steel or zinc-plated steel.
- b. Indoor Damp or Wet Locations: Galvanized steel or type 304 stainless steel.
- c. Outdoor Locations: Galvanized steel or type 304 stainless steel.
- d. Natatorium or other treated pool environments: Type 316 stainless steel.
- e. All nuts, brackets, and clamps shall have the same finish as the channel.

5. Minimum Channel Thickness: Steel sheet, 14 gage, 0.0747 inch.

6. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height with factory-punched attachment holes.

7. Provide plastic galvanic isolators for connecting bare copper pipe for use with pre-engineered support strut system where indicated.

C. Hanger Rods:

1. Material:

- a. Indoor Dry Locations: Zinc-plated steel.
- b. Indoor Damp or Wet Locations or Outdoor Locations: Zinc-plated steel or type 304 stainless steel.
- c. Natatorium or other treated pool environments: Type 316 stainless steel.

2. Threaded both ends or continuously threaded.

3. Minimum Size: Reference piping specification sections for rod thicknesses.

4. Threaded Rods: Threaded rods are not allowed for floor supports except when the maximum length of the rod is less than 12". Threaded rod sizes shall be the same size diameter as specified for pipe hanger rods based upon pipe size being supported. Refer to system piping specification sections for rod size requirements.

D. Wire Rope Pipe Hanging Systems:

1. Manufacturers:

- a. ASC Engineered Solutions.
- b. Gripple.

2. General: Wire rope hanger system shall have a minimum 5 to 1 safety factor based upon the applied working load being supported.

3. Source Limitations: Furnish associated fittings, accessories, and hardware produced by a single manufacturer.
4. Cast-in-place Concrete Insert: Pressed steel body with sintered steel wedge, 302 stainless steel spring and UV stabilized homopolymer polypropylene end cap. Model: Gripple Spider Hanging Kit.
5. Cable Stud: Carbon steel, zinc-coated, designed for attachment to concrete inserts. Model: ASC Engineered SolutionsC120.
6. Cable Coupling: Carbon steel, zinc-coated, designed for attachment to threaded rods. Model: ASC Engineered SolutionsC130.
7. Cable Eyelet: Carbon steel, zinc-coated, designed to be directly attached to structural supports via anchors or fasteners. Model: ASC Engineered SolutionsC150.
8. Cable Toggle: Carbon steel, zinc-coated, with toggle designed for insertion into 1/2 inch hole through steel deck hat channel and provides anchor when pulled in tension. Model: ASC Engineered SolutionsC160.
9. Swivel Toggle Insert: Single assembly attached to wire rope cable, manufactured from plated carbon steel toggle, pins, and shackles; swivel insert engineered to be compatible with concrete insert.
10. Wire Rope: High tensile steel wire rope, to ASTM A1023, Class A zinc coating; minimum 7 by 7 cross-sectional thread construction; having a tensile strength of 256,000 psi; No.3 wire size minimum.
11. Adjustable Fastener: Mild steel (type UG2), bright zinc plated, one-channel body; encasing a series of Type 302 stainless-steel springs with serrated self-locking grade 40 chrome steel balls, adjustable by means of an integrated mechanism, capable of accommodating load of 500 lb. Model: Gripple No. 2, 3 or 4 UniGrip.

2.2 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. MANUFACTURERS

1. ASC Engineered Solutions.
2. Cooper B-Line, Inc.
3. Elite Components
4. ERICO/Michigan Hanger Co./Caddy
5. Ferguson/FNW.
6. Halfen-DEHA.
7. Hilti.

8. National Pipe Hanger Corporation.
 9. PHD Manufacturing.
 10. Power-Strut.
 11. Unistrut.
- B. Single Hangers:
1. Split Ring: Carbon steel, adjustable swivel, split ring type.
 2. Split Ring 2 inch and smaller: Copper alloy, split ring type.
 3. Clevis Hanger: Carbon steel, adjustable, clevis type.
 4. Roll Support Hanger: Adjustable steel yoke, cast iron roll.
- C. Trapeze and Strut-mounted Supports:
1. Two-piece clamp: Designed for use with channel strut, held in place at channel shoulder when clamp attachment nut is tightened.
 2. Roll Support: Adjustable cast iron roll attached to metal channel strut framing system with brackets and nuts.
- D. Hangers and strut-mounted supports with pre-manufactured polymer inserts:
1. Manufacturers:
 - a. ASC Engineered Solutions.
 - b. Holdrite.
 - c. Klo-Shure.
 2. Strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts designed to receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation. Metal shields are not required with clevis hangers of this type.
- E. Spring Hangers:
1. Reference Section "Vibration Isolation for Plumbing Piping and Equipment" for spring isolation hangers.
- F. Wall Supports:
1. Two-hole strap, galvanized steel or copper to suit pipe material. Provide rigid insulation between strap and pipe to maintain continuous insulation and vapor barrier where required.

2. Welded steel bracket reinforced with angle or strut. Support pipe from bracket using horizontal pipe hanger or support appropriate for the pipe type.

G. Floor Supports:

1. Pipe Saddle: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
2. Roller Support: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

H. Pre-Insulated Supports:

1. Manufacturers:

- a. Aeroflex USA, Inc.
- b. ASC Engineered Solutions
- c. Armacell.
- d. Buckaroos, Inc.
- e. Cooper B-Line, Inc.
- f. Pipe Shields, Inc.

2. General Construction and Requirements:

- a. Flexible elastomeric insulation with integral high-density pipe support insert shall conform to ASTM C534, Type I.
 - b. Surface Burning Characteristics: Assembly shall have a flame spread index/smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.
 - c. Waterproof calcium silicate insulation shall conform to ASTM C795.
 - d. Rigid phenolic foam insulation shall conform to ASTM C1126, Type III.
 - e. Insulation inserts shall be surrounded by a 360 degree jacket or shield.
3. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.

2.3 SHIELDS

A. Insulation Protection Shield:

1. Sheet metal construction, meeting SP-58 Type 40, of 18 gauge for 5-1/2" inside dimension and smaller, 16 gauge for 6-1/2" to 10-3/4" inside dimension 14 gauge for 11-3/4" to 17" inside dimension, and 12 gauge for 18" to 28" inside dimension.
2. Shield shall cover half of the circumference of the pipe and shall be of length indicated by manufacturer for pipe size and thickness of insulation.
3. Lengths for pipes greater than 2 inches: Minimum 8 inch long section at each support.
4. For pipes 2 inch and smaller using fiberglass or flexible elastomeric insulation without pre-insulated supports, provide insulation protection shields installed between hanger and pipe which meets the following minimum length requirements:

Pipe Size (NPS)	Insulation Thickness (inches)	Minimum Shield Length, (in) Hanger Spacing, (ft)					
		5	6	7	8	9	10
≤ 1	0.5	5	6	8	-	-	-
	1	3	5	5	-	-	-
	1.5	3	5	5	-	-	-
	2	3	3	3	-	-	-
	3	3	3	3	-	-	-
≤ 2	0.5	8	8	11	11	12	14
	1	5	6	8	9	11	11
	1.5	5	6	8	8	9	9
	2	5	5	6	6	8	8
	3	5	5	6	6	6	8

- B. 360° Insulation Protection Shield: Shield shall cover all of the circumference of the pipe with two half circumference sections held together with bolts and nuts and shall be of length indicated by manufacturer for pipe size and thickness of insulation.
- C. Plastic Shields:
 1. Manufacturers:
 - a. Armacell.
 - b. Eaton.
 - c. Hydra-Zorb.
 - d. PHD Manufacturing.
 - e. Zsi Foster.
 2. Polymer-based, snap-on or clip-on design, with non-adhesive surface and lip to allow lateral movement of piping without damaging insulation, field-paintable.

2.4 VERTICAL-PIPING SUPPORTS

- A. Manufacturers:

1. ASC Engineered Solutions.
 2. Cooper B-Line, Inc.
 3. Halfen-DEHA.
 4. Hilti.
 5. ERICO/Michigan Hanger Co.
 6. National Pipe Hanger Corporation.
 7. PHD Manufacturing.
 8. Power-Strut.
 9. Unistrut.
- B. Components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.
1. Components shall have galvanized coatings where installed for piping and equipment that will not have factory applied or field-applied finish.
 2. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.
 3. Components as listed below shall be made of 304 stainless steel where installed in corrosive environments and/or where indicated on the drawings.
- C. Riser Clamps with pre-manufactured polymer insert:
1. Manufacturers:
 - a. Hydra-Zorb; Titan Riser Clamp.
 - b. National Pipe Hanger.
 - c. Pipe Hangers, Inc.
- D. Riser clamp with pre-manufactured polymer inserts designed to withstand vertical loading and receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation.
- 2.5 PIPE ALIGNMENT GUIDES
- A. Factory fabricated, constructed of cast semi-steel or heavy fabricated steel when applied to steel pipe and copper when applied to copper. Guide shall consist of bolted two-section outer cylinder and base with two-section guiding spider that bolts tightly to pipe. Length of guides shall be as recommended by manufacturer to allow indicated travel.

1. Pipe Diameter 8 inches and Smaller: Spider or sleeve type.
2. Pipe Diameter 10 inches and Larger: Roller type.
3. Pipe Diameter 18 to 30 inches: 1 inch U-bolt.

2.6 PIPE ANCHORS

- A. Pre-Insulated Anchors: Galvanized steel or stainless steel assembly with high density insulation insert and no metal-to-metal contact.
- B. Anchor Clamps: Assembly with multi-piece clamp, constructed of compatible material with piping or with dielectric barrier.

2.7 PRE-ENGINEERED ROOF PIPE SUPPORTS

A. Manufacturers:

1. Airtec.
2. ASC Engineered Solutions.
3. Cooper B-Line, Inc.
4. Elite Components.
5. ERICO/Michigan Hanger Co./Caddy.
6. Ferguson/FNW.
7. Miro.
8. PHP Systems/Design.
9. PHD Manufacturing.
10. Roof Top Blox.
11. Unistrut, a brand of Atkore International Inc.
12. Zsi Foster.

B. General: Pre-engineered devices with embedded pipe support fixtures as specified.

C. Pedestals: Steel pedestals with thermoplastic or rubber base with the following dimensions:

1. Up to 12 inch strut length support: 18 inch x 18 inch.
2. Up to 16 inch strut length support: 24 inch x 18 inch.
3. Up to 24 inch strut length support: 30 inch x 18 inch.

4. Thickness: Minimum 3/16 inch thick.
- D. Block Bases: Closed-cell polyethylene blocks with the following dimensions.
 1. Length: Nominal 10 inch, 12 inch, 16 inch, or 24 inch
 2. Width: Nominal 4 inches.
- E. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
- F. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.

2.8 ANCHORS AND FASTENERS

- A. Manufacturers:
 1. Hilti, Inc.
 2. Illinois Tool Works, Inc.
 3. Phillips.
 4. Powers Fasteners, Inc.
 5. Rawl.
 6. Simpson Strong-Tie Company Inc.
- B. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 1. Concrete: Use preset concrete inserts or expansion anchors.
 2. Solid or Grout-Filled Masonry: Use expansion anchors.
 3. Hollow Masonry: Use toggle bolts.
 4. Hollow Stud Walls: Use toggle bolts.
 5. Steel: Use beam clamps.
 6. Sheet Metal: Use sheet metal screws.
 7. Wood: Use wood screws.
 8. Plastic and lead anchors are not permitted.
 9. Hammer-driven anchors and fasteners are permitted only as follows:

- a. Nails are permitted for attachment of nonmetallic boxes to wood frame construction.
 - b. Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction.
 - C. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - 1. Comply with MFMA-4.
 - 2. Channel Material: Use galvanized steel.
 - 3. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.
 - 4. Spot Inserts: Carbon steel with zinc plating or galvanized steel body and base plate, with protective sleeve for anchor rod insert, sized to accommodate anchor rod dimensions.
 - 5. Manufacturers:
 - a. Same as manufacturer of metal channel (strut) framing system.
 - b. DeWalt "Bang-It" concrete inserts.
 - D. Post-Installed Concrete and Masonry Expansion Anchors:
 - 1. Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
 - 2. Self-drilling, drilled flush or shell type. Size inserts to suit threaded rods.
 - E. Beam Clamps: MSS SP-58 C-Type or adjustable, Types 19 through 23, 25 or 27 through 30 based on required load.
 - 1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.
 - 2. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
 - F. Vibration Isolation Anchors: Reference Division 22 Section "Vibration Isolation for Plumbing Piping and Equipment" for vibration isolation anchors.
- 2.9 MISCELLANEOUS MATERIALS
- A. Steel Plates, Shapes, and Bars: ASTM A 36.
 - B. Malleable Iron: ASTM A47
 - C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION, GENERAL

- A. Install hangers and supports in accordance with manufacturer's installation instructions.
- B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58 unless indicated otherwise.
- B. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
- C. Space attachments within maximum piping span length specified in Division 22 piping sections.
- D. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- E. Install hangers, supports, clamps and attachments to support piping properly from building structure.
- F. Do not attach to ceilings, equipment, ductwork, conduit and other non-structural elements such as floor and roof decking.
- G. Hanger and clamps sizing:
 - 1. Cold Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.

2. Hot Piping: Provide pipe hangers sized for the pipe outside diameter.
 3. Vertical Piping: Provide clamps sized for the pipe outside diameter and extend clamp through insulation.
 4. Refer to Division 22 Section "Plumbing Insulation" for definition of hot and cold piping and required insulation thickness.
- H. Where several pipes can be installed in parallel and at the same elevation, Contractor has option to provide metal channel strut framing. Install supports with maximum spacing specified within Division 22 piping sections.
1. Space strut framing at the required distance for the smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.
 2. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.
 - a. Uninsulated Copper Pipe: Install with plastic galvanic isolators
 - b. Insulated Tube or Pipe: Install with 360° insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 22 Section "Plumbing Insulation".
- I. Install building attachments within concrete or to structural steel.
1. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping as specified in Division 22 piping sections.
 2. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.
- J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Provide two nuts on threaded supports to securely fasten the support.
- K. Install appropriate types of hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
- L. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.
- N. Insulated Piping: Comply with the following installation requirements.
1. Riser Clamps: Attach riser clamps to piping with riser clamps projecting through insulation. Do not use riser clamps to support horizontal, insulated piping. Seal insulation

for hot piping and protect vapor barrier for cold piping as specified in Division 22 Section "Plumbing Insulation".

- a. Contractor's Option: Provide riser clamps with pre-manufactured polymer insert for cold piping 2-1/2 inches and larger.
2. Insulation Protection Shield: Install insulation protection shield with high density insulation insert where vapor barrier is indicated, sized for the insulation thickness used as specified in Division 22 Section "Plumbing Insulation". Do not use polymer-based shields for hot piping.
 - a. Exception for horizontal cold-piping with fiberglass or flexible elastomeric insulation 2 inch and smaller: Rest fiberglass insulated pipe on hanger shield with length specified for pipe size and insulation thickness to prevent puncture or other damage.
3. Contractor's Option: Provide pre-engineered thermal hanger inserts for piping insulated with flexible elastomeric insulation at pipe supports for piping 2-1/2 inches and larger.
4. Contractor's Option: Provide strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts.
- O. Strut Framing Systems: Channel strut systems can be used at the Contractors option in lieu of individual hangers for horizontal pipes. Arrange for grouping of parallel runs of horizontal piping. Space channel strut systems at the required distance for the smallest pipe supported. Provide channel gauge and hanger rods per the manufacturer's recommendations for the piping supported. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.
 1. Uninsulated Copper Pipe: Install with plastic galvanic isolators
 2. Insulated Tube or Pipe: Install with 360 degree insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 22 Section "Plumbing Insulation".
- P. Vertical Piping Risers:
 1. Reference Section "Vibration Isolation for Plumbing Piping and Equipment" for piping riser supports.
- Q. Wire Rope Hanging Systems:
 1. Install in accordance with manufacturer's instructions.
 2. Supported load shall not exceed manufacturer's recommended load rating.
 3. Applications for Pipe Supports:
 - a. 3 inch and smaller.
 - b. Wire rope hanging system is not allowed for steam or steam condensate piping.

4. Do not support pipe by wrapping the rope around the pipe.
 5. Provide appropriate hanger or support compatible with the wire rope hanging system adjustable fastener as specified in Division 22 piping sections.
 6. Install cast-in-place concrete inserts in elevated concrete slabs.
 7. Install bream clamps for attachment to structural beams as required.
- R. Expansion Anchors: Use in existing concrete, masonry or in pre-cast concrete construction.
- S. Pre-Engineered Roof Pipe Supports: Set supports on an 18" X 18" x 3/16" thick roof walkway material compatible with the roof material.

3.4 INSTALLATION OF PIPE ALIGNMENT GUIDES

- A. Install pipe alignment guides on piping that adjoins expansion joints, as required by expansion joint manufacturer, and elsewhere as indicated on plans and specification sections to eliminate binding and torsional stress on piping systems. Install guides per ASME B31.9 unless noted otherwise. Install pipe insulation at guide to not interfere with movement of pipe within the guide.
- B. Install guide to accommodate 1/2 the thermal movement at the adjacent expansion joint.
- C. Anchor to building substrate.

3.5 INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.
- C. Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.6 EQUIPMENT SUPPORTS

- A. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
- B. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls.
- C. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
- D. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

- E. Preset Concrete Inserts and Expansion Anchors: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
 - 1. Where concrete slabs form finished ceiling, locate anchors flush with slab surface.
- F. Secure fasteners according to manufacturer's recommended torque settings.
- G. Remove temporary supports.
- H. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.
- I. Grouting: Place grout under supports for piping and equipment.

3.7 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours welded surfaces to match adjacent contours.

3.8 FIELD QUALITY CONTROL

- A. Examine support and attachment components for damage and defects.
- B. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces. Comply with Division 09 Section "Painting."
 - 1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

- E. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.
- F. Correct deficiencies and replace damaged or defective support and attachment components.

3.9 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Provide the following acceptable hangers and supports for each type of piping system. Hangers and supports may be single type or strut-mounted:
- C. Single Hangers:
 - 1. All pipe sizes 1-1/2 inch and less:
 - a. Band hanger.
 - b. Swivel split ring.
 - c. Clevis hanger.
 - 2. Cold and Hot pipe sizes 2 to 4 inches: Clevis hanger.
 - 3. Cold and Hot pipe sizes 6 inches and greater: Roll support hanger.
 - 4. All drainage pipe sizes: Clevis hanger.
- D. Trapezes and Strut-mounted Supports:
 - 1. All pipe sizes less than 6 inches: Two-piece clamp.
 - 2. Pipe sizes 6 inches and greater: Roll support.
- E. Wall Supports:
 - 1. Pipe sizes 3 inches and less:
 - a. Two-hole strap mounted to wall.
 - b. Welded steel bracket with reinforced angle or strut.
 - 2. Pipe sizes 4 inch and greater:
 - a. U-bolt
 - b. Welded steel bracket with reinforced angle or strut.

F. Floor Supports:

1. Pipe sizes 4 inch and less: Pipe saddle.
2. Pipe sizes 6 inch and greater: Roll support.

END OF DOCUMENT 220529

DOCUMENT 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Extent of Plumbing work to be identified as required by this Section is indicated on drawings and/or specified in other Division 22 Sections.
- B. Types of identification devices specified in this Section include the following:
 - 1. Plastic Pipe Markers
 - 2. Plastic Tape
 - 3. Underground-Type Plastic Line Marker
 - 4. Valve Tags
 - 5. Valve Schedule Frames
 - 6. Engraved Plastic-Laminate Signs
 - 7. Plastic Equipment Markers
 - 8. Plasticized Tags

1.2 CODES AND STANDARDS:

- A. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- B. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.
- C. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.
- D. Maintenance Data: Include product data and schedules in Maintenance Manuals as specified in Division 1 and Section "General Plumbing Requirements."

1.4 SPARE PARTS

- A. Furnish minimum of 5% extra stock of each plumbing identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.
 - 1. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide plumbing identification materials of one of the following:
 - 1. Advanced Graphic Engraving, LLC.
 - 2. Brady Co.
 - 3. Brimar Industries, Inc.
 - 4. Craftmark.
 - 5. Kolbi Pipe Marker Co.
 - 6. Seton

2.2 PLUMBING IDENTIFICATION MATERIALS

- A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 22 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.3 PLASTIC PIPE MARKERS

- A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1
- B. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1
- C. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F (52 degrees C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
- D. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 2. Adhesive lap joint in pipe marker overlap.
 3. Laminated or bonded application of pipe marker to pipe (or insulation).
 4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1-1/2".
- E. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
1. Laminated or bonded application of pipe marker to pipe (or insulation).
 2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2" wide; full circle at both ends of pipe marker, tape lapped 3".
 3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.
- F. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.
- G. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with names as shown or specified.
- 2.4 PLASTIC TAPE
- A. General: Provide manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.
 - B. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2-1/2" wide tape for larger pipes.
 - C. Color: Comply with ANSI A13.1, except where another color selection is indicated.
- 2.5 UNDERGROUND-TYPE PLASTIC LINE MARKER
- A. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates the type of service of buried pipe.
 1. Provide multi-ply tape consisting of solid aluminum foil core between 2-layers of plastic tape.
- 2.6 VALVE TAGS
- A. Brass Valve Tags: Provide 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.

1. Provide 1-1/2" diameter tags, except as otherwise indicated.
 2. Fill tag engraving with black enamel.
- B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
- 2.7 CEILING TACKS
- A. Description: Steel with 3/4" diameter color coded head.
- B. Color:
1. Comply with ANSI A13.1, except where another color selection is indicated.
- 2.8 ACCESS PANEL MARKERS
- A. Access Panel Markers: Provide manufacturer's standard 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.
- 2.9 VALVE SCHEDULE FRAMES
- A. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.
- 2.10 ENGRAVED PLASTIC-LAMINATE SIGNS
- A. General: Provide engraving stock melamine plastic laminate, complying with ASTM D 709, in the sizes and thickness indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for plumbing fastening except where adhesive mounting is necessary because of substrate.
- B. Thickness: 1/16" for units up to 20 sq. in. or 8" length; 1/8" for larger units.
- C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
- 2.11 PLASTIC EQUIPMENT MARKERS
- A. General: Provide manufacturer's standard laminated plastic, color coded equipment markers. Conform to the following color code:
1. Green: Cooling equipment and components.
 2. Yellow: Heating equipment and components.
 3. Yellow/Green: Combination cooling and heating equipment and components.
 4. Brown: Energy reclamation equipment and components.

5. Blue: Equipment and components that do not meet any of the above criteria.
 6. For hazardous equipment, provide colors and designs recommended by ANSI A13.1.
- B. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
1. Name and plan number.
 2. Equipment service.
 3. Design capacity.
 4. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.
- C. Size: Provide 2-1/2" x 4" markers for control devices, dampers, and valves; and 4-1/2" x 6" for equipment.

2.12 PLASTICIZED TAGS

- A. General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing. Tags shall be minimum 3-1/4" x 5-5/8" in size, provided with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.13 LETTERING AND GRAPHICS

- A. General: Coordinate names, abbreviations and other designations used in plumbing identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment.
1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

- A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished plumbing spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 PIPING SYSTEM IDENTIFICATION

- A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
1. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.

B. Application: Provide piping system identification for the following systems:

1. Domestic cold water piping.
2. Domestic hot water piping.
3. Domestic hot water recirculating piping.
4. Non potable water piping
5. Lawn irrigation piping.
6. Sanitary and waste piping.
7. Storm water piping.
8. Vent piping.
9. Insulated and non-insulated storm water piping.
10. Natural gas piping.

C. Location: Install pipe markers and color bands in the following locations where piping is exposed to view, concealed only by a removable ceiling system, installed in machine rooms, installed in accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

1. Within 5 feet of each valve and control device.
2. Within 5 feet of each branch, excluding take-offs less than 25 feet in length for fixtures; mark flow direction of each pipe at branch connection.
3. Within 5 feet where pipes pass through walls, floors or ceilings or enter non-accessible enclosures. Provide identification on each side of wall, floor or ceiling.
4. At access doors, manholes and similar access points which permit view of concealed piping.
5. Within 5 feet of major equipment items and other points of origination and termination.
6. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment where there are more than two piping systems or pieces of equipment.

3.3 UNDERGROUND PIPING IDENTIFICATION

- A. General: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.4 VALVE IDENTIFICATION

- A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibbs, and shut-off valves at plumbing fixtures and similar rough-in connections of end-use fixtures and units.
- B. List each tagged valve in valve schedule for each piping system. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by Architect/Engineer.
 - 1. Where more than one major machine room is shown for project, install mounted valve schedule in each major machine room, and repeat only main valves which are to be operated in conjunction with operations of more than single machine room.

3.5 CEILING TACK INSTALLATION

- C. Install ceiling tacks to locate valves above lay-in panel ceilings. Locate in corner of panel closest to equipment.

3.6 PLUMBING EQUIPMENT IDENTIFICATION

- A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each major item of plumbing equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:
 - 1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - 2. Meters, gauges, thermometers and similar units.
 - 3. Pumps
 - 4. Water heaters, tanks and pressure vessels.
 - 5. Strainers, water treatment systems and similar equipment.
- B. Optional Sign Types: Where lettering larger than 1" height is needed for proper identification, because of distance from normal location of required identification, stenciled signs may be provided in lieu of engraved plastic, at Installer's option.
- C. Lettering Size: Minimum 1/4" high lettering for name of unit where viewing distance is less than 2'-0", 1/2" high for distances up to 6'-0", and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of size of the principal lettering.
- D. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
 - 1. Optional Use of Plasticized Tags: At Installer's option, where equipment to be identified is concealed above acoustical ceilings or similar concealment, plasticized tags may be

installed within concealed space to reduce amount of text in exposed sign (outside concealment).

2. Operational valves and similar minor equipment items located in non-occupied spaces (including machine rooms) may, at Installer's option, be identified by installation of plasticized tags in lieu of engraved plastic signs.

END OF DOCUMENT 220553

DOCUMENT 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping Insulation.
- B. Equipment Insulation.

1.2 RELATED REQUIREMENTS

- A. Division 22 Section "Hangers and Supports for Plumbing Piping," for insulation shields and high-density insulation inserts.

1.3 DEFINITIONS

- A. Cold Pipe: Piping that carries fluid with a minimum operating temperature less than 60 degrees F.
- B. Hot Pipe: Piping that carries fluid with a minimum operating temperature greater than 105 degrees F.
- C. Cold Equipment: Equipment that carries fluids with a minimum operating temperature less than 60 degrees F.
- D. Hot Equipment: Equipment that carries fluids with a minimum operating temperature greater than 105 degrees F.
- E. Exposed: Insulation that is visible from the occupied space.
- F. Exposed to Weather: Insulation that is exposed to potential damage caused by weather, including sunlight, moisture, wind, and solar radiation.
- G. Exterior: Locations outside of or within the building envelope (walls, roof, floors, etc) as defined by the architectural drawings and specifications.
- H. NAIMA: North American Insulation Manufacturers Association

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of Plumbing insulation.
- B. Insulation Schedule: Include product name, conductivity k-value, thickness, and furnished accessories for each service.
- C. Maintenance Data: Submit maintenance data and replacement material lists for each type of Plumbing insulation. Include this data and product data in maintenance manual.
- D. Manufacturer's Instructions: Include installation instructions for storage, handling, protection, examination, preparation, and installation of the product.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualification: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.
- B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- C. Flame/Smoke Ratings: Provide composite plumbing insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.
 - 1. Exception: Exterior plumbing insulation may have flame spread index of 75 and smoke developed index of 150.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage; store in original wrapping.

1.7 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 - PRODUCTS

2.1 PIPING INSULATION MATERIALS

- A. Mineral Fiber (rock, slag, or glass):
 - 1. Manufacturers:
 - a. Knauf Insulation
 - b. Johns Manville
 - c. Owens Corning
 - 2. Insulation: ASTM C547, Type I or II, rigid mineral fiber, pre-formed for the application.
 - a. K-value: ASTM C518 or C177, maximum 0.24 at 75 degrees F.
 - b. Minimum Service Temperature: 0 degrees F
 - c. Maximum Service Temperature: 850 degrees F for Type I, 1200 degrees F for Type II.

- d. Density: Between 3 to 6 pounds per cubic foot for Type I, between 6 to 8 pounds per cubic foot for Type II.
- 3. Factory Applied Jacket: ASTM C1136, Type I.
 - a. All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms and self-sealing lap.
 - b. Poly ASJ: Paper/Foil/Scrim with polymer coating, water vapor permeance of 0.01 perms and self-sealing lap.
 - c. Color: White.
- B. Calcium Silicate:
 - 1. Manufacturers:
 - a. CertainTeed Corp.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Owens Corning.
 - 2. Insulation: ASTM C533, Type I, rigid molded, asbestos free, pre-formed for the application.
 - a. K-value: ASTM C335 or C518, maximum 0.45 at 200 degrees F.
 - b. Minimum Service Temperature: 80 degrees F
 - c. Maximum Service Temperature: 1200 degrees F.
 - d. Density: Maximum 15 pounds per cubic feet.
- C. Flexible Elastomeric:
 - 1. Manufacturers:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
 - 2. Insulation: ASTM C534, Grade I, flexible elastomeric cellular rubber insulation, pre-formed for the application.
 - a. K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.

- b. Minimum Service Temperature: Minus 297 degrees F
 - c. Maximum Service Temperature: 220 degrees F for Grade I, 300 degrees F for Grade II.
- 3. Factory Applied Jacket:
 - a. Polymeric Coating: Multi-ply, polymeric blend coating, 16 mils thick, designed to prevent damage to underlying insulation from sunlight, installation, and physical abuse, with water vapor permeance of 0.03 perms. Reference Jacket requirements in Part 3 of this specification for application of this jacket.
- D. Field-Applied Jacket:
 - 1. Semi-rigid PVC: One-piece, pre-molded PVC cover conforming to ASTM D1784, including factory-furnished, pre-cut insulation blanket inserts for fittings.
 - a. Outdoor Applications: Provide minimum 30 mils thickness and UV protection.
 - b. Manufacturers:
 - 1) Johns Manville Zeston PVC Jacketing and 2000 Series Fitting Covers
 - 2) Proto Corp LoSmoke PVC Jacketing and Pro Fitting Covers.
 - 3) Or approved equal.
- E. Pipe Insulation Accessories: Provide staples, bands, wires, cement, and other appurtenances as recommended by insulation manufacturer for applications indicated.
- F. Adhesives, Sealers, Mastics, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.
 - 1. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36, Childers CP-50AHV2, or equal.
 - 2. Weather Barrier Breather Mastic: Permeance shall be 1.0 perms or less at 62 mils dry per ASTM E96, Procedure B. Provide Foster 46-50, Childers CP-10/11 or equal.
 - 3. Solvent-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 35 mils dry per ASTM F 1249.
 - 4. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance in accordance with ASTM C755 for insulation application. Provide Foster 30-80, Childers CP-38, or equal.

Table: Recommended Maximum Permeance of Water Vapor Retarders (Note 1)

Insulation Application	Insulation Permeability, Less than 4.0 perm-in.	Insulation Permeability, 4.0 or greater perm-in.
	(Note 2)	(Note 2)

	Vapor Retarder perms	Vapor Retarder perms
Pipe and vessels (33 F to ambient)	0.05	0.05
Pipe and vessels (-40 F to 32 F)	0.02	0.02

Notes:

1. Water vapor permeance of the vapor retarder in perms when tested in accordance with Test Methods E96.
 2. Water vapor permeability of the insulation material when tested in accordance with Test Methods E96.
- G. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.
- H. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.
- I. High Density Insulation Billets:
1. Calcium Silicate: ASTM C533 and C795.
- J. Pipe Insulation Accessories: Provide staples, Bands, Wires, and Cement and other appurtenances as recommended by insulation manufacturer for applications indicated.
- K. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.
- L. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.

2.2 EQUIPMENT INSULATION MATERIALS

- A. Flexible Mineral Fiber (rock, slag, or glass):
1. Manufacturers:
 - a. CertainTeed Corp.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Owens Corning.
 2. Insulation: ASTM C553, Type I and II or ASTM C547 Type II, flexible mineral fiber blanket.
 - a. K-value: ASTM C518 or C177, maximum 0.31 at 75 degrees F.
 - b. Minimum Service Temperature: Minus 20 degrees F

- c. Maximum Service Temperature: 450 degrees F for ASTM C553 Types I and II, 1200 degrees F for ASTM C547 Type II.
 - d. Density: Minimum 1.5 pounds per cubic foot.
 - 3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.
 - a. All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms.
 - b. Color: White.
- B. Flexible Removeable and Reusable Blanket Insulation:
 - 1. Manufacturers:
 - a. Auburn Manufacturing.
 - b. Approved equal.
 - 2. Insulation: ASTM C553, Type V, flexible, noncombustible.
 - a. Comply with ASTM C1695.
 - b. K-value: ASTM C518 or C177, maximum 0.37 at 100 degrees F.
 - c. Minimum Service Temperature: 32 degrees F
 - d. Maximum Service Temperature: 500 degrees.
- C. Rigid Mineral Fiber (rock, slag, or glass):
 - 1. Manufacturers:
 - a. Johns Manville.
 - b. Knauf Insulation.
 - c. Owens Corning.
 - 2. Insulation: ASTM C612, Type IA or IB, rigid mineral fiber board.
 - a. K-value: ASTM C518 or C177, maximum 0.25 at 75 degrees F.
 - b. Minimum Service Temperature: 0 degrees F
 - c. Maximum Service Temperature: 450 degrees.
 - d. Density: Minimum 3.0 pounds per cubic foot.
 - 3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.

- a. All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms.
 - b. Color: White.
- D. Flexible Elastomeric:
 - 1. Manufacturers:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
 - 2. Insulation: ASTM C534, Grade I or II, flexible elastomeric cellular rubber insulation, sheet form.
 - a. K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.
 - b. Minimum Service Temperature: Minus 40 degrees F
 - c. Maximum Service Temperature: 220 degrees F for Grade I, 300 degrees F for Grade II.
- E. Field-Applied Jacket:
 - 1. Aluminum: ASTM B209, 3003 alloy, H-14 temper, with 3-mil thick polyfilm moisture barrier to interior surface.
 - a. Thickness: 0.032 inch sheet.
 - b. Finish: Smooth.
 - c. Joining: Longitudinal slip joints and 2 inch laps.
 - d. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel.
 - 2. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW, or approved equal.
 - a. Water Vapor Transmission: 0.0 perms per ASTM E96.
 - b. Puncture Resistance: Minimum 65 pounds per ASTM D1000.
- F. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors, stud pins, and other appurtenances as recommended by insulation manufacturer for applications indicated.

- G. Adhesives, Sealers, Mastics, and Protective Finishes: Provide cements, adhesives, coating, sealers, mastics, and protective finishes as recommended by insulation manufacturer for applications indicated.
1. Mineral Fiber Lagging Adhesive: Comply with ASTM C916, Type 2 or MIL-A-3316C, Class 2, Grade A. Provide Foster 85-60, Childers CP-127, or equal water-based adhesive.
 2. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 47 mils dry per ASTM E96. Provide Foster 30-80, Childers CP-38, Design Polymerics 3040, or equal.
 3. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36, Childers CP-50AHV2 or equal.
 4. Tie Wire: Annealed steel, 16 gauge, 0.0508 inch diameter.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Test piping and ductwork for design pressure, liquid tightness, and continuity prior to applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 PROTECTION AND REPLACEMENT

- A. Provide all required protection for insulation (installed and uninstalled) throughout the duration of construction to avoid exposure to plaster, dust, dirt, paint, moisture, deterioration, and physical damage.
- B. Repair existing plumbing insulation that is damaged during this construction period. Use insulation of same type and thickness as existing insulation. Install new jacket lapping and sealed over existing.
- C. Replace damaged insulation which cannot be repaired satisfactorily at no additional expense to the Owner, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installation of new insulation that replaces the damaged or wet insulation.

3.3 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's installation instructions.
- B. Install in accordance with NAIMA National Insulation Standards.

3.4 PLUMBING PIPING SYSTEM INSULATION

- A. Maintain continuous thermal and vapor-retarder integrity throughout entire installation and protect it from puncture and other damage.
- B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Exposed Piping: Locate insulation and cover seams in least visible locations.
- E. Cold Piping Insulation:
 - 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
 - 2. Provide with factory applied vapor barrier jacket.
 - 3. Provide high density insulation material under supports or pre-insulated supports. Protect insulation with shields to prevent puncture or other damage. Refer to Section "Hangers and Supports for Plumbing Piping" for pre-insulated supports and insulation shields. and for exception where high density insulation inserts are not required.
 - 4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
 - 5. Secure all-service jacket with self-sealing longitudinal laps.
- F. Butt pipe insulation tightly at insulation joints. Apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture infiltration.
- G. Hot Piping Insulation:
 - 1. Insulate entire system, including fittings, valves, unions flanges, strainers, flexible connections, pump bodies, and expansion joints.
 - 2. Provide jackets without vapor barrier. Jackets with factory applied vapor barrier are allowed.
 - 3. Provide high density insulation material or pre-insulated supports where supports are installed outside of the insulation. Protect insulation with shields to prevent puncture or other damage. Refer to Section "Hangers and Supports for Plumbing Piping" for pre-insulated supports and insulation shields and for exception where high density insulation inserts are not required.
 - 4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.

5. Secure all-service jacket with self-sealing longitudinal laps.
6. Butt pipe insulation tightly at insulation joints and wrap insulation around supports. Apply 3 inch wide vapor barrier tape or band over joint.

H. Interior piping with heat trace:

1. Insulate and heat trace grease waste piping and grease waste P-traps as described below. Refer to Division 22 Section "Heat Tracing for Plumbing Piping" for heat trace system material and installation requirements.
 - a. Fiberglass: 2" thickness.
 - b. Flexible Elastomeric: 1" thickness.

3.5 EQUIPMENT INSULATION

A. Cold Equipment (Below Ambient Temperature):

1. Application Requirements: Insulate the following cold equipment:
 - a. Drip pans under chilled equipment.
 - b. Water softeners.
 - c. Pneumatic water tanks.
 - d. Roof drain bodies.
2. Insulate each item of equipment specified above with one of the following types and thicknesses of insulation:
 - a. Fiberglass: 2" thick for cold surfaces above 35 degrees F (2 degrees C) and 3" thick for surfaces 35 degrees F (2 degrees C) and lower.
 - b. Flexible Elastomeric: 1" thick.

B. Hot Equipment (Above Ambient Temperature):

1. Application Requirements: Insulate the following hot equipment:
 - a. Hot water storage tanks.
 - b. Heat exchangers.
 - c. Hot water pumps.
 - d. Condensate pumps.
2. Insulate each item of equipment specified above with one of the following types and thicknesses of insulation:

- a. Fiberglass: 2" thick, except 3" thick for steam-jacketed heat exchangers.

3.6 INSTALLATION OF PIPING INSULATION

- A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
- B. Maintain continuous thermal and vapor-retarder integrity throughout entire installation unless otherwise indicated.
- C. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- D. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- E. Clean and dry pipe surfaces prior to insulating.
- F. Cold Pipe Insulation:
 1. Insulate all cold piping to prevent moisture condensation on exterior surfaces.
 2. Provide high density insulation material under supports or pre-insulated supports. Refer to Division 22 Section "Hangers and Supports for Plumbing Piping" for pre-insulated supports.
 3. Protect insulation with shields to prevent puncture or other damage. Refer to division 22 Section "Hangers and Supports for Plumbing Piping" for insulation shields.
 4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
 5. Butt pipe insulation tightly at insulation joints. Apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.
- G. Hot Pipe Insulation:
 1. Provide pipe hangers for hot piping sized for the outside diameter of piping.
 2. Butt insulation to hanger or riser clamp for vertical pipe. Butt pipe insulation tightly at insulation joints. Seal exposed insulation at hanger with joint sealant.
- H. Pipe insulation:
 1. Insulate all cold piping to prevent moisture condensation on exterior surfaces.

2. Provide high density insulation material under supports or pre-insulated supports. Refer to Division 22 Section "Hangers and Supports for Plumbing Piping" for pre-insulated supports.
3. Protect insulation with shields to prevent puncture or other damage. Refer to division 22 Section "Hangers and Supports for Plumbing Piping" for insulation shields.
4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
5. Butt insulation to hanger or riser clamp for vertical pipe. Butt pipe insulation tightly at insulation joints.
6. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints.
7. For cold pipes, apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.

I. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves (except balancing and flow control valves), strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Butt tightly against adjoining pieces and bond with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves (except balancing and flow control valves), flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- J. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- K. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
- L. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.

3.7 INSTALLATION OF EQUIPMENT INSULATION

- A. General: Install equipment thermal insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices to ensure that insulation serves intended purpose.
- B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.
- C. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.
- D. Do not apply insulation to equipment, breechings, or stacks while hot.
- E. Apply insulation using the staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately.
- F. Coat insulated surfaces with layer of insulating cement, troweled in workmanlike manner, leaving a smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.
- G. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2". Apply over vapor barrier where applicable.
- H. Do not insulate boiler manholes, handholes, cleanouts, ASME stamp, and manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.
- I. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames, and accessories.
- J. Equipment Exposed to Weather: Protect outdoor insulation from weather by installation of weather-barrier mastic protective finish, or jacketing, as recommended by the manufacturer.

3.8 PROTECTION AND REPLACEMENT

- A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
- B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

3.9 PIPING SYSTEM INSULATION SCHEDULE

- A. Reference Pipe Insulation Thickness Schedule at the end of this specification for thickness requirements based on insulation conductivity.
- B. Do not apply insulation to piping that operates outside of the minimum and maximum service temperature range.

C. Omit insulation on the following:

1. Flexible connections and expansion joints in pipes with fluids above ambient temperatures.
2. Chrome-plated exposed piping
3. Water Hammer Arrestors
4. Balancing and flow valves
5. Drain lines from water coolers
6. Drainage piping located in crawl spaces or tunnels
7. Exterior condensate drain piping
8. Buried piping
9. Pre-insulated equipment.
10. Cold water piping
11. Condensate piping
12. Storm drainage piping
13. Overflow storm drainage piping

D. Cold Piping (minimum operating temperature less than 60 degrees F.)

1. Service
 - a. Potable cold water piping.
 - b. Non-potable cold water piping
 - c. Potable chilled water piping.
 - d. Plumbing vents within 6 lineal feet of roof outlet.
 - e. Horizontal interior above-ground storm drainage piping and vertical run from roof drain to horizontal run.
 - f. Horizontal and vertical interior above-ground storm drainage piping and vertical run from roof drain to horizontal run.
 - g. Horizontal and vertical interior above-ground overflow storm drainage piping and vertical run from roof drain to horizontal run. Where vertical overflow storm drainage piping from the outlet exceeds 15 feet, only insulate within 15 feet of the outlet.
 - h. Lawn irrigation piping.

- i. Condensate piping inside the building.
 - j. Trap arms, waste branches and dedicated stacks serving chilled water waste or condensate drains.
 - 2. Insulate each piping system specified above with one of the following types of insulation.
 - a. Mineral fiber.
 - E. Hot Temperature Piping (105 degrees to 180 degrees F (40 to 82 degrees C)):
 - 1. Service:
 - a. Hot water supply and return piping.
 - 2. Insulate each piping system specified above with one of the following types of insulation.
 - a. Mineral fiber.
- 3.10 PIPE INSULATION THICKNESS SCHEDULE
- A. P-traps:
 - 1. Insulate P-traps receiving chilled water waste and P-traps of water coolers as described below:
 - a. Flexible Elastomeric: 1" thick for pipe sizes up to and including 2", 1-1/2" thick for pipe sizes 2" to 6" (largest size permitted).
 - 2. Insulate P-traps receiving hot water waste above 140F as described below:
 - a. Fiberglass: 1" thickness.
 - B. Piping Inside Masonry Wall Units:
 - 1. Insulate cold, hot, and hot water recirculation piping installed inside of masonry walls where the piping needs to be insulated as the wall is constructed as described below:
 - a. Flexible Elastomeric: 1/2" thick for pipe sizes up to and including 2", 1" thick for pipe sizes 2-1/2" to 6" (largest size permitted).
 - C. IECC – 2018 Requirements, Pipe Insulation

Minimum Pipe Insulation Thickness							
Fluid Operating Temp. Range (°F) And Usage	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
	Conductivity, Btu·in./(hr·ft ² ·°F)	Mean Rating Temp., °F.	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
Insulation Thickness, in.							

141°F–200°F	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105°F–140°F	0.21–0.28	100	1.0	1.0	1.5	1.5	1.5
40°F–60°F	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0

Notes:

- a. For piping smaller than 1-1/2 inch and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less than 1 inch.
- b. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r[(1 + t/r)^{(K/k)} - 1]$ where
 - 1) T = minimum insulation thickness (in.),
 - 2) r = actual outside radius of pipe (in.),
 - 3) t = insulation thickness listed in the table for applicable fluid temperature and pipe size,
 - 4) K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in/hr·ft²·°F); and
 - 5) k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.
- c. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.
- d. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

3.11 PIPING JACKET SCHEDULE

- A. Exposed piping within mechanical rooms (below 10 feet):
 1. Semi-rigid PVC.
- B. Exposed piping within mechanical rooms (above 10 feet):
 1. Semi-rigid PVC.

C. Piping within return air plenums:

1. All-service jacket.

END OF DOCUMENT 220700

DOCUMENT 221100 - WATER DISTRIBUTION PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes domestic cold water, hot water, and hot water recirculation piping, fittings, and specialties within the building to a point 5 feet outside the building.
- B. Contractors Option:
 - 1. The Division 22 contractor may provide mechanically joined plumbing piping systems to connect mechanical joints, couplings, fittings, valves, and related components as an option in lieu of, in whole or in part, copper sweat, brazing, threaded or flanged piping methods. Mechanically joined water distribution piping systems where used shall be provided in compliance with specification Section 221111 "Mechanically Joined Plumbing Piping Systems".
- C. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 22 Section "General Plumbing Requirements," for trenching and backfilling materials and methods for underground piping installations.
 - 2. Division 2 Section "Water Service Systems," for water service piping beginning from 5'-0" outside the building.
 - 3. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.
 - 4. Division 11 Section "Kitchen and Food Service Equipment," for faucets and valves furnished with the food service and kitchen equipment.
 - 5. Division 22 Section "Identification, for Plumbing Piping and Equipment" for labeling and identification of water distribution piping.
 - 6. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall penetrations and equipment pads.
 - 7. Division 22 Section "Basic Piping Material and Methods," for materials and methods for strainers, flexible connectors, unions, dielectric unions, dielectric flanges, and mechanical sleeve seals.
 - 8. Division 22 Section "General Duty Valves for Plumbing Piping," for materials and methods for installing water distribution piping valves.
 - 9. Division 22 Section "Hangers and Supports for Plumbing Piping," for insulation shields, materials, and methods for hanging and supporting water distribution piping.
 - 10. Division 22 Section "Plumbing Insulation," for materials and methods for insulating water distribution piping.

11. Division 22 Section "Sanitary Drainage and Vent Piping and Specialties," for material and methods for trap primer outlet piping.

1.2 DEFINITIONS

- A. Water Distribution Pipe: A pipe within the building or on the premises that conveys water from the water service pipe or meter to the points of usage.
- B. Water Service Pipe: The pipe from the water main or other source of potable water supply to the water distribution pipe of the building served.
- C. Pipe sizes used in this Specification are nominal pipe size (NPS).
- D. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content $\leq 0.25\%$ per Safe Drinking Water Act as amended January 4th, 2011 Section 1417.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.
 1. Product data for each piping specialty and valve specified.
 2. Welder Certificates signed by Contractor certifying that welders comply with requirements specified in Article "Quality Assurance" below.
 3. Certification of Compliance with ASME and UL fabrication requirements specified in Article "Quality Assurance" below.
 4. Maintenance data for each piping specialty and valve specified for inclusion in Maintenance Manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."
 5. Test reports specified in Part 3 of this Section.
 6. Submit certification that specialties and fittings for domestic water distribution for drinking or cooking comply with NSF 61 Annex G and / or NSF 372. The following specialties need not comply:
 - a. Hose bibbs
 - b. Wall, yard, and roof hydrants
 - c. Backflow preventers isolating irrigation or mechanical make-up systems
 - d. Trap primers

1.4 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."

B. Regulatory Requirements: Comply with the provisions of the following codes:

1. ASME B31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.
2. ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications" for Qualifications for Welding Processes and Operators.

C. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution for drinking or cooking.

D. Pipe, fittings, and specialties shall be manufactured in the United States or be certified to meet ASTM and ANSI standards.

1.5 SPARE PARTS

A. Maintenance Stock: Furnish one valve key for each key-operated wall hydrant, hose bibb, fixture supply, or faucet installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hose Bibbs:

- a. Lee Brass Co.
- b. Mansfield Plumbing Products
- c. Mifab Manufacturing, Inc.
- d. Nibco, Inc.
- e. Prier, Inc.
- f. Watts Regulator Co.
- g. Woodford Mfg. Co.

2. Wall/Yard Hydrants:

- a. Josam Co.
- b. Mifab Manufacturing, Inc.
- c. Smith (Jay R.) Mfg. Co.

- d. Prier, Inc.
 - e. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
 - f. Watts Drainage
 - g. Woodford Mfg. Co.
 - h. Zurn Industries Inc., Hydromechanics Div.
3. Backflow Preventers:
- a. Cla-Val Co.
 - b. Conbraco Industries, Inc.
 - c. Febco
 - d. Hersey Products, Inc.
 - e. Mifab Manufacturing, Inc./Beeco
 - f. Watts Regulator Co.
 - g. Zurn Industries Inc. Wilkins Regulator Div.
4. Self Contained Pressure-Reducing Valves:
- a. Cash (A. W.) Valve Mfg. Corp.
 - b. Cla-Val Co.
 - c. Conbraco Industries, Inc.
 - d. Mifab Manufacturing, Inc./Beeco
 - e. Watts Regulator Co.
 - f. Zurn Industries Inc., Wilkins Regulator Div.
5. Relief Valves:
- a. Cash (A. W.) Valve Mfg. Corp.
 - b. Conbraco Industries, Inc.
 - c. Watts Regulator Co.
 - d. Zurn Industries, Inc. Wilkins Regulator Div.
6. Piston Type Water Hammer Arresters:

- a. Amtrol, Inc.
 - b. Josam Co.
 - c. Precision Plumbing Products, Inc.
 - d. PROFLO
 - e. Sioux Chief Manufacturing Co.
 - f. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
 - g. Watts Regulator Co.
 - h. Zurn Industries, Inc. Wilkins Regulator Div.
7. Point of Use Thermostatic Mixing Valves
- a. Acorn Engineering Co.
 - b. Cash Acme
 - c. Leonard Valve Co.
 - d. Powers Process Controls
8. Plumbing Pipe Support Brackets
- a. Holdrite
 - b. PROFLO
 - c. Sioux Chief
9. Tube Suspension Clamps
- a. PROFLO
 - b. Sioux Chief or approved Equivalent
10. Sanitary Roof Hydrants
- a. Hoeptner Perfected Products
 - b. Jay R. Smith Mtg Co.
 - c. Prier, Inc.
 - d. Mapa
 - e. Woodford Mfg. Co.

2.2 PIPE AND TUBE MATERIALS, GENERAL

- A. Pipe and Tube: Refer to Part 3, Articles "Above Ground Water Distribution Pipe and Fittings" or "Below Ground Water Distribution Pipe and Fittings", for identification of systems where the materials listed below are used.
- B. Copper Tube: ASTM B88, Type L Water Tube, drawn temper.
- C. Copper Tube: ASTM B88, Type K Water Tube, annealed temper.
- D. Ductile-Iron Pipe: AWWA C151 or AWWA C115 ductile-iron pipe, with AWWA C104 cement-mortar lining.
- E. Brass Pipe: Chrome Plated Schedule 40 ASTM B43 iron pipe size (IPS.)

2.3 FITTINGS

- A. Wrought Copper Solder-Joint Fittings: ANSI B16.22, streamlined pattern.
- B. Ductile or Gray-Iron Flanged Fittings: AWWA C110 Class 125 with AWWA C116 epoxy coating inside and outside.
- C. Ductile-Iron Gasketed Fittings: AWWA C153, 150 psi rating, with AWWA C104 cement mortar lining and AWWA C111 rubber gaskets.
- D. Brass Fittings: Chrome plated ANSI B16, Class 125 with threaded connections.
- E. Cast-Iron Threaded Flanges: ANSI B16.1, Class 125, raised ground face, bolt holes spot faced.
- F. Bronze Flanges: ANSI B16.24, Class 150, raised ground face, bolt holes spot faced.
- G. PVC to Ductile Iron Adapter Flanges: EBBA Iron, Inc. Series 2000PV or approved equivalent.

2.4 JOINING MATERIALS

- A. Solder Filler Metal: ASTM B32 Alloy Sb-5, 95-5 Tin-Antimony.
- B. Brazing Filler Metals: AWS A5.8, Bag-7 Silver.
- C. Gasket Material: Thickness, material, and type suitable for fluid to be handled and design temperatures and pressures.

2.5 GENERAL-DUTY VALVES

- A. General-duty valves (i.e., gate, globe, check, ball, and butterfly valves) are specified in Division 22 Section "General Duty Valves for Plumbing Piping." Special duty valves are specified below by their generic name; refer to Part 3, Article "Valve Applications" for specific uses and applications for each valve specified.

2.6 PIPING SPECIALTIES

- A. Hose Connections: Hose connections shall have garden hose thread outlets conforming to ASME B1.20.7.

- B. Hose Bibbs: Bronze body with chrome- or nickel-plated finish, with renewable composition disc, wheel handle, 1/2- or 3/4-inch solder inlet, hose outlet.
- C. Recessed Nonfreeze Wall Hydrants: Cast-bronze box, with chrome-plated face, tee handle key, vacuum breaker, hinged locking cover, 3/4-inch inlet, and hose outlet. Bronze casing shall be length to suit wall thickness.
- D. Roof Hydrants: As specified on the drawings.
- E. Backflow Preventers: Comply with requirements of ASSE Standard 1013 and as specified on the drawings.
- F. Relief Valves: Sizes for relief valves shall be in accordance with ASME Boiler and Pressure Vessel Codes for indicated capacity of the appliance for which installed.
 - 1. Combined Pressure-Temperature Relief Valves: Bronze body, test lever, thermostat, complying with ANSI Z21.22 listing requirements for temperature discharge capacity. Temperature relief valves shall be factory set at 210 deg F, and pressure relief at 150 psi.
- G. Piston Type Water Hammer Arresters: Piston type, with casing of type "L" copper tube and spun copper ends, nylon piston with two EPDM "O"rings pressure lubricated with FDA approved silicone, pressure rated for 250 psi, tested and certified in accordance with PDI Standard WH-201.
- H. Point of Use Thermostatic Mixing Valves:
 - 1. Lead free bronze or brass body meeting ASTM B584 with non-corrosive parts, tamper resistant temperature adjustment, checks, stops, other components as scheduled and meeting ASSE 1070. Valve shall be designed to fail to the cold side of the system. Maximum pressure drop shall not be exceeded for the scheduled flow rate.
- I. Pipe Support Brackets:
 - 1. Sheet Stud Bracket: 20 gauge copper with nominal copper tube holes of 1/2" on 2" centers and holes of 3/4" or 1" on 4" centers.
 - 2. Pipe Mounted Bracket: 20 gauge copper or plastic bracket with clamps for securing copper water tube and stainless steel hose clamp for securing bracket to vertical waste and vent pipe in wall.
 - 3. Carrier Bracket: 20 gauge copper bracket with 1" hole for supporting rough-in for flush valve copper tube and bolt slot for attaching to chair carrier.
- J. Tube Suspension Clamps
 - 1. Combination plastic supports and insulators for installing copper tube in stud walls with integral bracket for securing to stud with screws.

PART 3 - EXECUTION

1.1 INSTALLATION, GENERAL

- A. Install piping, valves and specialties in accordance with manufacturer's installation instructions.

3.2 PREPARATION FOUNDATION FOR BELOW GROUND WATER DISTRIBUTION PIPE AND FITTINGS

- A. Copper Tube: Provide 6" thick sand pipe bed underneath and around sides of pipe, up to middle half of the pipe. Support pipe in trench with sand bags level and true at fittings to prevent sand, gravel or debris from interfering with the brazing process. After pressure testing is complete, install bedding at fittings and install subbase. Refer to Section "General Plumbing Requirements" for bedding and subbase materials, excavation, trenching, backfill and compaction requirements.
- B. Ductile Iron Pipe: Shape bottom of trench to fit bottom of pipe for 90-degrees (bottom 1/4 of the circumference). Fill unevenness with tamped sand bedding. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation. For piping with rock trench bottoms, provide sand pipe bed 6" underneath and around sides of pipe up to middle half of the pipe, including fittings. After pressure testing is complete, provide first layer of pea gravel backfill 6" above pipe, tamp backfill with mechanical tamper and install bedding at fittings and install subbase. Refer to Section "General Plumbing Requirements" for bedding and subbase materials, excavation, trenching, backfill and compaction requirements.

3.3 ABOVE GROUND WATER DISTRIBUTION PIPE AND FITTINGS

- A. Install Type L, drawn copper tube with wrought copper fittings and solder joints for pipe sizes
- B. Install chrome plated brass pipe and fittings for exposed water piping within the building where indicated on the drawings.
- C. Install ductile or gray-iron epoxy coated fittings for 3" and larger at water service entrance riser and only upstream of the backflow preventer.

3.4 BELOW GROUND WATER DISTRIBUTION PIPE AND FITTINGS

- A. Install Type K, soft annealed copper tube and brazed joints for pipe sizes 2 inches and smaller, with minimum number of joints, inside and outside building.
- B. Install cement-lined ductile-iron pipe with rubber gasketed joints, inside and outside under the building, for pipe 3 inches and larger.

3.5 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.
- B. Use fittings for all changes in direction and branch connections.

- C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- H. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple and cap.
- I. Fire Barrier Penetrations: Where pipes pass through fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.
- J. Exterior Wall Penetrations: Seal pipe penetrations through exterior wall constructions with sleeves packing, and sealant. Refer to Division 22 Section "Basic Piping Materials and Methods" for additional information.
- K. Underground Exterior Wall Penetrations: Seal pipe penetrations through underground exterior walls with sleeves and mechanical sleeve seals. Refer to Division 22 Section "Basic Piping Materials and Methods" for additional information.
- L. Install piping level with no pitch.

3.6 HANGERS AND SUPPORTS

- A. General: Hanger, support, insulation protection shield and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.
- B. Pipe Attachments: Install the following:
 - 1. Adjustable steel clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.
 - 2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs. Provide copper coated riser clamps when in contact with copper tube.
 - 3. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections "Supports and Anchors" and "Plumbing Insulation".

4. Copper coated extension split ring pipe clamp, MSS SP-69 Type 12, for individual vertical exposed runs of copper tube 2" and smaller on walls and for securing 1-1/4" to 2" copper tube inside walls and chases for battery fixtures. Secure clamp to the copper tube.
 - a. Seal each joint with insulation and split ring pipe to maintain the insulation barrier. Refer to Section "Plumbing Insulation" for requirement for maintenance of the vapor barrier and vapor barrier seal method.
 5. Extension split ring pipe clamp, MSS SP-69 Type 12, for individual vertical exposed runs of stainless steel tube 2" and smaller on walls or for securing tube inside walls for connection to faucets.
 6. Support copper tube in chases and walls at plumbing fixtures with plastic or copper brackets secured to structure and U-bolts sized to bare on the pipe.
 7. Engineered strut support system may be provided, at the contractor's option, in lieu of individual hangers for horizontal pipes as specified in Division 22 "Hangers and Supports for Plumbing Piping". Provide two piece straps for uninsulated pipe secured to the bare pipe and provide plastic galvanic isolators for bare copper tube. Provide two piece straps and 360° insulation protection shields sized for the insulation thickness used for the pipe for all insulated pipes.
 8. Secure copper tube rough-in for individual fixtures with sheet stud brackets attached to the wall studs or pipe mounting brackets attached to the fixture waste & vent pipe at each plumbing fixture.
 9. Secure 1" and smaller copper water tubing in stud walls at stud penetrations with tube suspension clamps.
 - a. Cut hole through non-supporting studs with a minimum 1/8" clearance around each uninsulated copper tube or insulated copper tube.
 - b. Seal each joint of insulation and tube suspension clamp to maintain the insulation barrier. Refer to Division 22 "Plumbing Insulation" for requirement for maintenance of the vapor barrier similar to insulation butted against insulation inserts and vapor barrier seal method.
 10. Secure copper tubes for flush valve wall mounted water closets to the chair carrier with carrier brackets.
 11. Provide roll hangers for individual horizontal runs 100 feet or longer.
- C. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, this specification, and authorities having jurisdiction requirements, whichever are most stringent. Install hangers for horizontal piping with the following maximum spacing and minimum rod diameters:

Nom. Pipe Size - In.	Steel Pipe Max. Span - Ft.	Copper Tube Max. Span - Ft.	Min. Rod Dia. - In.
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Up to 1-1/4	12	6	3/8
1-1/2 to 2	12	10	3/8
2-1/2 to 4	12	10	3/8
5	12	10	1/2
6	12	10	1/2
8	12	10	1/2
10 to 12	12	10	5/8
14	12	N/A	3/4
16	12	N/A	7/8

1. Support vertical steel pipe at each floor and in intervals not to exceed 15 feet.
2. Support vertical copper tube at each floor and in intervals not to exceed 10 feet.

- D. Support water piping within 12" of each elbow or tee and for water piping 2-1/2" and larger at each valve or strainer.
- E. Support water piping above the floor with pipe supports attached to the floor with anchor bolts where indicated on the drawings. Conform to the table above for maximum spacing of supports.

3.7 PIPE AND TUBE JOINT CONSTRUCTION

- A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."
- B. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
 1. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts of piping specialties before soldering and brazing.
 2. Fill the tubing and fittings during brazing with an inert gas (nitrogen or carbon dioxide) to prevent formation of scale.
 3. Heat joints to proper and uniform temperature.
- C. Threaded Joints: Conform to ASME B1.20.1, tapered pipe threads for field-cut threads. Join pipe fittings and valves as follows:
 1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 2. Align threads at point of assembly.
 3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).
 4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
 - a. Damaged Threads: Do not use pipe with corroded or damaged threads. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

- D. Flanged Joints: Align flange surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.
- E. Joints Containing Dissimilar Metals: Provide dielectric unions for 2" and smaller and dielectric flanges for piping 2-1/2" and larger. Provide dielectric waterway fittings for 2" and smaller in concealed locations. Dielectric unions, waterway fittings and flanges are specified in Section "Basic Piping Materials and Methods".
- F. Joints at Valve Assemblies or Connections to Equipment: Provide unions downstream of shutoff valves at valve assemblies or equipment connections. Unions are not required at flanged connections. Unions are specified in Division 22 section "Basic Piping Materials and Methods".

3.8 SERVICE ENTRANCE

- A. Extend water distribution piping to connect to water service piping, of size and in location indicated for service entrance to building. Water service piping is specified in a separate section of Division 2.
- B. Underground exterior water distribution piping to be a depth as required by local conditions, in accordance with authority having jurisdiction's requirements and at depth no less than 18" below grade.
- C. Install sleeve and mechanical sleeve seal at penetrations through foundation wall for watertight installation.
- D. Install sleeve and caulk at penetrations through building floor for watertight installation.
- E. Install shutoff valve at service entrance inside building; complete with strainer, pressure gauge, and test tee with valve.
- F. Ductile-Iron Pipe: Install in accordance with AWWA C-600. Pipe below ground inside building and to a point 5 feet outside of building shall have restrained joints.

3.9 VALVE APPLICATIONS

- A. General-Duty Valve Applications: The Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shut-off duty: Use gate, ball, and butterfly valves.
 - 2. Throttling duty: Use globe, ball, and butterfly valves.

3.10 INSTALLATION OF VALVES

- A. Sectional Valves: Install sectional valves on each branch and riser, close to main, where branch or riser serves 2 or more plumbing fixtures or equipment connections, and elsewhere as indicated. For sectional valves 2 inches and smaller, use ball valves; for sectional valves 2-1/2 inches and larger, use ball or butterfly valves.

- B. Shutoff Valves: Install shutoff valves on inlet of each plumbing equipment item, on each supply to each plumbing fixture, and elsewhere as indicated. For shutoff valves 2 inches and smaller, use ball valves; for shutoff valves 2-1/2 inches and larger, use ball or butterfly valves.
- C. Drain Valves: Install drain valves on each plumbing equipment item, located to drain equipment completely for service or repair. Install drain valves at the base of each riser, at low points of horizontal runs, and elsewhere as required to drain distribution piping system completely. For drain valves 2 inches and smaller, use ball valves; for drain valves 2-1/2 inches and larger, use ball or butterfly valves.
- D. Check Valves: Install swing check valves on discharge side of each pump and elsewhere as indicated.
- E. Hose Bibbs: Install on exposed piping where indicated with vacuum breaker.
- F. Wall Hydrants: Install where indicated with vacuum breaker.
- G. Point-of-Use Thermostatic Mixing Valve: Install valve complying with ASSE 1070 on all public lavatories and handwashing sink locations. Install valve to be accessible by maintenance staff. Set temperature limit to 110F for dual temperature faucet or 100F for single temperature faucet.”

3.11 INSTALLATION OF FLOW CONTROL VALVES

- A. Install flow control valves or automatic flow control valves in each hot water recirculating loop, and elsewhere as indicated. Install a shutoff valve and strainer upstream and a union, check valve and shutoff valve downstream of each flow control or automatic flow control valve.
- B. Set flow control valve flow rate as follows:
 - 1. Preliminary Procedures For Hot Water Return System Balancing:
 - a. Before operating the system perform these steps:
 - 1) Open valves at recirculation pump and flow control valves to full open position.
 - 2) Remove and clean all strainers.
 - 3) Check recirculation pump rotation.
 - 4) Set water heater temperature as indicated on the drawings.
 - 2. Procedures For Hot Water Return System Balancing
 - a. Refer to the drawings for required flow rate for each flow control valve.
 - b. Provide required instrumentation to obtain proper measurements. Instruments shall be properly maintained and protected against damage.

- c. Apply instrument as recommended by the manufacturer.
 - d. Take readings with the eye at the level of the indicated value to prevent parallax.
 - e. Mark flow control valve setting with memory stop. Mark with paint or other suitable, permanent identification materials.
 - f. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.
- C. Reports: Prepare hot water return system balancing reports signed and submit to the Architect upon completion of the project. Include the following information:
 - a. Valve tag number and description of location
 - b. Valve body size
 - c. Differential pressure reading from instrument in psi
 - d. Actual flow rate derived from the manufacturer's charts and tables for the valve size and measured differential pressure.

3.12 INSTALLATION OF PIPING SPECIALTIES

- A. Install backflow preventers at each connection to mechanical equipment and systems and in compliance with the plumbing code and authority having jurisdiction. Locate in same room as equipment being connected. Install air gap fitting and pipe relief outlet drain without valves to nearest floor drain.
- B. Install pressure reducing valves with inlet and outlet shutoff valves and balance cock bypass. Install pressure gauge on valve outlet.

3.13 EQUIPMENT CONNECTIONS

- A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated, but in no case smaller than required by plumbing code.
- B. Mechanical Equipment Connections: Connect hot and cold water piping system to mechanical equipment as indicated. Provide shutoff valve and union for each connection; provide drain valve on drain connection. For connections 2-1/2 inches and larger, use flanges instead of unions.

3.14 FIELD QUALITY CONTROL

- A. Inspections: Inspect water distribution piping as follows:
 - 1. Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the authority having jurisdiction.
 - 2. During the progress of the installation, notify the plumbing official having jurisdiction at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.

- a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed in after system is roughed in and prior to setting fixtures.
 - b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to ensure compliance with the requirements of the plumbing code.
 - c. Reinspections: Whenever the plumbing official finds that the piping system will not pass the test or inspection, make the required corrections and arrange for reinspection by the plumbing official.
 - d. Reports: Prepare inspection reports signed by the plumbing official and turn over to the Architect upon completion of the project.
 - B. Piping System Test: Test water distribution systems in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:
 1. Test for leaks and defects all new water distribution piping systems and parts of existing systems that have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
 2. Leave uncovered and unconcealed all new, altered, extended, or replaced water distribution piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.
 3. Cap and subject the piping system to a static water pressure of 50 psig above the operating pressure without exceeding the pressure rating of the piping system materials. Isolate the test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.
 4. Repair all leaks and defects with new materials and retest system or portion thereof until satisfactory results are obtained.
 5. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.
- 3.15 ADJUSTING AND CLEANING
- A. Clean and disinfect water distribution piping as follows:
 1. Purge all new water distribution piping systems and parts of existing systems that have been altered, extended, or repaired prior to use.
 2. Use the purging and disinfecting procedure proscribed by the authority having jurisdiction or, in case a method is not proscribed by that authority, the procedure described in either AWWA C651, or AWWA C652, or as described below:
 - a. Flush the piping system with clean, potable water until dirty water does not appear at the points of outlet.

- b. Fill the system or part thereof with a water/chlorine solution containing at least 50 parts per million of chlorine. Isolate (valve off) the system or part thereof and allow to stand for 24 hours.
 - c. Drain the system or part thereof of the previous solution and refill with a water/chlorine solution containing at least 200 parts per million of chlorine and isolate and allow to stand for 3 hours.
 - d. Following the allowed standing time, flush the system with clean, potable water until chlorine residual is lowered to incoming city water level.
 - e. Submit water samples in sterile bottles to the authority having jurisdiction. Repeat the procedure if the biological examination made by the authority shows evidence of contamination.
3. Reports: Prepare disinfection reports signed by the authority having jurisdiction and turn over to the Architect upon completion of the project.

3.16 COMMISSIONING

- A. Fill the system. Check compression tanks to determine that they are not air bound and that the system is completely full of water.
- B. Before operating the system, perform these steps:
 1. Close drain valve, hydrants, and hose bibbs.
 2. Open valves to full open position.
 3. Remove and clean strainers.
 4. Check pumps for proper direction of rotation. Correct improper wiring.
 5. Lubricate pump motors and bearings.

END OF DOCUMENT 221100

DOCUMENT 221111 - MECHANICALLY JOINED PLUMBING PIPING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section only applies to Mechanically Joined Plumbing Piping Systems for joining piping for Plumbing applications as defined in Division Section 22 "Water Distribution Piping and Specialties".
- B. The Division 22 contractor may provide mechanically joined, couplings, fittings, valves and related components as an option in lieu of, in whole or in part, copper sweat, brazing, threaded or flanged piping methods.
- C. Mechanically joined couplings, fittings, valves and related components specified in this section shall not be provided for natural gas piping in lieu of welded, threaded or flanged piping methods.

1.2 DEFINITIONS

- A. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content $\leq 0.25\%$ per Safe Drinking Water Act as amended January 4th, 2011 Section 1417.
- B. CWP: Cold working pressure in psi.
- C. CTS: Copper tube size.

1.3 RELATED SECTIONS INCLUDE THE FOLLOWING:

- A. Division 22 section "Basic Plumbing Piping Materials and Methods" for materials for dielectric waterway fittings and flange kits.
- B. Division 22 Section "Water Distribution Piping and Specialties" for related sections.

1.4 SUBMITTALS

- A. Product Data: Submit data for each type of coupling, fitting and special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing.
- B. Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure.
 - 1. If an assembly of flexible couplings are used for seismic vibration, thermal expansion, or noise and vibration reduction, submit shop drawings indicating location of assembly, including anchors and guides. Include movement analysis of the assembly, and performance data of the assembly.
- C. Maintenance Data: Include for each piping specialty and valve in Maintenance Manual specified in Division 01 and Division 22 Section "General Plumbing Requirements."
- D. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1. Test procedures used.
 2. Test results that comply with requirements.
 3. Failed test results and corrective action taken to achieve requirements.
- E. Submit a schedule of dissimilar metal joints and adaptor flanges and flange kits. Include joint type material, connection method and proposed flange kits to isolate dissimilar metals. Include minimum and maximum torque requirements for flange connections to valves. Dielectric flange kits are specified in Division 22 section "Basic Plumbing Piping Materials and Methods".
- F. Submit certification that valves and fittings for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.
- G. Submit certification that pipe, pipe fittings, pipe specialties, and valves and fittings are manufactured in plants located in the United States or certified that they comply with applicable ANSI, ASTM and MSS standards.
- H. Submit contractor certificates indicating completion of installation training course from manufacturer of piping to be used.
- 1.5 QUALITY ASSURANCE
- A. All grooved and press to connect components shall be of one manufacturer, be date and origin stamped for quality assurance and traceability.
- B. Press to connect end product manufacturer shall be ISO certified.
- C. Obtain training from the press to connect manufacturer for all workers that will be installing or handling the press to connect piping systems.
- D. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of valves and fittings containing no more than 0.25% lead by weight for domestic water distribution.
- E. Pipe, fittings, specialties, and valves shall be manufactured in plants located in the United States or certified to meet the specified ASTM, ANSI, and MSS standards.

1.6 COORDINATION

- A. Reference Division 22 Section "Water Distribution Piping and Specialties" for coordination.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Refer to manufacturer's current literature for comparable products and pressure ratings of couplings and standard fittings for various pipe sizes and pipe schedules. Products identified by model number are based on available size ranges from that manufacturer. Products offered by manufacturers with extended ranges are acceptable provided they meet the specified requirements.
- B. Press to Connect Copper Tubing System

1. Apollo "Xpress"
2. GRINNELL Mechanical Products "G-Press"
3. Mueller Streamline PRS
4. NIBCO Inc., Press System.
5. Viega ProPress

2.2 PRESS TO CONNECT COPPER TUBING SYSTEM

A. Copper Tube:

1. CTS ½inch through 4inch: ASTM B-88 Type K or L.

B. General requirements for couplings, adapters, and standard fittings:

1. Acceptable body materials:
 - a. Wrought copper conforming to ASTM B75 alloy C12200 or ASTM B152 alloy C1100.
 - b. Cast copper conforming to ASTM B584 alloy C87600 or C84400.
2. Coupling and fitting housings with soldered ends shall conform to ASME B16.18 and B16.22.
3. Coupling and fitting housings with flared ends shall conform to ASME B16.26.
4. Coupling and fitting housings with threaded ends shall conform to ASME B1.20.1.
5. Coupling and fitting housings for press ends shall have self-contained O-ring seals in the coupling/fitting ends.
6. Rated for 200 psi CWP up to 250 degrees F maximum.

C. O-Ring Seals: EPDM compound conforming to ASME B16.51, style suitable for the application.

D. Flange Adapters:

1. For connection to ANSI class components according to ANSI B16.1 (steel) or ANSI B16.24 (copper).
2. 2-1/2 inch through 4 inch (ANSI class 125/150):
 - a. Steel flange with NSF 14 compliant fused epoxy coating, copper or brass press to connect joint with copper face ring and plastic or rubber dielectric isolating ring separating the flange from the press to connect joint.
3. Rated for 200 psi CWP up to 250 degrees F maximum.

E. Valves:

1. Provide 2 inch and smaller press to connect valves listed in this section or lead free cast bronze valves 2 inch and smaller listed in Division 22 section "Water Distribution Piping and Specialties" may be used with sweat connections or sweat X press adapters.
2. Ball Valve:
 - a. Rated for 200 psi CWP up to 250 degrees F maximum, conforming to MSS SP-110.
 - b. Body and trim: Lead free cast bronze conforming to B584.
 - c. Ends: Female press to connect ends of copper material.
 - d. Ball: Full port, chrome-plated brass ball.
 - e. Stem: Blow-out proof, of material silicon bronze conforming to ASTM B371 or ASTM B99, or stainless steel.
 - f. Seat: PTFE or TFE, suitable for intended service.
 - g. Operator: Lever handle with non-thermal conductive material for insulated piping. Provide with 2 inch extended sleeve to allow valve operation without disturbing the insulation and with memory stop for throttling, metering or balancing service.
 - 1) Apollo # 77WLF
 - 2) NIBCO # PC-585-LF
 - 3) Milwaukee # UPBA-450-12
3. Check Valves (Y pattern, swing type or in-line)
 - a. Rated for 200 psig CWP up to 250 degrees F maximum, conforming to MSS SP-80.
 - b. Body and trim: Cast bronze conforming to ASTM B62.
 - c. Disc: PTFE renewable seat and disc.
 - d. Ends: Female press to connect ends of copper or brass material.
 - e. 2 inch and smaller:
 - 1) Apollo # 163T-PRLF
 - 2) Hammond # UP904 P2
 - 3) NIBCO # PF-413-Y-LF
 - 4) Milwaukee # UP509 P2

4. Check Valves (lift type, in-line)
 - a. Rated for 250 psig CWP up to 250 degrees F maximum, conforming to MSS SP-80.
 - b. Body: Cast bronze conforming to ASTM B584.
 - c. Spring: 316 stainless steel.
 - d. Ends: Female press to connect ends of copper or brass material.
 - e. 2 inch and smaller:
 - 1) Apollo # 61LF
 - 2) Milwaukee # UP548T P2
5. Butterfly Valves – 2-1/2 inch and Larger
 - a. MSS SP-67; 200-psi CWP; lug-type body constructed of ductile iron conforming to ASTM A 126, Class B or ductile iron conforming to ASTM A 536. Provide valves with field replaceable EPDM sleeve/seat, aluminum-bronze disc, 416 stainless steel stem, and EPDM O-ring stem seals. Provide lever operators, (10 position minimum), with lock and stops with locks. Drill and tap valves on dead-end service or requiring additional body strength. Valves must be rated for dead end service at 150 psi with no downstream flange required. Provide with factory installed press to connect flange adapters, as described herein, with bolts, nuts and washers.
 - 1) NIBCO # PFD2000
 - 2) Viega # 2873.81

F. Strainers:

1. Provide 2 inch and smaller press to connect strainers listed in this section or lead free cast bronze strainers 2 inch and smaller listed in Division 22 section "Basic Piping Materials and Methods" may be used with sweat connections or sweat X press adapters.
2. Strainers (Y pattern)
 - a. Rated for 250 psig CWP up to 250 degrees F maximum.
 - b. Body: Cast bronze conforming to ASTM B584.
 - c. Screen: Stainless steel mesh with 0.062" perforations.
 - d. Ends: Female press to connect ends of copper or brass material.
 - e. 2 inch and smaller:
 - 1) Apollo # 59LF

PART 3 - EXECUTION

3.1 PIPING INSTALLATIONS

- A. Install pipe, fittings, valves and specialties in accordance with manufacturer's installation instructions.
- B. Water distribution piping installations shall be installed subject to Division 22 Section "Water Distribution Systems and Specialties" in addition to those requirements specified in this Section.
- C. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

3.2 PIPE APPLICATIONS ABOVE GRADE

- A. Water piping in sizes 4 inches and smaller shall be Type L drawn copper tube with plain ends and copper tube dimensioned press to connect copper couplings and fittings.

3.3 HANGERS AND SUPPORTS

- A. Support of piping must account for expansion and contraction, vibration, and the dead load of the piping and its contents.
- B. General: Hanger supports, and anchors devices are specified in Division 22 Section "Hangers and Supports for Plumbing Piping." Reference Division 22 Section "Water Distribution Systems and Specialties" for pipe spacing limitations.

3.4 PIPE JOINT CONSTRUCTION

- A. Press to connect Copper Tubing System
 - 1. Ream, deburr and clean tube ends and verify they are free from indentations, projections, burrs and foreign matter.
 - 2. Install permanent inspection mark on tube.
 - 3. Clean tube and fittings of all dirt and oil. Verify O-ring is in place and free of oil, grease or dirt.
 - 4. Push copper tube into fittings with twisting action to all the way to the fitting stop or shoulder.
 - 5. Mark tube with permanent marker to indicate proper tube insertion depth.
 - 6. Verify press tool has correct size jaw set for tube size used.
 - 7. Complete one tool cycle with empty jaw to calibrate tool for each time new jaw is inserted into tool.

8. Squeeze jaw arms to open tool jaws and place jaws around the contour of the fitting. Verify tool is perpendicular to the fitting and depress tool switch.
 9. Squeeze jaw open to remove the tool and observe witness mark.
 10. Verify crimped fitting connection for misalignment of the copper tube, misalignment of the tool or improper insertion of the tube. If any of these conditions are found cut out the joint and provide a new joint.
 11. Maintain minimum distance between joints per the manufacturer's published installation instructions.
- B. Dielectric Isolation Requirements for Copper Grooved Connections: Provide dielectric grooved waterway fittings or couplings at grooved galvanized steel, stainless steel or ductile iron to grooved copper joints. Dielectric waterway fittings are specified in Section "Basic Piping Materials and Methods".
- C. Dielectric Isolation Requirements for Press to Connect Adapter Flange Connections: Provide dielectric flanges or flange kits for the following joint types:
1. Adapter Flanges to Iron, Ductile Iron or Steel Body Valves and Fittings (Except Butterfly Valves with EPDM Sleeve/Seats): Provide full face gaskets between flanges and adapter flanges. At each bolt provide, steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves on valve and adapter flanges.
 2. Adapter Flanges to Butterfly Valves with EPDM Sleeve/Seats in Series with Iron, Ductile Iron or Steel Body Valves and Fittings: At each bolt provide, steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves on adapter flange. Provide steel bolts on butterfly valve flange.
 3. Adapter Flanges to Butterfly Valves in Copper Tubing: Install flat washers at each bolt on adapter flange. Provide full face gasket only for butterfly valves without integral liner acting as a gasket.
 4. Full face gaskets, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves are specified in Section "Basic Piping Materials and Methods".
- D. Flange Adapters:
1. Install flange adapter washers when flange adapters are used against the following surfaces:
 - a. Rubber.
 - b. Adapting to ANSI/AWWA cast flanges.
 - c. Rubber faced lug valves.
 - d. Serrated flanged surfaces.

2. Do not install flange adapters for applications that incorporate tie rods for anchoring or on standard grooved-end fittings within 90 degrees of each other.

3.5 VALVE APPLICATIONS

- A. Reference Division 22 Section "Water Distribution Piping and Specialties" for valve applications.

3.6 EQUIPMENT CONNECTIONS

- A. Press to connect joints shall not be provided for equipment connections. Provide flanges, unions, di-electric unions or waterway fittings. Flanges, unions, di-electric unions and waterway fittings are specified in Division 22 specification section "Basic Piping Materials and Methods"

3.7 STRAINERS

- A. Provide strainers as specified in part 2 of this specification section or Division 22 specification section "Basic Piping Materials and Methods".
 1. Provide manufacturer strainer with press to connect ends for 2 inches and smaller.
 2. Provide copper press to connect X screwed NPT adapters for 2 inches and smaller.

3.8 WATER DISTRIBUTION SPECIALTIES INSTALLATION

- A. Reference Division 22 Section "Water Distribution Systems and Specialties" for water distribution specialties and installation requirements.

3.9 FIELD QUALITY CONTROL

- A. The following procedures are paraphrased from the ASME B-31.9, code for pressure piping, building services piping.
- B. Installing contractor shall schedule training session with the grooved or press to connect manufacturer for all workers that will be installing or handling the grooved or press to connect piping systems. Submit certification letter along with list of attendees to engineer of record within 30-days of mobilization. Include copy of certification letter with closeout documents.
- C. Press to connect fitting manufacturer shall provide certification training to contractor without cost and without additional cost to Owner.
- D. Provide testing procedures as defined in Division 22 Section "Water Distribution Systems and Specialties" and as specified in grooved mechanical piping manufacturer's installation instructions.
- E. Installing contractor shall visually inspect couplings and repair or replace any misaligned couplings and couplings with gaps prior to calling for inspection as defined in Division 22 Section "General Plumbing Requirements."
- F. Press to connect fitting manufacturer's representative shall make periodic visits to the jobsite during construction to ensure the installing contractor is following the latest published manufacturer's field installation instructions and best practice procedures provided during the training session.

3.10 STARTUP

- A. Refer to Division 22 Section "Water Distribution Piping and Specialties" for startup procedures.

END OF DOCUMENT 221111

DOCUMENT 221123 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following types of plumbing pumps:
 - 1. Cartridge type inline circulators
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 3 Section "Concrete Work" for specifications on concrete and reinforcing materials and concrete placing requirements for equipment pads.
 - 2. Division 22 Section "Coordination" for basic requirements for electrical components that are an integral part of packaged system components.
 - 3. Division 22 Section, "Basic Piping Materials and Methods" for rubber flexible connectors.
 - 4. Division 22 Section "Vibration Isolation for Plumbing Piping and Equipment" for inertia pads, isolation pads, spring supports, and spring hangers.
 - 5. Division 26 Section "Common Work Results for Electrical" required electrical devices.
 - 6. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.2 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
 - 1. Product data including standard performance curves, weights (shipping, installed, and operating), furnished specialties, and accessories, plus installation and start-up instructions.
 - 2. Shop drawings showing layout and connections for plumbing pumps. Include setting drawings with templates, and directions for installation of foundation bolts, anchor bolts, and other anchorages.
 - 3. Wiring diagrams detailing wiring for power, signal, and control systems; differentiating between manufacturer-installed wiring and field-installed wiring.
 - 4. Maintenance data for plumbing pumps, for inclusion in Operating and Maintenance Manuals specified in Division 1 and Division 22 Section "General Plumbing Requirements."
 - 5. Submit certification that pumps, valves, fittings and specialties comply with NSF 61 Annex G.

1.3 QUALITY ASSURANCE

- A. Hydraulic Institute Compliance: Design, manufacture, and install plumbing pumps in accordance with "Hydraulic Institute Standards."
- B. National Electrical Code Compliance: Components shall comply with NFPA 70 "National Electrical Code."
- C. UL Compliance: Plumbing pumps shall be listed and labeled by UL and comply UL Standard 778 "Motor Operated Water Pumps."
- D. UL Compliance: Control panels shall be listed and labeled by UL and comply with Standard 508A "Control Panels".
- E. NEMA Compliance: Electric motors and components shall be listed and labeled NEMA.
- F. Single-Source Responsibility: Obtain plumbing pumps of the same type from a single manufacturer.
- G. Design Criteria: The Drawings indicate sizes, profiles, connections, and dimensional requirements of plumbing pumps and are based on the specific manufacturer types and models indicated. Pumps having equal performance characteristics by other manufacturers may be considered, provided that deviations in dimensions and profiles do not change the design concept or intended performance as judged by the Architect. The burden of proof for equality of plumbing pumps is on the proposer.
- H. Comply with NSF 61 Annex G (pending) for wetted surfaces of valves, fittings and specialties containing no more than 0.25% lead by weight compliance for valves for domestic water service.
- I. Valves, pumps and fittings shall be manufactured in plants located in the United States or certified that they comply with applicable ANSI, ASTM and MSS standards.

1.4 SPARE PARTS

- A. Furnish spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

- 1. Mechanical Seals: One mechanical seal for each pump.

1.5 WARRANTY

- A. Warranty on Pumps: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, pumps with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement includes both parts and labor for removal and reinstallation.

- 1. Warranty Period: One year from date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the following:

1. Cartridge Type Inline Circulators:

- a. Armstrong Pumps, Inc.
- b. Bell & Gossett, ITT.
- c. Grundfos Pumps, Corp.
- d. Taco, Inc.

2. Aquastats:

- a. Dayton
- b. Honeywell
- c. Penn
- d. White-Rodgers

2.2 PUMPS, GENERAL

- A. Pumps and circulators: factory assembled and factory tested.
- B. Preparation for shipping: After assembly and testing, clean flanges and exposed machined metal surfaces and treat with an anticorrosion compound. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- C. Motors: Conform to NEMA standards; single, multiple, or variable speed with type of enclosure and electrical characteristics as indicated; have built-in thermal-overload protection and grease-lubricated ball bearings. Select motors that are nonoverloading within the full range of the pump performance curve.
- D. Apply factory finish paint to assembled, tested units prior to shipping.

2.3 CARTRIDGE TYPE CIRCULATOR PUMPS

- A. General Description: Leakproof, inline, seamless, volute-type pump. Pump and motor shall be assembled on a common shaft in a single hermetically sealed unit, without stuffing boxes or mechanical seals. Accomplish sleeve bearings lubrication by circulating pumped liquid through the motor section. Isolate motor section from the motor stator windings with a thin corrosion-resistant, nonmagnetic, alloy liner. Pumps shall be rated for 125 psig working pressure and 225 deg F continuous water temperature.
- B. Casings: Cast lead free bronze, with stainless steel liner and static O-ring seal to separate motor section from motor stator, and with union piping connections.

- C. Impeller: Overhung, single-suction, closed or open nonmetallic impeller.
- D. Pump Shaft and Sleeve: Stainless steel shaft with carbon steel bearing sleeve.
- E. Motors: 1750 RPM one piece sealed type.

2.4 AQUASTATS:

- A. Remote sensing bulb type, non-modulating, single pole double pole throw with surface mount sensing bulb and mounting bracket, adjustable direct reading scale for set point with adjustable differential.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install pumps in accordance with manufacturer's installation instructions.
- B. General: Comply with the manufacturer's written installation and alignment instructions.
- C. Install pumps in locations and arrange to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.
- D. Support pumps and piping separately so that the weight of the piping system does not rest on the pump.
- E. Suspend inline pumps with althread hanger rod and vibration isolation hangers of sufficient size to support the weight of the pump independent from the piping system.

3.2 EXAMINATION

- A. Examine areas, equipment foundations, and conditions with Installer present, for compliance with requirements for installation and other conditions affecting performance of plumbing pumps. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Examine rough-in for plumbing piping systems to verify actual locations of piping connections prior to installation.

3.3 ALIGNMENT

- A. Align pump and motor shafts and piping connections after setting on foundations, after grout has been set and foundations bolts have been tightened, and after piping connections have been made.
 - 1. Adjust alignment of pump and motor shafts for angular and parallel alignment by one of the two methods specified in the Hydraulic Institute "Centrifugal Pumps - Instructions for Installation, Operation and Maintenance."
- B. After alignment is correct, tighten the foundation bolts evenly but not too firmly. Fill the base plate completely with nonshrink, nonmetallic grout, with metal blocks and shims or wedges in place. After grout has cured, fully tighten foundation bolts.
 - 1. Alignment tolerances shall meet manufacturers recommendations.

3.4 CONNECTIONS

- A. General: Install valves that are same size as the piping connecting the pump.
- B. Install suction and discharge pipe sizes equal to or greater than the diameter of the pump nozzles.
- C. Install a nonslam check valve and shutoff valve on the discharge side of pumps.
- D. Install a gate valve and strainer on the suction side of inline pumps.
- E. Install surface mounted aquastat on bare metal pipe, fastened securely to pipe upstream of circulator pump when indicated on the drawings.
- F. Interlock aquastat and or timer with hot water recirculation pump motor. Electrical wiring and connections are specified in Division 26 section "Common Work Results for Electrical".
- G. Electrical wiring and connections are specified in Division 26 section "Common Work Results for Electrical".

3.5 FIELD QUALITY CONTROL

- A. Check suction lines connections for tightness to avoid drawing air into the pump.

3.6 STARTUP

- A. Final Checks Before Start-Up: Perform the following preventative maintenance operations and checks before start-up:
 - 1. Lubricate oil-lubricated bearings.
 - 2. Remove grease-lubricated bearing covers and flush the bearings with kerosene and thoroughly clean. Fill with new lubricant in accordance with the manufacturer's recommendations.
 - 3. Disconnect coupling and check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
 - 4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.
- B. Starting procedure for pumps with shutoff power not exceeding the safe motor power:
 - 1. Prime the pump, opening the suction valve, closing the drains, and prepare the pump for operation.
 - 2. Open the valve in the cooling water supply to the bearings where applicable.
 - 3. Open the sealing liquid supply valve if the pump is so fitted.
 - 4. Open the warm-up valve of a pump handling hot liquids if the pump is not normally kept at operating temperature.

5. Open the recirculating line valve if the pump should not be operated against dead shutoff.
 6. Start motor.
 7. Open the discharge valve slowly.
 8. Observe the leakage from the stuffing boxes and adjust the sealing liquid valve for proper flow to ensure the lubrication of the packing. Do not tighten the gland immediately, but let the packing run in before reducing the leakage through the stuffing boxes.
 9. Check the general mechanical operation of the pump and motor.
 10. Close the recirculating line valve once there is sufficient flow through the pump to prevent overheating.
- C. If the pump is to be started against a closed check valve with the discharge gate valve open, the steps are the same except that the discharge gate valve is opened some time before the motor is started.

END OF DOCUMENT 221123

DOCUMENT 221300 - SANITARY DRAINAGE AND VENT PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes building sanitary drainage and vent piping systems, including drains and drainage specialties.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 22 Section "General Plumbing Requirements," for trenching and backfilling materials and methods for underground piping installations.
 - 2. Division 33 Section "Sanitary Sewage Systems," for sanitary drainage piping beginning from 5'-0" outside the building.
 - 3. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.
 - 4. Division 11 Section "Kitchen and Food Service Equipment," for drains and trim furnished with the food service and kitchen equipment.
 - 5. Division 22 Section "Plumbing Identification," for labeling and identification of drainage and vent piping.
 - 6. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall and floor penetrations and equipment pads
 - 7. Division 22 Section "Basic Piping Material and Methods," for materials and methods for mechanical sleeve seals.
 - 8. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hanging and supporting drainage and vent piping.
 - 9. Division 22 Section "Plumbing Insulation," for materials and methods for insulating drainage piping.
 - 10. Division 22 Section "Water Distribution Piping and Specialties," for material and methods for trap primers and trap primer inlet piping.
 - 11. Division 22 Section "Condensate Pumps for HVAC Equipment," for material and methods for condensate pumps.

1.2 DEFINITIONS

- A. Sanitary Building Drain: That part of the lowest piping of a drainage system which receives the discharge from soil, waste, and other drainage pipes inside the walls of the building and conveys it to the building sewer.

- B. Sanitary Building Sewer: That part of the drainage system which extends from the end of the building drain and conveys its discharge to a public sewer, private sewer, individual sewage disposal system, or other point of disposal.
- C. Drainage System: Includes all the piping within a public or private premises which conveys sewage or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.
- D. Vent System: A pipe or pipes installed to provide a flow of air to or from a drainage system, or to provide a circulation of air within such system to protect trap seals from siphonage and back pressure.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.
- B. Product data for the following products:
 - 1. Drainage piping
 - 2. Drainage piping specialties
 - 3. Floor drains
 - 4. Trench drains
 - 5. Interceptors
- C. Test reports specified in Part 3 of this Section.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the provisions of the following codes:
 - 1. 2018 International Plumbing Code with Amendments.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Drainage Piping Specialties, including cleanouts, and floor drains,:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Mfg. Co.
 - c. Mifab Manufacturing Co.

- d. Sioux Chief Manufacturing Co. Inc.
 - e. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
 - f. Watts Industries, Inc.
 - g. Zurn Industries, Inc.; Hydromechanics Div.
2. Cast Iron Soil Pipe and Fittings
- a. AB & I Foundry
 - b. Charlotte Pipe and Foundry Company
 - c. Tyler Pipe / Soil Pipe Division
3. Shielded Transition Couplings
- a. FERNCO, "Proflex 3000 Series"
 - b. Mission Rubber Company, "Band Seal Specialty Couplings"
4. Underground Shielded Adapter Couplings
- a. FERNCO, "1056 Series with SR73 Shear Ring"
 - b. Mission Rubber Company, "MR56 Series"
5. Trap Seals
- a. Green Drain, Inc.
 - b. Jay R. Smith Mfg. Co.
 - c. Mifab Manufacturing, Inc.
 - d. Proset Systems "Trap Guard"
 - e. Rector Seal, Inc.
 - f. Zurn Industries, Inc.; Hydromechanics Div.
6. Hubless Couplings:
- a. Anaco
 - b. Ideal Tridon
 - c. Mission Rubber Company
 - d. ProFlo "PFNH"

e. Tyler Pipe / Soil Pipe Division

2.2 ABOVE GROUND DRAINAGE AND VENT PIPE AND FITTINGS

- A. Refer to Part 3, Article "Pipe Applications - Above Ground, Within Building" for identification of systems where the materials listed below are used.
- B. Cast-Iron Soil Pipe: CISPI 301 and ASTM A888, no-hub pipe and fittings and bearing the trademark of CISPI and NSF.
 - 1. Couplings and compression gaskets, NSF certified: ASTM C564 and CISPI 310.
- C. Copper Tube: ASTM B306, Type DWV, hard drawn for pipe, and cast copper alloy solder joint drainage fittings (DWV) meeting ASME / ANSI B16.23.
 - 1. Solder Filler Materials: ASTM B32, 95-5 tin-antimony solder.
- D. Copper Tube: ASTM B88, Type M, hard drawn for pipe and wrought copper fittings with soldered joints.
 - 1. Solder Filler Materials: ASTM B32, 95-5 tin-antimony solder.
- E. PVC DWV Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 and ASTM D2665 with "solid wall" PVC meeting ASTM D1784 with cell class 12454-B.
 - 1. Fittings: DWV pattern meeting ASTM D2665 with solvent cement socket joints.
 - 2. Solvent: ASTM D2564.
- F. PVC Pressure Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 with "solid wall" PVC meeting ASTM D1784 with cell class 12454.
 - 1. Solvent: ASTM D2564.
 - 2. Fittings: Schedule 40 meeting ASTM D2466 with solvent cement socket joints.
- G. Shielded Transition Couplings: ASTM C1460 with neoprene adapter gasket with stainless steel Shield and hose clamps.

2.3 UNDERGROUND BUILDING DRAIN AND VENT PIPE AND FITTINGS

- A. Refer to Part 3, Article "Pipe Applications - Below Ground, Within Building" for identification of systems where the materials listed below are used.
- B. PVC DWV Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 and ASTM D2665 with "solid wall" PVC meeting ASTM D1784 with cell class 12454-B.
 - 1. Fittings: DWV pattern meeting ASTM D2665 with solvent cement socket joints.
 - 2. Solvent: ASTM D2564.

- C. Underground Shielded Adapter Couplings: ASTM C1173 with neoprene adapter gasket with stainless steel shield and stainless steel hose clamps.

2.4 DRAINAGE PIPING SPECIALTIES

- A. Cleanout Plugs: As specified on the drawings.
- B. Floor Cleanouts: As specified on the drawings.
- C. Wall Cleanouts: As specified on the drawings.
- D. Floor Drains: As specified on the drawings.
- E. Trap seals: Provide trap seals meeting either description below:
 - 1. Smooth, soft, flexible, elastomeric PVC material molded into shape of duck's bill, open on top with curl closure at bottom. The flow of wastewater allows duck's bill to open and adequately discharge to floor drain through its interior. The duck's bill closes and returns to original molded shape after wastewater discharge is complete. Or, smooth, soft, flexible, elastomeric PVC material with a flapper closure. The flow of wastewater allows flapper to open and adequately discharge to floor drain through its interior. The flapper closes and returns to original molded shape after wastewater discharge is complete.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install pipe and specialties in accordance with manufacturer's installation instructions.

3.2 PREPARATION FOUNDATION FOR UNDERGROUND SANITARY BUILDING DRAINS

- A. Pipe Beds:
 - 1. PVC and ABS Pipe: Support pipe in trench with sand bags level and true to prevent sand, gravel or debris from interfering with the solvent cement process. After pressure testing is complete, gradually install bedding to maintain continuous pipe slope and prevent pipe deflection and then install subbase. Refer to Section "General Plumbing Requirements" for bedding and subbase materials, excavation, trenching, backfill and compaction requirements and refer to ASTM D2321 "Underground Installation of Thermoplastic Pipe for Sewers and Gravity-flow Applications" for additional requirements.

3.3 PIPE APPLICATIONS - ABOVE GROUND, WITHIN BUILDING

- A. Install hubless, cast-iron soil pipe and fittings for 15" and smaller soil, waste, and vent pipe.
- B. Install Type DWV copper tube with cast copper alloy solder joint drainage fittings (DWV) fittings, copper sweat X screwed with solder joints, for waste connections from urinals, lavatories, sinks, water coolers, and kitchen equipment to cast iron drainage piping.
- C. Install Type M copper tube with wrought copper fittings with solder joints, 1" and smaller, with $\frac{3}{4}$ " minimum size and install Type DWV copper tube with cast copper alloy solder joint drainage

fittings (DWV) fittings for 1-1/4" and larger for waste connections from kitchen equipment and terminate over floor receptors with air gap.

- D. Condensate drain piping and pumped condensate drain piping inside the building: Provide 3/4" minimum size or as indicated on the drawings. Slope gravity drainage condensate piping from mechanical equipment at 1/8" per foot minimum slope. Discharge to floor receptor with air gap.
 - 1. Install Type M copper tube with wrought copper fittings with solder joints, 1" and smaller and install Type DWV copper tube with cast copper alloy solder joint drainage (DWV) fittings for 1-1/4" and larger. Provide galvanic isolators as specified in Division 22 "Basic Piping Materials and Methods".
 - 2. As a contractor's option with Owner approval, install PVC pressure pipe and fittings for 1" and smaller and install "solid wall" PVC Type DWV pipe and fittings for 1-1/4" and larger. Except no plastic pipe shall be installed in return air plenums.
- E. Condensate drain piping outside the building: Provide 3/4" minimum size or as indicated on the drawings. Slope condensate piping at 1/8" per foot minimum slope to discharge point. Discharge to roof receptors or roof drains with air gap.
 - 1. Install galvanized schedule 40 steel pipe and malleable iron fittings.
- F. As a contractor's option with Owner approval, install PVC Type DWV Plastic pipe and fittings for drainage and vent pipe, except install no plastic pipe in return air plenums.
- G. Install 1/2" type L copper tube for trap primer outlet piping.

3.4 PIPE APPLICATIONS - BELOW GROUND, WITHIN BUILDING

- A. Install PVC Type DWV Plastic pipe and fittings for drainage and vent pipe for 24" and smaller. Install fabricated fittings for 16 inch and larger.
- B. Install 1/2" type K soft copper tube for trap primer outlet piping.

3.5 PIPE AND TUBE JOINT CONSTRUCTION

- A. Copper Tubing: Solder joints in accordance with the procedures specified in AWS "Soldering Manual."
- B. Cast-Iron Soil Pipe: Make hubless joints in accordance with the Cast-Iron Soil Pipe & Fittings Handbook, Chapter IV. Install Couplings as followings:
 - 1. Install hubless couplings complying with CISPI 310 on soil, waste and vent piping.
- C. PVC DWV Pipe: Joining and installation of PVC drainage pipe and fittings shall conform to ASTM D2665.
- D. ABS to PVC Transition Joints: When joining ABS to PVC components (such as an ABS building drain to PVC sewer pipe) make joints using solvent cements conforming to ASTM D3138.
- E. Cast Iron to PVC Above Grade: Join cast iron to PVC with shielded transition couplings.

- F. Cast Iron to PVC Below Grade: Join cast iron to PVC with underground shielded adapter couplings.

3.6 INSTALLATION

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing, slope, expansion, and other design considerations. So far as practical, install piping as indicated.
- B. Use fittings for all changes in direction and all branch connections.
- C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- G. Paint exposed copper drain lines serving kitchen equipment with a minimum of two coats of chromium-based paint.
- H. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and sealer. Refer to Division 22 Section "Basic Piping Material and Methods" for special sealers and materials.
- I. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings and floors, maintain the fire rated integrity. Refer to Division 22 Section "Basic Piping Material and Methods" for special sealers and materials.
- J. Foundation Penetrations: Where pipes pass through foundation walls above strip footings or under strip footings, protect pipes from building load with cast iron soil pipe sleeves two pipe sizes larger than the pipe. Sleeves installed under the strip footing shall be encased in concrete.
- K. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.
- L. Make changes in direction for drainage and vent piping using appropriate 45 degree wyes, combination wye and eighth bend, or long sweep, quarter, sixth, eighth, or sixteenth bends. Sanitary tees or quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn pattern combination wye and eighth bends where two fixtures are installed back to back and have a common drain. Straight

tees, elbows, and crosses may be used on vent lines. Double wyes or double wye combinations shall not be used in the horizontal. No change in direction of flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper sized standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

- M. Install underground building drains to conform with the plumbing code, and in accordance with the Cast Iron Soil Pipe Institute Engineering Manual. Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.
- N. Install drainage piping pitched down at a minimum slope of 1/4 inch per foot (2 percent) for piping 3 inch and smaller, and 1/8 inch per foot (1 percent) for piping 4 inch and larger. Install vent piping pitched to drain back by gravity to the sanitary drainage piping system.
- O. Install condensate drains pitched down at a minimum slope of 1 to 10 for piping 3 inches and smaller.
- P. Extend building drain to connect to service piping, of size and in location indicated for service entrance to building. Sewer service piping is specified in a separate section of Division 2.
- Q. Install 1 inch thick extruded polystyrene over underground building drain piping not under building. Width of insulation shall extend minimum of 12" beyond each side of pipe. Install directly over, and center on pipe center line.

3.7 HANGERS AND SUPPORTS

- A. General: Hanger, support, insulation protection shields, and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.
- B. Install the following pipe attachments:
 - 1. Adjustable clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.
 - 2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs.
 - 3. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections "Hangers and Supports for Plumbing Piping" and "Plumbing Insulation".
 - a. Install high density insulation on insulated pipe.
 - 4. Provide vinyl coated hangers and riser clamps for use with PVC pipe.
 - 1. Provide roll hangers for individual horizontal runs 100 feet or longer.

2. Provide ceiling flanges attached to the floor, all thread rod and split ring pipe clamps for indirect drains and condensate drains supported from the floor 2" and smaller.

- C. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, this specification, and authorities having jurisdiction requirements, whichever are most stringent. Install hangers for horizontal piping with the following maximum spacing and minimum rod diameters:

Nom. Pipe	Steel Pipe		Copper Tube		Min. Rod	
	<u>Size – In.</u>		<u>Max. Span – Ft.</u>		<u>Max. Span – Ft.</u>	
Up to 1-1/4	12	6		3/8		
	1-1/2 to 2		12		10	3/8
	2-1/2 to 4		12		10	3/8
	5		12		10	1/2
	6		12		10	1/2
	8		12		10	1/2
	10 to 12		12		10	5/8
	14 to 15		12		N/A	3/4

1. Support all sizes of horizontal cast iron piping every five feet, except up to ten feet where ten foot sections are installed. Support all sizes of hubless horizontal cast iron piping every other joint, unless over four feet, then support each joint. Provide support adjacent to joint, not to exceed 18". Provide support at each horizontal branch.
2. Support all sizes of vertical cast iron piping every ten feet.
3. Support all sizes of horizontal of PVC piping every four feet.
4. Support piping within 12" of each elbow or tee.
5. Support each P-trap.

- D. Support condensate piping located on roof with pre-engineered roof supports, pre-engineered roof supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table above for maximum spacing of supports. Adjust pipe support to maintain minimum pipe slope.

- E. Sway bracing:

1. Provide rigid sway bracing for pipe 4" and larger at changes of direction greater than 45 degrees.

3.8 INSTALLATION OF PIPING SPECIALTIES

- A. Above Ground Cleanouts: Install in above ground piping and building drain piping as indicated, and:

1. as required by plumbing code;
2. at each change in direction of piping greater than 45 degrees;

3. at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping;
 4. at base of each vertical soil and waste stack.
- B. Cleanout Covers: Install floor and wall cleanout covers for concealed piping, types as indicated.
- C. Floor Cleanouts: Install in below floor building drain piping as indicated, and:
1. as required by plumbing code;
 2. at each change in direction of piping greater than 45 degrees;
 3. Install in below floor building drain piping at minimum intervals of 50' for piping 4" and smaller and 75' for larger piping;
 4. Install floor cleanouts in waterproof floors with waterproof membrane securely flashed with cleanout body flashing clamp so that no leakage occurs between cleanout body and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.
- D. Exterior Cleanouts: Install exterior cleanouts embedded in a 18" x 18" x 8" block of concrete, flush with finished grade.

3.9 INSTALLATION OF FLOOR DRAINS, FLOOR SINKS AND FLOOR TROUGHS

- A. Install floor drains, floor sinks, shower linear trench drains and floor troughs in locations indicated.
- B. Install floor drains, trench drains and shower linear trench drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor. Set floor sinks and floor troughs flush with the level finish floor.
- C. Refer to architectural documents for floor slope requirements and set floor drain elevation to match. Where architectural documents do not indicate the requirements, set the floor drain elevation depressed below the finished slab elevation as listed below to provide proper slope to drain:

<u>DEPRESSION IN INCHES</u>	<u>RADIUS OF AREA DRAINED - FEET</u>
1/2	5
3/4	10
1	15
1-1/4	20
1-1/2	25

- D. Provide P-traps for drains connected to the sanitary sewer.
- E. Install floor drains, floor sinks, shower linear trench drains, and floor troughs in waterproof floors with waterproof membrane securely flashed with drain flashing clamp so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.
- F. Position drains so that they are level, accessible and easy to maintain.

3.10 INSTALLATION OF TRAP PRIMERS

- A. Install trap primer outlet piping with 1/32" per foot slope towards drain trap where possible.
- B. Connect trap primer outlet piping only to factory installed taps on the drain body or P-trap assembly or provide an auxiliary inlet fitting with factory installed trap primer tap.
- C. Install trap primer outlet piping in elevated slabs or slabs on grade below concrete reinforcing bars. Wrap with 1/2" thick flexible unicellular insulation, attach to the reinforcing bars with plastic ties and spacers every five feet to eliminate galvanic corrosion. Refer to Division 22 Section "Plumbing Insulation" for flexible unicellular insulation.
- D. Where proper trap primer outlet piping slope can be maintained and the trap primer outlet line would not be subject to freezing, trap primer outlet lines may be installed as follows:
 - 1. Install below elevated floor slabs.
 - 2. Install in the sub grade of slab on grade.
- E. Install sleeves and caulk at penetrations through building floor for watertight installation. In an elevated floor slab installation, bracket the piping to bottom of floor once the slab is poured.
- F. Refer to Division 22 Section "Water Distribution Piping and Specialties" for trap primer and trap primer inlet pipe requirements.

3.11 INSTALLATION TRAP SEALS:

- A. Install trap seals in accordance with manufacturer's written instructions and in locations indicated.
- B. Make watertight seal using an adhesive type caulk along bottom of trap seal, if required by the manufacturer.
- C. Employ a test plug for testing and remove before normal floor drain use. Clean inside of drain tailpiece and install trap seal after testing.
- D. Do not touch elastomeric plug or allow contact with primer or solvent cement.

3.12 CONNECTIONS

- A. Piping Runouts to Fixtures: Provide drainage and vent piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by the plumbing code.
- B. Locate piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

3.13 FIELD QUALITY CONTROL

- A. Inspections
 - 1. Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the authority having jurisdiction.

2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.
 - a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
 - b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.
 - c. Reinspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for reinspected by the plumbing official.
 - d. Reports: Prepare inspection reports, signed by the plumbing official.
- B. Piping System Test: Test drainage and vent system in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:
 1. Test for leaks and defects all new drainage and vent piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
 2. Leave uncovered and unconcealed all new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.
 3. Rough Plumbing Test Procedure: Except for outside leaders and perforated or open jointed drain tile, test the piping of plumbing drainage and venting systems upon completion of the rough piping installation. Tightly close all openings in the piping system, and fill with water to the point of overflow, but not less than 10 feet head of water. Water level shall not drop during the period from 15 minutes before the inspection starts, through completion of the inspection. Inspect all joints for leaks.
 4. Final Plumbing Test Procedure: After the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proved gas and water-tight. Tightly close all openings, initially except vents thru the roof, in the system and fill the system with smoke from one or more smoke machines designed for smoke testing of plumbing systems. When smoke appears at a vent thru the roof, seal the vent thru roof with a test plug. Pressurize the system with 1" water column of smoke for 15 minutes. Use a "U" tube or manometer inserted in the trap of a water closet to measure this pressure. Visually verify all joints for leaks.
 5. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.
 6. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

3.14 ADJUSTING AND CLEANING

- A. Clean interior of piping system. Remove dirt and debris as work progresses.
- B. Clean drain strainers, domes, and traps. Remove dirt and debris.

3.15 PROTECTION

- A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.
- C. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with 2 coats of a water based latex paint.

END OF DOCUMENT 221300

DOCUMENT 221400 - STORM DRAINAGE PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes building storm drainage piping systems, including drains and drainage specialties.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 22 Section "General Plumbing Requirements," for trenching and backfilling materials and methods for underground piping installations.
 - 2. Division 33 Section "Storm Systems," for storm drainage piping beginning from 5'-0" outside the building.
 - 3. Division 33 Section "Foundation Drainage," for foundation drainage piping.
 - 4. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.
 - 5. Division 22 Section "Identification for Plumbing Piping and Equipment," for labeling and identification of drainage piping.
 - 6. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall and floor penetrations and equipment pads
 - 7. Division 22 Section "Basic Piping Material and Methods," for materials and methods for mechanical sleeve seals.
 - 8. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hanging and supporting drainage piping.
 - 9. Division 22 Section "Plumbing Insulation," for materials and methods for insulating drainage piping.

1.2 DEFINITIONS

- A. Storm Building Drain: That part of the lowest piping of a drainage system which receives the discharge from storm drainage pipes inside the walls of the building and conveys it to the building sewer.
- B. Storm Building Sewer: That part of the drainage system which extends from the end of the building drain and conveys its discharge to a public sewer or private sewer or other point of disposal.
- C. Drainage System: Includes all the piping within a public or private premises which conveys storm water or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.
- B. Product data for the following products:
 - 1. Drainage piping
 - 2. Drainage piping specialties
 - 3. Roof drains
 - 4. Hubless fitting restraints
- C. Test reports specified in Part 3 of this Section.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the provisions of the following codes:
 - 1. 2018 International Plumbing Code with Amendments.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Drainage Piping Specialties, including cleanouts, area/roof drains and downspout nozzles:
 - a. Josam Mfg. Co.
 - b. Sioux Chief Manufacturing Co. Inc.
 - c. Smith (Jay R) Mfg. Co.
 - d. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.
 - e. Watts Industries, Inc.
 - f. Zurn Industries, Inc.; Hydromechanics Div.
 - g. Mifab Manufacturing, Inc.
 - 2. Heavy Duty Hubless Couplings
 - a. Anaco Husky HD-2000
 - b. Clamp-All 80in. lb.

- c. Ideal Tridon "HD"
 - d. Mission Rubber Company "Heavyweight"
 - e. ProFlo "HD"
 - 3. Cast Iron Soil Pipe and Fittings
 - a. AB & I Foundry
 - b. Charlotte Pipe and Foundry Company
 - c. Tyler Pipe / Soil Pipe Division
 - 4. Shielded Transition Couplings
 - a. FERNCO, "Proflex 3000 Series"
 - b. Mission Rubber Company, "Band Seal Specialty Couplings"
 - 5. Underground Shielded Adapter Couplings
 - a. FERNCO, "1056 Series with SR73 Shear Ring"
 - b. Mission Rubber Company, "MR56 Series"
 - 6. Hubless Fitting Restraints
 - a. Holdrite
- 2.2 ABOVE GROUND DRAINAGE PIPE AND FITTINGS
- A. Refer to Part 3, Article "Pipe Applications - Above Ground, Within Building" for identification of systems where the materials listed below are used.
 - B. Cast-Iron Soil Pipe: CISPI 301 and ASTM A888, hubless pipe and fittings, and bearing the trademark of CISPI and NSF.
 - 1. Heavy duty couplings and compression gaskets: ASTM C564, ASTM C1540 and meeting FM 1680.
 - C. PVC DWV Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 and ASTM D2665 with "solid wall" PVC meeting ASTM D1784 with cell class 12454-B.
 - 1. Fittings: DWV pattern meeting ASTM D2665 with solvent cement socket joints. Fittings 16" and larger shall be fabricated type.
 - 2. Solvent: ASTM D2564.
 - D. Shielded Transition Couplings: ASTM C1460 with neoprene adapter gasket with stainless steel Shield and hose clamps.

2.3 UNDERGROUND BUILDING DRAIN PIPE AND FITTINGS

- A. Refer to Part 3, Article "Pipe Applications - Below Ground, Within Building" for identification of systems where the materials listed below are used.
- B. Cast-Iron Soil Pipe: ASTM A74, Service weight, hub-and-spigot soil pipe and fittings, and bearing the trademark of CISPI and NSF. Pipe and fittings shall have a heavy coating of coal tar varnish or asphaltum on both inside and outside surfaces.
 - 1. Neoprene Compression Gaskets: ASTM C564.
- C. PVC DWV Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 and ASTM D2665 with "solid wall" PVC meeting ASTM D1784 with cell class 12454-B.
 - 1. Fittings: DWV pattern meeting ASTM D2665 with solvent cement socket joints.
 - 2. Solvent: ASTM D2564.
 - a. [PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).]
- D. Underground Shielded Adapter Couplings: ASTM C1173 with neoprene adapter gasket with stainless steel shield and stainless steel hose clamps.

2.4 DRAINAGE PIPING SPECIALTIES

- A. Cleanout Plugs: As specified on the drawings.
- B. Floor Cleanouts: As specified on the drawings.
- C. Wall Cleanouts: As specified on the drawings.
- D. Roof Drains: As specified on the drawings.

2.5 HUBLESS FITTING RESTRAINTS

- A. Pre-engineered kits of galvanized steel pipe straps with stainless steel band clamps and tee bolts, meeting requirements of the CISPI Installation Handbook.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install pipe and specialties in accordance with manufacturer's installation instructions.

3.2 PREPARATION FOUNDATION FOR UNDERGROUND BUILDING DRAINS

- A. Pipe Beds:
 - 1. PVC and ABS Pipe: Support pipe in trench with sand bags level and true to prevent sand, gravel or debris from interfering with the solvent cement process. After pressure testing is complete, gradually install bedding to maintain continuous pipe slope and prevent pipe

deflection and then install subbase. Refer to Section "General Plumbing Requirements" for bedding and subbase materials, excavation, trenching, backfill and compaction requirements and refer to ASTM D2321 "Underground Installation of Thermoplastic Pipe for Sewers and Gravity-flow Applications" for additional requirements.

3.3 PIPE APPLICATIONS - ABOVE GROUND, WITHIN BUILDING

- A. Install hubless, cast-iron soil pipe and fittings 15" and smaller for storm pipe.
- B. Install Type DWV copper tube with cast bronze Type DWV fittings 15" and smaller for storm pipe where indicated on the drawings.
- C. As a contractor's option with Owner approval, install PVC Type DWV Plastic pipe and fittings for 24 inch and smaller storm pipe. Install fabricated fittings for 16 inch and larger.

3.4 PIPE APPLICATIONS - BELOW GROUND, WITHIN BUILDING

- A. Install PVC Type DWV Plastic pipe and fittings for 24 inch and smaller storm pipe. Install fabricated fittings for 16 inch and larger.

3.5 PIPE AND TUBE JOINT CONSTRUCTION

- A. Copper Tubing: Solder joints in accordance with the procedures specified in AWS "Soldering Manual."
- B. Cast-Iron Soil Pipe: Make hubless joints in accordance with the Cast-Iron Soil Pipe & Fittings Handbook, Chapter IV. Install Couplings as followings:
 - 1. Install heavy duty hubless couplings on storm drainage piping, including connections to roof drains.
 - 2. Install Hubless fitting restraints on joints 5" and larger at:
 - a. Changes of direction from vertical to horizontal
 - b. 4" branch connections, including tees, wyes and wye combination fittings to storm drainage piping 5" and larger
 - c. Horizontal changes of direction 22-1/2 degrees and greater
- C. PVC DWV Pipe: Joining and installation of PVC drainage pipe and fittings shall conform to ASTM D2665.
- D. ABS to PVC Transition Joints: When joining ABS to PVC components (such as an ABS building drain to PVC sewer pipe) make joints using solvent cements conforming to ASTM D3138.
- E. Cast Iron to PVC Above Grade: Join cast iron to PVC with shielded transition couplings.
- F. Cast Iron to PVC Below Grade: Join cast iron to PVC with underground shielded adapter couplings.

- G. Gasketed Fittings: Install fittings per the Uni-Bell PVC Pipe Association "Installation Guide for PVC Fittings and Laterals for Solid Wall PVC Sewer Pipe".

3.6 INSTALLATION

- A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing, slope, expansion, and other design considerations. So far as practical, install piping as indicated.
- B. Use fittings for all changes in direction and all branch connections.
- C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- G. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and sealer. Refer to Division 22 Section "Basic Piping Materials and Methods" for special sealers and materials.
- H. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings and floors, maintain the fire rated integrity. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.
- I. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.
- J. Foundation Penetrations: Where pipes pass through foundation walls above strip footings or under strip footings, protect pipes from building load with cast iron soil pipe sleeves two pipe sizes larger than the pipe. Sleeves installed under the strip footing shall be encased in concrete.
- K. Make changes in direction for drainage piping using appropriate 45 degree wyes, combination wye and eighth bend, or long sweep, quarter, sixth, eighth, or sixteenth bends. Sanitary tees or quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn pattern combination wye and eighth bends where two fixtures are installed back to back and have a common drain. No change in direction of flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper sized standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

- L. Install underground building drains to conform with the plumbing code, and in accordance with the Cast Iron Soil Pipe Institute Engineering Manual. Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.
- M. Install drainage piping pitched down at a minimum slope of 1/4 inch per foot (2 percent) for piping 3 inch and smaller, and 1/8 inch per foot (1 percent) for piping 4 inch and larger.
- N. Extend building drain to connect to service piping, of size and in location indicated for service entrance to building. Storm service piping is specified in a separate section of Division 2.
- O. Install 1 inch thick extruded polystyrene over underground building drain piping not under building. Width of insulation shall extend minimum of 12" beyond each side of pipe. Install directly over, and center on pipe center line.

3.7 HANGERS AND SUPPORTS

- A. General: Hanger, support, insulation protection shields, and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.
- B. Install the following pipe attachments:
 - 1. Adjustable clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.
 - 2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs.
 - 3. Provide 304 stainless steel dual rods, nuts, washers, pre-engineered support struts and split two piece pipe clamps for supporting floor cleanouts under slab as detailed on the drawings. Connect rods with rebar tie wires to reinforcing bars in top layer of slab.
 - 4. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections "Hangers and Supports for Plumbing Piping" and "Plumbing Insulation".
 - a. Install high density insulation on insulated pipe.
 - 5. Provide vinyl coated hangers and riser clamps for use with PVC pipe.
 - 6. Provide roll hangers for individual horizontal runs 100 feet or longer.
- C. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, this specification, and authorities having jurisdiction requirements, whichever are most stringent. Install hangers for horizontal piping with the following maximum spacing and minimum rod diameters:

Nom. Pipe Size	Steel Pipe Max. Span	Copper Tube Max. Span.	Min. Rod Dia. - Inches
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<u>In Inches</u>	<u>In Feet</u>	<u>In Feet</u>	
Up to 1-1/4	12	6	3/8
1-1/2 to 2	12	10	3/8
2-1/2 to 3	12	10	3/8
4	12	10	3/8
5	12	10	1/2
6	12	10	1/2
8	12	10	1/2
10 to 12	12	10	5/8
14	12	N/A	3/4
16	12	N/A	7/8

1. Support all sizes of hubless horizontal cast iron piping every five feet, except up to ten feet where ten foot sections are installed. Support all sizes of hubless horizontal cast iron piping every other joint, unless over four feet, then support each joint. Provide support adjacent to joint, not to exceed 18". Provide sway brace on horizontal piping at not more than 40' intervals to prevent horizontal movement. Provide support at each horizontal branch.
2. Support all sizes of vertical cast iron piping every ten feet.
3. Support all sizes of vertical steel piping every other floor, not to exceed twenty-five feet.
4. Support all sizes of horizontal of PVC piping every four feet.
5. Support all sizes of vertical of PVC piping every floor, but not to exceed ten feet. For sizes 2 inches and smaller, provide guide midway between required vertical supports.
6. Support vertical PVC pipe and tube every six feet, at base of each floor, and provide mid-story guides.
7. Support piping within 12" of each elbow or tee.

D. Sway bracing:

1. Provide rigid sway bracing for pipe 4" and larger at changes of direction greater than 45 degrees.

3.8 INSTALLATION OF PIPING SPECIALTIES

A. Above Ground Cleanouts: Install in above ground piping and building drain piping as indicated, and:

1. as required by plumbing code;
2. at each change in direction of piping greater than 45 degrees;
3. at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping;
4. at base of each vertical soil, waste, or storm water stack.

- B. Cleanout Covers: Install floor and wall cleanout covers for concealed piping, types as indicated.
- C. Floor Cleanouts: Install in below floor building drain piping as indicated and:
 - 1. as required by plumbing code;
 - 2. at each change in direction of piping greater than 45 degrees;
 - 3. Install in below floor building drain piping at minimum intervals of 50' for piping 4" and smaller and 75' for larger piping;
 - 4. Install floor cleanouts in waterproof floors with waterproof membrane securely flashed with cleanout body flashing clamp so that no leakage occurs between cleanout body and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.
- D. Exterior Cleanouts: Install exterior cleanouts embedded in a 18" x 18" x 8" block of concrete, flush with finished grade.

3.9 INSTALLATION OF AREA DRAINS

- A. Install area drains in locations indicated.
- B. Install area drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor.
- C. Refer to architectural documents for floor slope requirements and set area drain elevation to match. Where architectural documents do not indicate the requirements, set the area drain elevation depressed below the finished slab elevation as listed below to provide proper slope to drain:

<u>DEPRESSION IN INCHES</u>	<u>RADIUS OF AREA DRAINED - FEET</u>
1/2	5
3/4	10
1	15
1-1/4	20
1-1/2	25

- D. Provide P-traps for drains connected to combined sanitary and storm sewer.
- E. Install area drains in waterproof floors with waterproof membrane securely flashed with drain flashing clamp so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.
- F. Position drains so that they are level, accessible and easy to maintain.

3.10 INSTALLATION OF ROOF DRAINS

- A. Install roof drains at low points of roof areas with the roof membrane securely flashed with drain flashing clamp so that no leakage occurs between drain and roof membrane.

- B. Install drain flashing collar or flange so that no leakage occurs between roof drain and adjoining roofing. Maintain integrity of waterproof membranes, where penetrated.
- C. Position roof drains so that they are accessible and easy to maintain.

3.11 FIELD QUALITY CONTROL

A. Inspections

1. Do not enclose, cover, or put into operation the storm drainage piping system until it has been inspected and approved by the authority having jurisdiction.
2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.
 - a. Rough-in Inspection: Arrange for inspection of the storm drainage piping system before concealed or closed-in after system is roughed-in.
 - b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to ensure compliance with the requirements of the plumbing code.
 - c. Reinspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for reinspected by the plumbing official.
 - d. Reports: Prepare inspection reports, signed by the plumbing official.

B. Piping System Test: Test storm drainage system in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:

1. Test for leaks and defects all new storm drainage piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
2. Leave uncovered and unconcealed all new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.
3. Rough Plumbing Test Procedure: Except for outside leaders and perforated or open jointed drain tile, test the piping of storm drainage piping systems upon completion of the rough piping installation. Tightly close all openings in the piping system, and fill with water to the point of overflow, but not less than 10 feet head of water. Water level shall not drop during the period from 15 minutes before the inspection starts, through completion of the inspection. Inspect all joints for leaks.
4. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.

5. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

3.12 ADJUSTING AND CLEANING

- A. Clean interior of piping system. Remove dirt and debris as work progresses.
- B. Clean drain strainers and domes. Remove dirt and debris.

3.13 PROTECTION

- A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.
- C. Exposed PVC Piping: Protect storm drainage piping exposed to sunlight with 2 coats of a water based latex paint.

END OF DOCUMENT 221400

DOCUMENT 223400 - FUEL FIRED DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes commercial gas fired water heaters.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 3 Section "Concrete Work" for specifications on concrete and reinforcing materials and concrete placing requirements for equipment pads.
 - 2. Division 22 Section "Common Work Results for Plumbing" for concrete equipment pads.
 - 3. Division 22 Section "Basic Piping Materials and Methods" for flexible metal braid connectors, pipe joining materials, specialties, unions, dielectric unions, dielectric flanges, dielectric flange kits and basic installation requirements.
 - 4. Division 22 Section "Meters and Gauges for Plumbing Piping." for thermometers and their installation requirements.
 - 5. Division 22 Section "Natural Gas Piping" for natural gas equipment connections.
 - 6. Division 23 Section "Breechings, Chimneys, and Stacks" for gas-fired water heater vents.
 - 7. Division 26 Section "Common Work Results for Electrical" required electrical devices.
 - 8. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.2 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
 - 1. Product data including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories, and indicating dimensions, required clearances, and methods of assembly of components, and piping and wiring connections.
 - 2. Wiring diagrams from manufacturers detailing electrical requirements for electrical power supply wiring to water heaters. Include ladder-type wiring diagrams for interlock and control wiring required for final installation of water heaters and controls. Differentiate between portions of wiring that are factory installed and portions that are to be field installed.
 - 3. Certificates of shop inspection and data report as required by provisions of the ASME Boiler and Pressure Vessel Code.
 - 4. Maintenance data for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."

1.3 QUALITY ASSURANCE

- A. Electrical Component Standard: Provide components complying with NFPA 70 "National Electrical Code."
- B. Listing and Labeling: Provide water heaters that are listed and labeled.
 - 1. The terms "listed" and "labeled" shall be as defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- C. AGA Standards: Provide water heaters that bear the label of the American Gas Association.
- D. ASME Code Compliance: Provide water heaters and safety relief valves that comply with ASME Boiler and Pressure Vessel Code and that bear the appropriate code symbols.
- E. State Boiler Code Compliance: Provide rated water heaters, safety relief valve, gas train and accessories that comply with the state boiler code in effect.
- F. ASHRAE Standards: Provide water heaters with performance efficiencies not less than prescribed in ASHRAE 90.1b, "Energy Conservation in New Building Design."
- G. Design Concept: The drawings indicate types and capacities of water heaters and are based on specific descriptions and manufacturers indicated. Water heaters having equal performance characteristics by other manufacturers may be considered provided that deviations in capacities, dimensions, operation, or other characteristics are minor and do not change the design concept or intended performance as judged by the Architect. Burden of proof for equality of water heaters is on the proposer.

1.4 WARRANTY

- A. Special Project Warranty: Submit a written warranty, executed by manufacturer, agreeing to repair or replace water heater units that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to, controls, tanks, coils, heat exchangers, and burners. This warranty shall be in addition to, and not a limitation of, other rights the Owner may have against the Contractor under the Contract Documents.
 - 1. Commercial, Gas Fired, Storage Water Heaters:
 - a. Storage Tank: Three years.
 - b. Controls and Other Components: One year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Commercial Sealed Combustion Gas-Fired Condensing Tank Type Water Heaters:

- a. A.O. Smith Water Products Co. Div.; A.O. Smith Corp.
- b. Bock Water Heaters, Inc.
- c. Bradford-White Corp.
- d. HTP Comfort Solutions, LLC
- e. Lochinvar Water Heater Corp.
- f. State Industries, Inc.
- g. Rheem Mfg.
- h. Ruud Mfg. Div.; Rheem Mfg.

2. Thermal Expansion Tanks

- a. Armstrong Pumps, Inc.
- b. Amtrol, Inc.
- c. Bell & Gosset, ITT
- d. Elbi
- e. TACO, Inc.

a. Watts

b. Wessels Tank Co.

3. Vacuum Relief Valves

- a. Apollo #37
- b. Cash ACME #VR-801
- c. Watts #N36
- d. Wilkins #VR-10

2.2 SEALED COMBUSTION GAS-FIRED CONDENSING TANK TYPE WATER HEATERS

- A. Description: sealed combustion gas-fired tank type with submerged combustion chamber, glass lined heat exchanger coil, 150-psig-rated storage tank, fan assisted combustion with exhaust fan, hot surface ignition system with flame monitoring system, magnesium anode, integral thermostats and controls, and temperature & pressure relief valve. Low NOx burner meeting SCAQMD Rule 1146.2.

1. Fuel: Natural gas.
 - B. Insulation: Fiberglass, surrounding tank.
 - C. Jacket: Steel, with baked-on enamel finish.
 - D. Tank: Glass-lined steel, with anode rods and drain valve.
 - E. Safety Controls: Automatic gas shutoff device to shut off entire gas supply in event of excessive temperature in tank.
 - F. Controls: Adjustable surface mounted thermostat, intermittent electronic ignition and flue damper control.
 - G. Temperature and Pressure Relief Valve: Lead free brass body meeting ANSI Z21.22.
 - H. Condensate Neutralization Kits: PVC body with socket weld inlets and outlets, minimum $\frac{3}{4}$ ". Capacity to match heater input.
- 2.3 THERMAL EXPANSION TANKS
- A. Thermal Expansion Tanks: Provide size and number as indicated; construct of welded carbon steel listed for 150 psig working pressure, 200 deg F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity, by means of a FDA approved butyl rubber diaphragm securely sealed into tank. Provide taps for pressure gauge and air charging fitting, and drain fitting. Support vertical tanks with steel legs or base.
- 2.4 VACUUM RELIEF VALVES
- A. Lead free brass body meeting ANSI Z21.22 with silicon disc. Valve shall open at 0.5 inches HG vacuum and be rated for 200 psig working pressure and 250 F operating temperature.
- 2.5 WATER HEATER DRAIN PANS
- A. Galvanized steel or aluminum with outside diameter minimum 2" greater than water heater diameter, with $\frac{3}{4}$ " screwed drain outlet.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

- A. Install in accordance with manufacturer's installation instructions.
- B. General: Install water heaters on concrete equipment bases. Set and connect units in accordance with manufacturer's installation-instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances. Orient so controls and devices needing servicing are accessible.
- C. Install thermometers on water heater outlet piping. Thermometers are specified in Division 22 Section "Meters and Gauges for Plumbing Piping."

- D. NFPA Compliance: Install gas-fired water heaters in compliance with NFPA 54, "National Fuel Gas Code."
- E. Install temperature and pressure relief valve furnished with water heater. The temperature shall be normally set to relieve at 210F and the pressure relief shall be equal to the tank pressure rating. Install line size relief valve discharge line to discharge to an approved receptor with air gap.
- F. Vacuum Relief Valve: Install in cold water supply to each water heater downstream of the shutoff and check valves.
- G. Water Heater Drain Pan: Install under water heater on wall or ceiling supports or resting on elevated floor slabs. Install drain pan drain line to discharge to an approved receptor with air gap.
- H. Install condensate neutralization kit furnished with water heater condensate drain downstream of trap at condensate connection. Fill kit with water heater manufacturer recommended neutralization media.

3.2 CONCRETE EQUIPMENT BASES

- A. Construct concrete equipment bases in accordance with Section "Basic Mechanical Materials and Methods" for setting of equipment.

3.3 EXPANSION TANK INSTALLATION

- A. Install in-line expansion tanks in the vertical or horizontal position (where allowed by manufacturer). Where tanks are installed in horizontal position, provide supports per manufacturer requirements.
- B. Install stand mounted expansion tanks on concrete equipment bases.
- C. Charge expansion tank bladder with air to a pressure equal to the domestic water static pressure.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Sections of Division 22. The Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
 - 1. Install piping adjacent to equipment arranged to allow servicing and maintenance.
 - 2. Connect hot and cold water piping to units with shutoff valves and unions. Connect hot water circulating piping to unit with shutoff valve, check valve, and union. Extend relief valve discharge to closest floor drain.
 - a. Where water heater piping connections are dissimilar metals, install dielectric waterway fittings or dielectric unions for joints 2" and smaller and dielectric flanges for joints 2-1/2" and larger. Dielectric waterway fittings, unions and flanges are specified in Division 22 Section "Basic Piping Materials and Methods."
 - b. Install vacuum relief valve in cold water inlet piping.

3. Connect gas supply piping to burner with drip leg, tee, gas cock, and union; minimum size same as inlet connection. Arrange piping to allow unit servicing. Gas piping is specified in Division 22 Section "Natural Gas Piping".
 - a. Install vent piping from gas train pressure regulators and valves to outside the building. Terminate vent piping with brass screened vent cap fitting. Do not combine vents except with approval of local authority.
 - b. Install gas pressure regulators where indicated.
 4. Install drain as indirect waste to spill into open drain or over floor drain.
 - a. Install drain valve at low point in water piping, for water heaters not having tank drain.
 5. Connect oil piping to oil burner with shutoff valve and union in supply, and check valve and union in return. Arrange piping to allow unit servicing.
 6. Install heat traps at inlet and outlet of each water heater storage tank. Heat trap shall be made of elbows and piping. Heat trap shall turn down to 12" below the outlet or inlet, run 12" horizontal and turn up to the cold water to the heater or hot water from the heater. Where multiple tanks are connected with a manifold, a single heat trap may be provided at the connection of the cold water supply to the cold water manifold together.
- B. Electrical Connections:
1. Power wiring is specified in Division 26 Section "Common Work Results for Electrical"
 2. Field-installed disconnects are specified in Division 26 Sections "Enclosed Switches and Circuit Breakers".
 3. Grounding: Connect unit components to ground in accordance with the National Electrical Code.
- C. Vent Connections: Connect gas-fired water heater draft hood to the vent system. Unless otherwise indicated provide vent same size as outlet on heater. Comply with gas utility requirements.
1. Vents are specified in Division 23 Section "Breechings, Chimneys, and Stacks."
- D. Vent Connections: Connect oil-fired water heater vent and draft regulator to the vent system. Provide vent and draft regulator same size as outlet on heater.
1. Vents are specified in Division 23 Section "Breechings, Chimneys, and Stacks."
- E. Vent Connections for Sealed Combustion Tank Type Gas Fire Water Heaters:
1. Vents are specified in Division 23 Section "Breechings, Chimneys, and Stacks."
 2. Furnish intake and exhaust vent terminal furnished by heater manufacturer for installation by mechanical.

3. Provide ¾" PVC indirect drain from manufacturer exhaust fitting indirect drain connection furnished with water heater. Provide ¾" PVC P-trap with minimum 1" trap seal and route indirect drain to nearest floor drain, discharge to floor drain with air gap.
4. Install condensate neutralization kit furnished with water heater on floor adjacent to water heater in an accessible location.

F. Vent Connections for Instantaneous Gas Fired Water Heaters:

1. Vents are specified in Division 23 Section "Breechings, Chimneys, and Stacks."
2. Furnish intake and exhaust vent terminal furnished by heater manufacturer for installation by mechanical.
3. Provide ¾" PVC indirect drain from condensate indirect drain connection furnished with water heater. Provide ¾" PVC P-trap with minimum 1" trap seal and route indirect drain to nearest floor drain, discharge to floor drain with air gap.
4. Install condensate neutralization kit furnished with water heater on floor adjacent to water heater in an accessible location.

3.5 FIELD QUALITY CONTROL

- A. General: Provide the services of a factory-authorized service representative to test and inspect unit installation, provide start-up service, and demonstrate operation of equipment as specified below.
1. Test and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment.

3.6 STARTUP

A. Perform the following before start-up final checks:

1. Fill water heaters with water.
2. Piping systems test complete.
3. Check for piping connections leaks.
4. Check for adequate combustion air.
5. Check for clear vent.
6. Test operation of safety controls and devices.

B. Perform the following start-up procedures:

1. Energize circuits.
2. Adjust operating controls.

3. Adjust hot water outlet temperature setting.

3.7 TRAINING

- A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of two hours on the operation and maintenance of the equipment provided under this section.
- B. Content: Training shall include but not be limited to:
 1. Overview of the system and/or equipment as it relates to the facility as a whole.
 2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.
 3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."
- C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.
- D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF DOCUMENT 223400

DOCUMENT 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes plumbing fixtures and trim, fittings, and accessories, appliances, appurtenances, equipment, and supports associated with plumbing fixtures.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 7 Section "Joint Sealers," for materials and methods for sealing between plumbing fixtures and interior walls.
 - 2. Division 22 Section "General Duty Valves for Plumbing Piping" for valves used as supply stops.
- C. Products furnished but not installed under this Section include:
 - 1. Plumbing fittings (including faucets) and piping indicated, for fixtures, appliances, appurtenances, and equipment provided by Owner.
 - 2. Plumbing fittings (including faucets) and piping indicated, for fixtures, appliances, appurtenances, and equipment specified in other Sections.
- D. Products installed but not furnished under this Section include:
 - 1. Owner furnished fixtures, as indicated.
 - 2. Accessories, appliances, appurtenances, and equipment specified in other Sections, requiring plumbing services or fixture-related devices, as indicated.

1.2 DEFINITIONS

- A. Accessible: Describes a plumbing fixture, building, facility, or portion thereof that can be approached, entered, and used by physically handicapped people.
- B. Accessory: Device that adds effectiveness, convenience, or improved appearance to a fixture but is not essential to its operation.
- C. Appliance: Device or machine designed and intended to perform a specific function.
- D. Appurtenance: Device or assembly designed to perform some useful function when attached to or used with a fixture.
- E. Equipment: Device used with plumbing fixtures or plumbing systems to perform a certain function for plumbing fixtures but that is not part of the fixture.
- F. Fitting: Fitting installed on or attached to a fixture to control the flow of water into or out of the fixture.

- G. Fixture: Installed receptor connected to the water distribution system, that receives and makes available potable water and discharges the used liquid or liquid-borne wastes directly or indirectly into the drainage system. The term "Fixture" means the actual receptor, except when used in a general application where terms "Fixture" and "Plumbing Fixture" include associated trim, fittings, accessories, appliances, appurtenances, support, and equipment.
- H. Roughing-In: Installation of piping and support for the fixture prior to the actual installation of the fixture.
- I. Support: Device normally concealed in building construction, for supporting and securing plumbing fixtures to walls and structural members. Supports for urinals, lavatories, and sinks are made in types suitable for fixture construction and the mounting required. Categories of supports are:
 - 1. Carrier: Floor-mounted support for wall-mounted water closet, and support fixed to wall construction for wall-hung fixture.
 - 2. Chair Carrier: Support for wall-hung fixture, having steel pipe uprights that transfer weight to the floor.
 - 3. Chair Carrier, Heavy Duty: Support for wall-hung fixture, having rectangular steel uprights that transfer weight to the floor.
 - 4. Reinforcement: Wood blocking or steel plate built into wall construction, for securing fixture to wall.
- J. Trim: Hardware and miscellaneous parts, specific to a fixture and normally supplied with it required to complete fixture assembly and installation.
- K. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content $\leq 0.25\%$ per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
 - 1. Product data for each type of plumbing fixture specified, including fixture and trim, fittings, accessories, appliances, appurtenances, equipment, supports, construction details, dimensions of components, and finishes.
 - 2. Wiring diagrams for field-installed wiring of electrically operated units.
 - 3. Maintenance data for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."
- B. Submit third party certification that faucets and trim for domestic water distribution for drinking or cooking comply with NSF 61 Annex G and / or NSF 372. The following faucets and trim need not comply:

1. Electronic faucets
2. Service sink faucets
3. Flush valves
4. Shower valves and heads

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with requirements of ICC Standard A117.1, "Accessible and Usable Buildings and Facilities," and "2010 ADA Standards for Accessible Design" with respect to plumbing fixtures for individuals with disabilities.
- B. Listing and Labeling: Provide electrically operated fixtures specified in this Section that are listed and labeled.
 1. The terms "listed" and "labeled" shall be as defined in the National Electrical Code, Article 100.
 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- C. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of faucets and trim containing no more than 0.25% lead by weight for domestic water distribution for drinking or cooking.
- D. Design Concept: The drawings indicate types of plumbing fixtures and are based on the specific descriptions, manufacturers, models, and numbers indicated. Plumbing fixtures having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions, operation, color or finish, or other characteristics are minor and do not change the design concept or intended performance as judged by the Architect. Burden of proof for equality of plumbing fixtures is on the proposer.

1.5 SPARE PARTS

- A. Deliver spare parts to Owner. Furnish spare parts described below matching products installed, packaged with protective covering for storage, and identified with labels clearly describing contents.
- B. Faucet Cartridges and O-rings: Furnish quantity of identical units not less than 5 percent of amount of each installed.
- C. Flushometer Repair Kits: Furnish quantity of identical units not less than 10 percent of amount of each flushometer installed.
- D. Provide individual metal boxes or a hinged-top wood or metal box having separate compartments for each type and size of above extra materials.
- E. Water Closet Tank Repair Kits: Furnish quantity of identical flush valve units not less than 5 percent of amount of each type installed.

- F. Toilet Seats: Furnish quantity of identical units not less than 5 percent of amount of each type toilet seat installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products in each category, by one of the following listed for that category:

1. Water Closets:
 - a. American Standard, Inc.
 - b. Gerber Plumbing Fixture Corp.
 - c. Kohler Co.
 - d. PROFLO
 - e. Sloan Valve Co.
 - f. TOTO KIKI USA, Inc.
 - g. Zurn Plumbing Products Group
2. Urinals:
 - a. American Standard, Inc.
 - b. Gerber Plumbing Fixture Corp.
 - c. Kohler Co.
 - d. PROFLO
 - e. Sloan Valve Co.
 - f. TOTO KIKI USA, Inc.
 - g. Zurn Plumbing Products Group
3. Mop Basins:
 - a. Acorn Engineering Co.
 - b. Fiat Products.
 - c. Stern-Williams Co., Inc.
4. Water Coolers:

- a. Acorn / Aqua
 - b. Elkay Manufacturing Co.
 - c. Halsey Taylor; A Household International Co.
 - d. Haws Drinking Faucet Co.
5. Outlet Boxes:
- a. Guy Gray Manufacturing Co., Inc.
 - b. Symmons Industries, Inc.
 - c. Oatey Co.
6. Toilet Seats:
- a. Bemis Mfg. Co.
 - b. Beneke Div.; Sanderson Plumbing Products, Inc.
 - c. Church Seat Co.
 - d. Kohler Co.
 - e. Olsonite Corp.
 - f. Sperzel Industries, Inc.
7. Flushometers – Diaphragm Type:
- a. Sloan Valve Co.
 - b. Zurn Industries, Inc.; Flush Valve Operations.
8. Commercial/Industrial Cast-Brass Faucets:
- a. Chicago Faucet Co.
 - b. Delta-Commercial
 - c. Speakman Co.
 - d. T & S Brass and Bronze Works, Inc.
 - e. Zurn Industries, LTD. "Aqua Spec"
9. Sensor-Operated Faucets and Devices:
- a. Sloan Valve Co.

- b. Zurn Industries, LTD. "Aqua Spec"
- 10. Stop Valves & Supplies:
 - a. Brass Craft Subsidiary; Masco Co.
 - b. Engineered Brass Company
 - c. McGuire Manufacturing Co., Inc.
 - d. PROFLO
 - e. Watts Brass and Tubular
 - f. Zurn Industries
- 11. P-traps, Drains & Miscellaneous Fittings:
 - a. Brass Craft Subsidiary; Masco Co.
 - b. Dearborn Brass
 - c. Engineered Brass Company
 - d. Franke
 - e. McGuire Manufacturing Co., Inc.
 - f. PROFLO
 - g. Watts Brass and Tubular
 - h. Zurn Industries
- 12. Supports:
 - a. Josam Co.
 - b. Smith (Jay R.) Mfg. Co.
 - c. Wade Div.; Tyler Pipe.
 - d. Watts Drainage Products
 - e. Zurn Industries, Inc.; Hydromechanics Div.
 - f. Mifab Manufacturing, Inc.
- 13. Insulation Kits

- a. Brocar
- b. McGuire
- c. Plumberex
- d. PROFLO
- e. Trap-Wrap
- f. Truebro, Inc.

2.2 PLUMBING FIXTURES, GENERAL

- A. Provide plumbing fixtures and trim, fittings, other components, and supports as specified on the drawings and below:

2.3 FAUCETS

- A. Faucets General: As described on the drawings.
 - 1. Electronic faucets shall be of the same manufacturer as the water closet and urinal flush valves.

2.4 STOP VALVES & SUPPLIES

- A. Supplies General: As described on the drawings.
 - 1. Exposed piping and parts shall be polished chrome plated.

2.5 P-TRAPS, DRAINS AND MISCELLANEOUS FITTINGS:

- A. Fittings General: As described on the drawings, except as listed below.
 - 1. Exposed piping and fittings shall be polished chrome plated.
 - 2. Fittings installed concealed inside a plumbing fixture or within wall construction may be without chrome plate finish.
 - 3. Fitting and faucet bodies for domestic water distribution shall be of lead free brass or lead free cast bronze.
- B. Sink Continuous Wastes: Polished chrome-plated, tubular brass, 1-1/2 inches, 17 gauge, with brass nuts on slip inlets, and of configurations indicated.
- C. Scullery sink Continuous Wastes: Polished chrome-plated, tubular brass, 2 inches, 17 gauge, with brass nuts on slip inlets, and of configurations indicated.
- D. Escutcheons: Wall flange with set screw.
- E. Escutcheons: Polished chrome-plated, sheet steel wall flange with friction clips.

- F. Deep Pattern Escutcheons: Wall flange with set screw or sheet steel wall flange with friction clips, of depth adequate to conceal protruding roughing-in fittings.

2.6 FLUSHOMETERS

- A. Provide flushometers compatible with fixtures, with features and of consumption indicated As described on the drawings.
 - 1. Exposed metal parts shall be polished chrome plated.
 - 2. Flush valves installed within wall construction may be without chrome plate finish.

2.7 TOILET SEATS

- A. General: As described on the drawings.

2.8 PLUMBING FIXTURE SUPPORTS

- A. Supports: ASME A112.6.1M, categories and types as required for wall-hanging fixtures specified, and wall reinforcement.
- B. Support categories are:
 - 1. Carriers: Supports for wall-hanging water closets and fixtures supported from wall construction. Water closet carriers shall have an additional faceplate and coupling when used for wide pipe spaces. Provide tiling frame or setting gauge with carriers for wall-hanging water closets.
 - 2. Chair Carriers: Supports with steel pipe uprights for wall-hanging fixtures. Urinal chair carriers shall have bearing plates.
 - 3. Chair Carriers, Heavy Duty: Supports with rectangular steel uprights for wall-hanging fixtures.
 - 4. Reinforcement: 2-inch by 4-inch wood blocking between studs or 1/4-inch by 6-inch steel plates attached to studs, in wall construction, to secure floor-mounted and special fixtures to wall.
- C. Support Types: Provide support of category specified, of type having features required to match fixture.
- D. Provide supports specified as part of fixture description, in lieu of category and type requirements above.

2.9 INSULATION KITS

- A. Insulation kits for lavatory and sink waste and supplies of vinyl plastic with reusable fasteners and openings for access to supply stop handles.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install fixtures, trim and supports in accordance with manufacturer's installation instructions.

3.2 APPLICATION

- A. Install plumbing fixtures and specified components, in accordance with designations and locations indicated on Drawings.
- B. Install supports for plumbing fixtures in accordance with categories indicated, and of type required:
 - 1. Carriers for following fixtures:
 - a. Wall-hanging water closets.
 - b. Wall hanging lavatories
 - c. Wall hanging electric water coolers and drinking fountains.
 - d. Wall-hanging fixtures supported from wall construction.
 - 2. Chair carriers for the following fixtures:
 - a. Wall-hanging urinals.
 - b. Wall-hanging lavatories and sinks.
 - c. Wall-hanging drinking fountains and electric water coolers.
 - 3. Heavy-duty chair carriers for the following fixtures:
 - a. Accessible lavatories.
 - b. Fixtures where specified.
 - 4. Reinforcement for the following fixtures:
 - a. Floor-mounted lavatories required to be secured to wall.
 - b. Floor-mounted sinks required to be secured to wall.
 - c. Recessed, box-mounted electric water coolers.
 - d. Wall mounted and mop sink faucets.
 - e. Urinal flush valve solid pipe ring supports.

3.3 INSTALLATION OF PLUMBING FIXTURES

- A. Install plumbing fixtures level and plumb, in accordance with fixture manufacturers' written installation instructions, roughing-in drawings, and referenced standards.
- B. Install wall-hanging, back-outlet water closets with support manufacturer's tiling frame or setting gauge.
- C. Install wall-hanging, back-outlet urinals with gasket seals.
- D. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.
- E. Fasten floor-mounted fixtures and special fixtures having holes for securing fixture to wall construction, to reinforcement built into walls.
- F. Fasten wall-mounted fittings to reinforcement built into walls.
- G. Fasten counter-mounting-type plumbing fixtures to casework.
- H. Secure supplies behind wall or within wall pipe space, providing rigid installation.
- I. Set mop basins in leveling bed of cement grout.
- J. Install stop valve in an accessible location in each water supply to each fixture.
- K. Install trap on fixture outlet except for fixtures having integral trap.
- L. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork. Use deep pattern escutcheons where required to conceal protruding pipe fittings.
- M. Seal fixtures to walls, floors, and counters using a sanitary-type, one-part, mildew-resistant, silicone sealant in accordance with sealing requirements specified in Division 7 Section "Joint Sealers." Match sealant color to fixture color.
- N. Install insulation kits on ADA compliant sink and lavatory waste, continuous wastes, hot and cold water supplies where indicated on the drawings and as required by the ADA.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other sections of Division 22. The Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
 - 1. Install piping connections between plumbing fixtures and piping systems and plumbing equipment specified in other sections of Division 22.
 - 2. Install piping connections indicated between appliances and equipment specified in other sections, direct connected to plumbing piping systems.

3.5 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.

3.6 ADJUSTING AND CLEANING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Operate and adjust disposers, hot water dispensers, and controls. Replace damaged and malfunctioning units and controls.
- C. Adjust water pressure at drinking fountains, electric water coolers, and faucets, shower valves, and flushometers having controls, to provide proper flow and stream.
- D. Replace washers of leaking and dripping faucets and stops.
- E. Clean fixtures, fittings, and spout and drain strainers with manufacturers' recommended cleaning methods and materials.
- F. Adjust faucet wrist blade handles perpendicular to the spout while in the closed position.
- G. Review the data in Operating and Maintenance Manuals. Refer to Division 1 Section "Project Closeout."

3.7 FIXTURE SCHEDULE

- A. Provide plumbing fixtures as specified on the drawings.
- B. Install rough-in for plumbing fixtures as scheduled on the drawings.

3.8 MOUNTING HEIGHTS SCHEDULE:

- A. Refer to the architectural drawings for plumbing fixture mounting heights. Unless indicated otherwise, install plumbing fixtures with the mounting heights as listed below with final approval by the Architect:

FIXTURE	MOUNTING HEIGHT
Lavatory or Sink	
Standard Height	31" floor to rim
ADA Accessible	34" floor to rim
Standard Height	24" floor to rim
ADA Accessible	17" floor to rim
Child Height	14" floor to rim
Water Closet	
Standard	15" floor to rim
ADA Accessible	17" to 19" floor to top of seat

City of Lee's Summit
Lee's Summit - Market Plaza

Water Cooler or Drinking Fountain

Standard Height

ADA Accessible

Ice Maker Outlet Boxes

Janitor's Sink Faucet Fittings

Hose Bibbs

Non Freeze Wall Hydrant

41" floor to spout

36" floor to spout

24" floor to center of box

42" floor to centerline

36" AFF to centerline

18" AFG to centerline

END OF DOCUMENT 224000

DOCUMENT 227000 - NATURAL GAS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes distribution piping systems for natural gas, liquid petroleum-gas and manufactured gas within the building and extending from the point of delivery to the connections with gas utilization devices. Piping materials and equipment specified in this Section include:
 - 1. Pipes, fittings, and specialties.
 - 2. Special duty valves.
 - 3. Pressure regulators.
 - 4. Service meters.
- B. Contractors Option:
 - 1. The Division 22 contractor may provide mechanically joined joints for natural gas systems to connect couplings, fittings, valves, and related components as an option in lieu of, in whole or in part, welded, threaded or flanged piping methods. Mechanically joined natural gas systems where used shall be provided in compliance with specification Section 227011 "Mechanically Joined Natural Gas Systems".
- C. This Section does not apply to liquid petroleum piping; industrial gas applications using such gases as acetylene and acetylenic compounds, hydrogen, ammonia, carbon monoxide, oxygen and nitrogen; gas piping, meters, gas pressure regulators and other appurtenances used by the serving gas supplier in distribution of gas.
- D. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 22 Section "General plumbing Requirements," for trenching, excavation, backfill and compaction materials and methods for underground piping installations.
 - 2. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls.
 - 3. Division 9 Section "Painting," for materials and methods for painting pipe.
 - 4. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations and wall and floor penetrations.
 - 5. Division 22 Section "Basic Piping Material and Methods," for materials and methods for strainers, unions, dielectric flanges, and mechanical sleeve seals.
 - 6. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hanging and supporting gas distribution piping.
 - 7. Division 26 Section "Common Work Results for Electrical" required electrical devices.

- E. Gas pressures for systems specified in this Section are limited to 5 psig.
- F. Products furnished under this Section include gas meters and gas service piping, which will be provided by the utility company to the site. The following is the name and address of the utility company:
 - Contact: Richi Garcia
 - Company: Spire Energy
 - Address: 3025 SE Clover Dr.
 - Telephone number: (816) 507-0713

1.2 DEFINITIONS

- A. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).
- B. Gas Distribution Piping: A pipe within the building which conveys gas from the point of delivery to the points of usage.
- C. Gas Service Piping: The pipe from the gas main or other source of supply including the meter, regulating valve, or service valve to the gas distribution system of the building served.
- D. Point of Delivery: The outlet of the service meter assembly, or the outlet of the service regulator (service shutoff valve when no meter is provided).

1.3 SUBMITTALS

- A. Product data for each gas piping specialty and special duty valves. Include rated capacities of selected models, furnished specialties and accessories, and installation instructions.
- B. Shop drawings detailing dimensions, required clearances, for connections to gas meter.
- C. Coordination drawings for gas distribution piping systems in accordance with Division 22 Section "General Plumbing Requirements."
- D. Maintenance data for gas specialties and special duty valves, for inclusion in operating and maintenance manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."
- E. Welders' qualification certificates, certifying that welders comply with the quality requirements specified under "Quality Assurance" below.
- F. Test reports specified in Part 3 below.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Installation and replacement of gas piping, gas utilization equipment or accessories, and repair and servicing of equipment shall be performed only by a qualified installer. The term qualified is defined as experienced in such work (experienced shall mean having a minimum of 5 previous projects similar in size and scope to this project), familiar with precautions required, and has complied with the requirements of the authority having jurisdiction. Upon request, submit evidence of such qualifications to the Architect.

- B. Qualifications for Welding Processes and Operators: Comply with the requirements of ASME Boiler and Pressure Vessel Code, "Welding and Brazing Qualification."
 - C. Regulatory Requirements: Comply with the requirements of the following codes:
 - 1. NFPA 54 - National Fuel Gas Code, for gas piping materials and components, gas piping installation and inspections, testing, and purging of gas piping systems.
 - 2. 20018 International Fuel Gas Code with amendments
 - D. Local Gas Utility Requirements: Comply with local gas utility installation rules and regulations.
 - E. Pipe, pipe fittings and pipe specialties shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.
- 1.5 SPARE PARTS
- A. Valve Wrenches: Furnish to Owner, with receipt, 2 valve wrenches for each type of gas valve installed, requiring same.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide gas piping system products from one of the following:
 - 1. Gas Ball Valves – 2" and Smaller:
 - a. Apollo Valves # 77F-1XX-01
 - b. Hammond Valve # 8901
 - c. Milwaukee Valve # BA-475B
 - d. Nibco Inc. # T-FP 600A
 - e. Watts # FBV-3C
 - 2. Gas Ball Valves – 2-1/2" to 4":
 - a. Apollo Valve # 77F-1XX-01
 - b. Hammond Valve # 8901
 - c. Milwaukee Valve # BA-475B
 - d. Nibco Inc. # T-FP 600A
 - 3. CSA Listed Gas Pressure Regulators

- a. Karl Dungs, Inc.
- b. Maxitrol
- c. Pietro-Fiorentini
- 4. Insect Screens
 - a. Northtown Pipe Protection Products "BUGSCRN Series"
- 5. Gas Relief Vents
 - a. Richards "GV Series"

2.2 PIPE AND TUBING MATERIALS

- A. General: Refer to Part 3, Article "PIPE APPLICATIONS" for identification of systems where the specified pipe and fitting materials listed below are used.
- B. Steel Pipe: ASTM A 53, Grade B, Schedule 40, (Type E electric-resistance welded or Type S seamless, black steel pipe, beveled ends).

2.3 FITTINGS

- A. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.
- B. Steel Fittings: ASTM A 234, seamless or welded, for welded joints.
 - 1. 2-1/2" and larger shall be butt weld type.
- C. Forged Steel Flanges and Flanged Fittings: ASME B16.5, Class 150, butt weld ends, standard pattern with bolts, nuts and gaskets of material group 1.1.
- D. Insect screens: Black steel body with 20 mesh stainless steel screen and MNPT end.
- E. Gas Relief Vents: Galvanized steel body with 90 degree inlet to screened outlet, 20 mesh stainless steel screen and FNPT end.

2.4 JOINING MATERIALS

- A. Joint Compound: Suitable for the gas being handled.
- B. Gasket Material: Thickness, material, and type suitable for gas to be handled, and for design temperatures and pressures.

2.5 PIPING SPECIALTIES

- A. Strike Plates: 16 gauge carbon steel, tested and listed by CSA International.

2.6 VALVES

- A. Gas Ball Valves – 2" and Smaller: Full port brass body with brass ball, PTFE seats, threaded ends 150psi steam, 600 WOG, UL listed for natural gas service.
- B. Gas Ball Valves – 2-1/2" to 4": Standard port brass body with brass ball, PTFE seats, threaded ends 150psi steam, 400 WOG, UL listed for natural gas service.
- C. Gas Line Pressure Regulators: Single stage, steel jacketed, corrosion-resistant gas pressure regulators; with atmospheric vent, elevation compensator; internal relief vent, vent limiter for indoor installation, with threaded ends for 2 inch and smaller, flanged ends for 2-1/2 inch and larger; for inlet and outlet gas pressures, specific gravity, and volume flow as indicated on the drawings.
 - 1. CSA listed for 2 PSI gas systems

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install pipe, fittings, valves and specialties in accordance with manufacturer's installation instructions.

3.2 PREPARATION

- A. Precautions: Before turning off the gas to the premises, or section of piping, turn off all equipment valves. Perform a leakage test as specified in "FIELD QUALITY CONTROL" below, to determine that all equipment is turned off in the piping section to be affected.
- B. Conform with the requirements in NFPA 54, for the prevention of accidental ignition.

3.3 PIPE APPLICATIONS

- A. Install steel pipe with threaded joints and fittings for 2 inch and smaller, and with welded joints for 2-1/2 inch and larger.

3.4 PIPING INSTALLATION

- A. General: Conform to the requirements of NFPA 54 - National Fuel Gas Code.
- B. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Design locations and arrangements of piping take into consideration pipe sizing, flow direction, slope of pipe, expansion, and other design considerations. So far as practical, install piping as indicated.
- C. Concealed Locations: As specified below:
 - 1. Inaccessible Above-Ceiling Locations: Install concealed gas piping in inaccessible above-ceiling spaces without valves or unions.
 - 2. Accessible Above-Ceiling Locations: Gas piping may be installed in accessible above-ceiling spaces (subject to the approval of the authority having jurisdiction), whether or not

such spaces are used as a plenum. Valves and unions shall not be located in such spaces used as a plenum.

3. In Floors: Install concealed gas piping in concrete floor slabs in an air-tight conduit constructed of Schedule 40 PVC with socket weld joints two pipe sizes larger than the gas pipe served. Extend conduit a minimum of 12" above finish floor and cap air tight at both ends. Vent conduit to the outside with a minimum 2" pipe and terminate with a screened vent cap.
 4. Piping In Partitions: Install concealed gas piping in hollow partitions with welded joint (subject to the approval of the authority having jurisdiction) and protect gas piping against physical damage. Install gas piping passing through partitions with no joints or unions inside the partition.
 5. Concrete or Masonry Walls: Do not install gas piping in masonry or concrete walls.
 6. Prohibited Locations: Do not install gas piping in or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumbwaiter or elevator shaft. This does not apply to accessible above-ceiling space specified above.
- D. Fire Barrier Penetrations: Where pipes pass through fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.
- E. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of No-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Basic Piping Materials and Methods" for special sealers and materials.
- F. Exterior Wall Penetrations: Seal pipe penetrations through exterior wall constructions with sleeves, packing, and sealant. Refer to Division 22 Section "Common Work Results for Plumbing" for additional information.
- G. Dirt legs and Sediment Traps: Install a dirt leg at points where condensate and impurities may collect, at the outlet of the gas meter, as close to the inlet of each gas appliance or equipment as possible, and in a location readily accessible to permit cleaning and emptying.
1. Construct dirt legs and sediment traps using a tee fitting with the bottom outlet plugged or capped. Provide a 3" length of pipe and screwed cap for the dirt leg. Use line size pipe for dirt leg, refer to the drawings for sizes. Enter the tee with flow from the top and exit the tee from the side outlet. Install the dirt leg a minimum of 3-1/2" above the roof or floor readily accessible to permit cleaning and emptying.
 2. Install line size gas cock, union and dirt leg at each equipment connection; refer to the drawings for sizes. Provide reducers at the equipment connection as required. Unions are specified in Division 22 section "Basic Piping Materials and Methods".
- H. Use fittings for all changes in direction and all branch connections.

- I. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- J. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- K. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.
- L. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Allow sufficient space above removable ceiling panels to allow for panel removal.
- M. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- N. Install gas piping at a uniform grade of 1/4 inch in 15 feet, upward to risers, and from the risers to the meter, or service regulator when meter is not provided, or the equipment.
- O. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.
- P. Connect branch outlet pipes from the top or sides of horizontal lines, not from the bottom.
- Q. Install unions in pipes 2 inch and smaller, adjacent to each valve, and elsewhere as indicated. Unions are not required on flanged devices. Unions are specified in Section "Basic Piping Materials and Methods".
- R. Joints Containing Dissimilar Metals: Provide dielectric unions for 2" and smaller and dielectric flanges for piping 2-1/2" and larger. Dielectric unions and flanges are specified in Section "Basic Piping Materials and Methods".
- S. Install flanges on valves, apparatus, and equipment having 2-1/2 inch and larger connections.
- T. Install strainers on the supply side of each control valve, pressure reducing valve, pressure regulating valve, solenoid valve, and elsewhere as indicated.
- U. Anchor piping to ensure proper direction of expansion and contraction. Install expansion loops and joints as indicated on the Drawings and specified in Division 22 Section "Expansion Fittings and Loops for Plumbing Piping."
- V. Paint Exposed Outdoor Gas Piping: Cleaning and painting of exposed outdoor gas piping is specified in Division 9 Section "Painting".
 - 1. Final color per the architect.

3.5 HANGERS AND SUPPORTS

- A. General: Hanger, support, and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.

B. Pipe Attachments: Install the following:

1. Adjustable clevis hangers, MSS SP-69 Type 1, for steel pipe 2-1/2" and larger for individual horizontal runs.
2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs.
3. Extension split ring pipe clamp, MSS SP-69 Type 12, for individual exposed runs on walls.
4. Engineered strut support system may be provided, at the contractor's option, in lieu of individual hangers for horizontal pipes as specified in Division 22 "Hangers and Supports for Plumbing Piping". Provide two piece straps for uninsulated pipe secured to the bare pipe and provide plastic galvanic isolators for bare copper tube.
5. Provide roll hangers for individual horizontal runs 100 feet or longer.
6. Provide roll hangers for individual horizontal runs 20 feet or longer for exposed piping installed on roofs.
7. Install hangers with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58 and SP-69, locally enforced codes, this specification, and authorities having jurisdiction requirements, whichever are most stringent. Install hangers for horizontal piping with the following maximum spacing and minimum rod diameters:

<u>Nom. Pipe Size in Inches</u>	<u>Max Span In Feet</u>	<u>Min. Rod Dia. - Inches</u>
1/2	6	3/8
3/4 to 1	8	3/8
1-1/4 to 2	10	3/8
2-1/2 to 3	10	3/8
4	10	3/8
6	10	1/2
8	10	3/4

C. Support vertical piping at every floor.

D. Support gas piping within 12" of each elbow or tee and for gas piping 2-1/2" and larger at each valve or pressure regulator.

E. Support gas piping located on roof with pre-engineered roof supports, pre-engineered roof supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table above for maximum spacing of supports. Support pipe at a minimum 7" above the roof.

3.6 PIPE JOINT CONSTRUCTION

A. Welded Joints: Comply with the requirements in ASME Boiler and Pressure Vessel Code, Section IX.

B. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe, fittings, and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint. Refer to NFPA 54, for guide for number and length of threads for field threading steel pipe.
 2. Align threads at point of assembly.
 3. Apply thread compound for use with gas systems to the external pipe threads. Pipe thread tape is not accepted.
 4. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.
 5. Damaged Threads: Do not use pipe with threads which are corroded, or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.
- C. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.

3.7 VALVE APPLICATIONS

- A. General: The Drawings indicate valve types, locations, and arrangements.
- B. Shut-off duty: Use gas cocks specified in Part 2 above.

3.8 VALVE INSTALLATIONS

- A. Install valves in accessible locations, protected from physical damage. Tag valves with a metal tag attached with a metal chain indicating the piping systems supplied.
- B. Install the emergency natural gas shutoff valve furnished with exhaust hood fire extinguishing system in an accessible location.
- C. Install line size gas cock at the outlet of the gas meter set or gas riser and install a line size union downstream of the gas cock outside of the building.
- D. Installation of Gas Pressure Regulators:
1. Install a gas cock 10 pipe diameters upstream of each gas pressure regulator. Where two gas pressure regulators are installed in series in a single gas line, a manual valve is not required at the second regulator.
 2. Install line pressure regulators a minimum of 10 pipe diameters upstream of each atmospheric or power burner equipment connection.
 3. Install line pressure regulators a minimum of 10'-0" upstream of each condensing boiler or water heater connection.
 4. Install gas pressure regulator relief devices so they can be readily operated to determine if the valve is free; so they can be tested to determine the pressure at which they will operate; and examined for leakage when in the closed position.

5. Install gas pressure regulators with listed vent limiters indoors where allowed by the AHJ. Install with regulator dome vertically upright and level.
6. Install gas pressure regulators located outside the building with the relief port facing down to prevent the entry of moisture with the relief port a minimum of 18" above the roof or finish grade. Remove vent limiter and provide with line size (same size as gas vent relief port) insect screen or gas relief vent and 1" long schedule 40 black steel nipple.
 - a. Where manufacturer does not allow the gas pressure regulator to be installed upside down, install gas pressure regulator with regulator dome in the horizontal or vertically upright with factory breather plug.
7. Gas Pressure Regulator Relief Vents: Provide for gas pressure regulators that require them or for vent less regulators where the AHJ requires them. Install steel pipe with threaded joints and fittings for 2 inch and smaller, and with welded joints for 2-1/2 inch and larger. Route vent to the outdoors thru building side wall and turn down or thru the roof and turn down minimum 18" above the roof or grade. Provide with line size (same size as gas relief) insect screen or gas relief vent. Provide vent sizes per the following developed length and include 3 feet of length for each elbow:
 - a. 10 feet developed length = size vent one pipe size larger than relief vent outlet size
 - b. 20 feet developed length = size vent two pipe size larger than relief vent outlet size
 - c. 30 feet developed length = size vent three pipe size larger than relief vent outlet size
 - d. 40 feet developed length = size vent four pipe size larger than relief vent outlet size

3.9 TERMINAL EQUIPMENT CONNECTIONS

- A. Install line size gas cock upstream and within 6 feet of gas appliance. Install a line size union or flanged connection downstream from the gas cock to permit removal of controls. Install reducer at the gas appliance connection, if required.
- B. Install stainless steel flexible gas pipe connector, of size and length as required to complete equipment hook-up of foodservice equipment. Verify appropriate length of flexible gas pipe connector for movement of the foodservice equipment for cleaning.

3.10 ELECTRICAL BONDING AND GROUNDING

- A. Install above ground portions of gas piping systems, upstream from equipment shutoff valves electrically continuous and bonded to a grounding electrode in accordance with NFPA 70 - "National Electrical Code."
- B. Do not use gas piping as a grounding electrode.
- C. Conform to NFPA 70 - "National Electrical Code," for electrical connections between wiring and electrically operated control devices.

3.11 FIELD QUALITY CONTROL

- A. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility requirements.

END OF DOCUMENT 227000

DOCUMENT 227010 – MECHANICALLY JOINED NATURAL GAS PIPING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes mechanically joined fittings and valves for distribution piping systems for natural gas, liquid petroleum-gas and manufactured gas within the building and extending from the point of delivery to the connections with gas utilization devices. Piping materials and equipment specified in this Section include:
 - 1. Fittings.
- B. This Section does not apply to liquid petroleum piping; industrial gas applications using such gases as acetylene and acetylenic compounds, hydrogen, ammonia, carbon monoxide, oxygen and nitrogen; gas piping, meters, gas pressure regulators and other appurtenances used by the serving gas supplier in distribution of gas.
- C. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 22 Section "Natural Gas Systems," for valves, hangers, natural gas systems and installation requirements.
- D. Gas pressures for systems specified in this Section are limited to 5 psig.

1.2 SUBMITTALS

- A. Product data for each mechanically joined gas pipe fitting. Include rated capacities of selected models, furnished specialties and accessories, and installation instructions.
- B. Maintenance data for mechanically joined gas pipe fittings, for inclusion in operating and maintenance manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."
- C. Installer qualification certificates, certifying that installers comply with the quality requirements specified under "Quality Assurance" below.
- D. Test reports specified in Part 3 below.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Installation of mechanically joined fittings shall be performed only by a qualified installer. The term qualified is defined as experienced in such work (experienced shall mean having a minimum of 5 previous projects similar in size and scope to this project), familiar with precautions required, and has complied with the requirements of the authority having jurisdiction. Upon request, submit evidence of such qualifications to the Architect.
- B. Local Gas Utility Requirements: Installation of mechanically joined fittings shall comply with local gas utility installation rules and regulations.

- C. Mechanically joined fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.
- D. Obtain training from the mechanically joined fittings manufacturer for all workers that will be installing or handling the mechanically joined fittings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Subject to compliance with requirements, provide gas piping system products from one of the following:
 - 1. Mechanically Joined Fittings:
 - a. Viega "Mega-Press G Fittings"
 - b. Apollo "PowerPress"
 - c. Mueller Streamline STL

2.2 FITTINGS

- A. Mechanically Joined Fittings: ½ inch through 4 inch meeting ANSI LC4-2012 /CSA 6.32-2012 2nd Edition with zinc/nickel coating, HNBR sealing element, 420 stainless steel grip ring, 304 stainless steel separator ring, and Smart Connect (SC) Feature that allows the joint to leak if not properly sealed. Fittings shall be for use with IPS schedule 10 thru schedule 40 carbon steel, or galvanized pipe meeting ASTM A53. Fittings shall have temperature and pressure rating of -40F to 180F at a maximum operating pressure of 125 psi.

2.3 VALVES

- A. Mechanically Joined Gas Ball Valves: ½ inch through 2 inch carbon steel body meeting ASTM A216 with full port 316 stainless steel ball meeting ASTM A276, blowout-proof stem, with replaceable "Teflon" or "PTFE" seats and seals, solder ends and vinyl-covered steel handle. Provide with mechanically joined ends meeting ASTM LC4 with HNBR O-ring.
 - 1. Apollo "PowerPress" # 89FHV4 series
 - 2. Apollo "PowerPress" # 89FVH4 series
- B. Mechanically Joined Gas Ball Valves: 2-1/2 inch through 4 inch carbon steel body meeting ASTM A216 with zinc-nickel coating, with full port chrome plated brass ball, blowout-proof stem, with replaceable "Teflon" or "PTFE" seats and seals, solder ends and vinyl-covered steel handle. Provide with mechanically joined ends meeting ASTM LC4 with HNBR O-ring.
 - 1. Viega "MegaPress G" series #6675XL

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Install fittings and valves in accordance with manufacturer's installation instructions.

3.2 PREPARATION

- A. Precautions: Before turning off the gas to the premises, or section of piping, turn off all equipment valves. Perform a leakage test as specified in "FIELD QUALITY CONTROL" below, to determine that all equipment is turned off in the piping section to be affected.
- B. Conform with the requirements in NFPA 54, for the prevention of accidental ignition.

3.3 PIPE APPLICATIONS

- A. Install above floor steel pipe with mechanically joined fittings for pipe 1/2 inch and larger up to 4".

3.4 PIPING INSTALLATION

- A. Piping Installation requirements are specified in Division 22 Section "Natural Gas Systems".

3.5 PIPE JOINT CONSTRUCTION

- A. Joint materials and installation requirements are specified in Division 22 Section "Natural Gas Systems".
- B. Joints for Mechanically Joined Fittings: Comply with the manufacturer's installation instructions and Requirements:
 - 1. Cut pipe ends at right angle (square) to the pipe.
 - 2. Ream pipe ends with chamfer.
 - 3. Remove paint, lacquer, grease, oil or dirt from the pipe end with an abrasive cloth, or with the "Ridgid MegaPress" pipe end prep tool.
 - 4. Visually examine the fitting sealing element to ensure there is no damage.
 - 5. Utilize a "Viega MegaPress Insertion Depth Inspection Gauge" to mark the pipe wall, with a felt tip pen, at the appropriate location, or insert the pipe fully into the fitting and mark the pipe wall at the face of the fitting.
 - 6. Verify the pipe is fully inserted into the fitting prior to pressing the joint.
 - 7. Install mechanically joined fittings using "Ridgid" MegaPress Tools.

3.6 VALVE APPLICATIONS

- A. Valves are specified in Division 22 Section "Natural Gas Systems".

- B. Valves can be installed with screwed joints for 2" and smaller and flanged joints for 2-1/2" and larger. Or, valves can be provided with mechanically joined fitting adapters and the joints installed as specified herein.

3.7 VALVE INSTALLATIONS

- A. Valve installation requirements are specified in Division 22 Section "Natural Gas Systems".

3.8 FIELD QUALITY CONTROL

- A. Field quality control requirements are specified in Division 22 Section "Natural Gas Systems".
- B. Installing contractor shall schedule training session with the mechanically joined fittings manufacturer at project site for all workers that will be installing or handling mechanically joined fittings. Submit certification letter along with list of certified attendees to Architect within 30-days of mobilization. Include copy of certification letter with closeout documents. Mechanically joined fittings manufacturer shall provide certification training to the contractor without cost and without additional cost to the Owner.
- C. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility requirements.
- D. Manufacturer's Piping Test: Provide two-step test process as follows:
 - 1. Pressurize the system between 0.5 psi and 45 psi with air or dry nitrogen.
 - 2. If the system does not hold pressure, walk the system and check for un-pressed fittings.
 - 3. If un-pressed fittings are found, ensure the pipe is fully inserted into the fitting and properly marked prior to pressing the joint.
 - 4. If failed joints are found, cut out the failed fitting and replace with new as specified herein.
 - 5. After appropriate repairs have been made, test the system per local code, not to exceed 200 psig.

END OF DOCUMENT 227010

DOCUMENT 230010 - GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.
- B. Division 23 of the Specifications and Drawings numbered with prefixes M, MP or ME, or MEP generally describe these systems, but the scope of the Mechanical work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.
- C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, ductwork, piping, etc. without showing all the exact details as to elevations, offsets, control lines, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

1.2 QUALITY ASSURANCE

- A. All work under this Division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.
- B. All work shall be installed in strict conformance with manufacturers' requirements, recommendations, and installation instructions. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.
- C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.
- D. Unless specified otherwise, manufactured items shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this project.

1.3 CODES, REFERENCES AND STANDARDS

- A. Execute Work in accordance with the National Fire Protection Association and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of

the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.

- B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.
- C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.
- D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes:

BOCA	Building Officials Code Administration
UBC	Uniform Building Code
UMC	Uniform Mechanical Code
UPC	Uniform Plumbing Code
IBC	International Building Code
IMC	International Mechanical Code
IPC	International Plumbing Code
IECC	International Energy Conservation Code
IFC	International Fire Code
IFGC	International Fuel Gas Code
ADA	American Disabilities Act
ADC	Air Diffusion Council
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
AHRI	Air Conditioning, Heating and Refrigeration Institute
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
ETL	Electrical Testing Laboratories
FGI	Facilities Guideline Institute
HI	Hydraulic Institute
MSS	Manufacturer's Standardization Society of the Valve and Fitting Industry
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code
NFPA	National Fire Protection Association
NEMA	National Electrical Manufacturers' Association
OSHA	Occupational Safety and Health Act
PDI	Plumbing and Drainage Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
UL	Underwriter's Laboratories

- E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.
- F. All mechanical work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the mechanical work shall be provided by the Contractor.

1.4 DEFINITIONS

A. General:

- 1. **Furnish:** The term “furnish” is used to mean “supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations.”
- 2. **Install:** The term “install” is used to describe operations at the project site including the actual “unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.”
- 3. **Provide:** The term “provide” means “to furnish and install, complete and ready for the intended use. When ‘furnish’, ‘install’, ‘perform’, or ‘provide’ is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, “provide” is implied.
- 4. **Furnished by Owner or Furnished by Others:** The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.
- 5. **Engineer:** Where referenced in this Division, “Engineer” is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the “Architect”.
- 6. **AHJ:** The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
- 7. **NRTL:** Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.
- 8. **Substitution:** Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.

- a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.
- 9. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.
- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.
- C. The following definitions apply to excavation operations:
 - 1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
 - 2. Bedding: Bedding as used in this section refers to the compacted sand or pea gravel installed in the bottom of a trench to immediately support and cover a pipe or duct.
 - 3. Subbase: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.
 - 4. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.
 - 5. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.
 - 6. Building Fill: Building fill as used in this section refers to borrowed fill material of rock 1" and larger used to fill foundation excavations

1.5 COORDINATION

- A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.

- B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping and ductwork in the manner anticipated in the design.
- C. The Contractor shall confirm and coordinate the final location and routing of all mechanical, electrical, plumbing, fire protection, control and audio-visual systems with all architectural features, structural components, and other trades. The contractor shall locate equipment, components, ductwork, piping, conduit, and related accessories to maintain the desired ceiling heights as indicated on the architectural drawings. The contractor shall inform the architect of any areas where conflicts may prevent the indicated ceiling height from being maintained. The contractor shall not proceed with any installation in such areas until the architect has given written approval to proceed or has provided modified contract drawings or written instructions to resolve the apparent conflict.
- D. The Contractor shall provide materials with trim which will fit properly the types of ceiling, wall, or floor finishes actually installed.
- E. The Contractor shall maintain a foreman on the jobsite at all times to coordinate the work with other contractors and subcontractors so that various components of the mechanical systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the Work in such a manner that the Work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.
- F. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and their subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

1.6 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.
 - 1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
 - 2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
 - 3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
 - 4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.

5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
 6. Indicate required installation sequence to minimize conflicts between entities.
 7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
 8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.
- B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of electrical equipment locations within electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.
1. Clearly identify all required working clearances and access provisions required for installation and maintenance.
 2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.
 3. Indicate path to allow for the future removal of each large piece of equipment (up to and including generators and unit sub-station transformers) without removal of non-related equipment or architectural elements.
 4. Include work provided by others routed through the equipment rooms.
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
 2. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.
 - a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.
 3. Where the Engineer's digital data files are provided to the Contractor for use in preparing coordination digital data files, the Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.

4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.

1.7 MEASUREMENTS AND LAYOUTS

- A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.8 SUBMITTALS

- A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.
- B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.
- C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives. Contractor shall allow for the Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.
- D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time or time specified in the Engineer's Agreement with the Client, plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.
- E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.
- F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

- H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.
 - I. Refer to individual Sections for additional submittal requirements.
 - J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
 - K. Submittals shall contain the following information:
 - 1. The project name.
 - 2. The applicable specification section and paragraph.
 - 3. Equipment identification acronym as used on the drawings.
 - 4. The submittal date.
 - 5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
 - 6. Submittals not so identified will be returned to the Contractor without action.
 - L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Contract Administrator prior to implementing any deviation.
 - M. Provide welders' qualification certificates.
- 1.9 ELECTRONIC DRAWING FILES
- A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.10 SUBSTITUTIONS

- A. Refer to Division 01 and General Conditions for Substitutions in addition to requirements specified herein.
- B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.
- D. Request for Substitution:
 - 1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
 - 2. The burden of proof of the merit of the proposed substitution is upon the proposer.
 - 3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:
 - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
 - b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
 - c. Proposed substitution has received necessary approvals of authorities having jurisdiction.
 - d. Same warranty will be furnished for proposed substitution as for specified Work.
 - e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
 - f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.
- E. Substitution Consideration:
 - 1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
 - 2. No substitutions will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.

3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.
- B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.
- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Prior to Substantial Completion of the project, furnish to the Architect, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.
- E. Each manual shall contain data listed in each individual Section.
- F. Refer to Division 01 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representative.

1.12 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections in Division 23 of this specification.

1.13 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.
- B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.

- C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.

1.14 TRAINING

- A. Provide training as indicated in each specific section. Schedule training with the Owner at least 7 days in advance. Video record the training sessions in format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

1.15 PAINTING

- A. Exposed ductwork and ferrous surfaces, including pipe, pipe hangers, equipment stands and supports and exposed insulated piping shall be painted by the Contractor using materials and methods as specified under Division 09 of the Specifications; colors shall be as selected by the Architect.
- B. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.
- C. Where factory finishes are provided and no additional field painting is specified, marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish.

1.16 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.
- B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.
- D. The Contractor shall be responsible for the safe storage of their own tools, material and equipment.

1.17 GUARANTEES AND WARRANTIES

- A. Refer to Division 01 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.

- B. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.
- C. The following additional items shall be guaranteed:
 - 1. Piping shall be free from obstructions, holes or breaks of any nature.
 - 2. Insulation shall be effective.
 - 3. Proper circulation of fluid in each piping system.
- D. The above guarantees shall include both labor and material; and repairs or replacements shall be made without additional cost to the Owner.
- E. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.
- F. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.18 TEMPORARY FACILITIES

- A. Refer to Division 01 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.
- B. Temporary Utilities: The types of services required include, but are not limited to, water, sewerage, surface drainage and gas. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.
 - 1. Provide the necessary backflow prevention devices where connecting to the potable water system. Protect water service from freezing by draining system or by providing adequate heat. Where non-potable water is used, mark each outlet with health hazard warning signs.
 - 2. Sewer Sediment: Maintain sewers and temporary connecting sewers in a clean, non-clogged condition during construction period.
- C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.
 - 1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.

2. Heating: Provide heat, as necessary, to protect work, materials and equipment from damage due to dampness and cold. In areas where building is occupied, maintain a temperature not less than 65 degrees Fahrenheit. Use steam, hot water, or gas from piped distribution system where available. Where steam, hot water or piped gas are not available, heat with self-contained LP gas or fuel oil heaters, bearing UL, FM or other approval labels appropriate for application. Vent fuel-burning heaters, and equip units with individual-space thermostatic controls. Use electric-resistance space heaters only where no other, more energy-efficient, type of heater is available and allowable.

1.19 PROJECT CONDITIONS

- A. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - EXECUTION

2.1 PERMITS

- A. Secure and pay for permits required in connection with the installation of the Mechanical Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

B.

2.2 CUTTING AND PATCHING

- A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.
- B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.
- C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.
- D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.
- E. Patch around openings to match adjacent construction, including fire ratings, if applicable.
- F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

2.3 CLEANING

- A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Mechanical Contractor shall cooperate in maintaining reasonably clean premises at all times.

- B. Immediately prior to the final inspection, the Mechanical Contractor shall clean material and equipment installed under the Mechanical Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

2.4 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:
 - 1. Submit complete Operation and Maintenance Manuals.
 - 2. Submit complete Record Drawings.
 - 3. Perform special inspections as required in each individual Section.
 - 4. Start-up testing of systems.
 - 5. Removal of temporary facilities from the site.
 - 6. Comply with requirements for Substantial Completion in the "General Conditions".
- B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.
- C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, the Contractor shall reimburse the Architect/Engineer for time and expenses incurred for the visit.
- F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.
- G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.
- H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. The Contractor shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF DOCUMENT 230010

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER

Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

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

Reason for not providing specified item: _____

Similar Installation:

Project: _____ Architect: _____

Address: _____ Owner: _____

Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

- ▲ A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
- B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
- C. Proposed substitution does not affect dimensions and functional clearances.
- D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
- E. Same warranty will be furnished for proposed substitution as for specified Work.
- F. Same maintenance service and source of replacement parts, as applicable, is available.
- G. Proposed substitution will not adversely affect other trades or delay construction schedule.
- H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

_____ Submitting Contractor	_____ Date	_____ Company
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Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

_____ Manufacturer's Representative	_____ Date	_____ Company
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Engineer Review and Recommendation Section

Recommend Acceptance	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Additional Comments:	<input type="checkbox"/> Attached	<input type="checkbox"/> None	

Acceptance Section:

_____ Contractor Acceptance Signature	_____ Date	_____ Company
_____ Owner Acceptance Signature	_____ Date	_____ Company
_____ Architect Acceptance Signature	_____ Date	_____ Company
_____ Engineer Acceptance Signature	_____ Date	_____ Company

DOCUMENT 230015 - ELECTRICAL COORDINATION FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section 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 furnished motors, starters, and disconnect switches furnished as an integral part of packaged mechanical equipment.
- B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.
- C. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.2 SUBMITTALS

- A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification Sections.

1.3 QUALITY ASSURANCE

- A. Electrical components and materials shall be UL labeled.
- B. All electrical equipment provided, and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section and Division 26.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

- A. The Contractors shall provide all motors, starters, disconnects, wire, conduit, etc. as specified in the Construction Documents. If, however, the Division 23 Contractor furnishes a piece of equipment requiring a different motor, starter, disconnect, wire size, etc. than what is shown and/or intended on the Construction Documents, this Contractor shall coordinate the requirements with any other Contractor and shall be responsible for any additional cost incurred by any other Contractor that is associated with installing the different equipment and related accessories for proper working condition.
- B. Refer to Division 26, "COMMON WORK RESULTS FOR ELECTRICAL" for specification of motor connections.
- C. Refer to Division 26, "ENCLOSED CONTROLLERS" for specification of motor starters.

- D. Refer to Division 26, "ENCLOSED SWITCHES AND CIRCUIT BREAKERS" for specification of disconnect switches and enclosed circuit breakers.

PART 3 - EXECUTION

3.1 CONTRACTOR COORDINATION

- A. Unless otherwise indicated, all motors, equipment, controls, etc. shall be furnished, set in place and wired in accordance with Table 1. Any items not listed but shown on the drawings shall be considered part of the Contract Documents and brought to the attention of the Architect.
- B. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Engineer.

TABLE 1: ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

ITEM	FURN BY	SET BY	POWER WIRING	CONTROL WIRING
Equipment motors	DIV23m	DIV23m	DIV26	---
Motor control centers	DIV26	DIV26	DIV26	DIV23t
Factory furnished motor starters contactors and disconnects	DIV23m	DIV23m	DIV26	DIV23t
Loose motor starters, disconnect switches, thermal overloads and heaters.	DIV26	DIV26	DIV26	DIV23t
Manual operating multi-speed switches	DIV23m	DIV26	DIV26	DIV23t
Control relays	DIV23t	DIV23t	DIV26	DIV23t
Thermostats (low voltage)	DIV23t	DIV23t	---	DIV23t
Thermostats (line voltage)	DIV23m	DIV23m	DIV26	---
Time switches (for mechanical equipment)	DIV23t	DIV23t	DIV26	DIV23t
Control power transformers	DIV23t	DIV23t	DIV26	DIV23t
Control power transformers furnished with equipment	DIV23m	DIV23m	DIV26	DIV23t
Temperature control panels (housing controllers)	DIV23t	DIV23t	DIV26	DIV23t
Building controllers, advanced application controllers, and application specific controllers	DIV23t	DIV23t	DIV23t	DIV23t
Motor and solenoid operated valves	DIV23t	DIV23m	DIV23t	DIV23t
Pressure independent control valves	DIV23t	DIV23m	DIV23t	DIV23t
Damper operators, PE & switches	DIV23t	DIV23t	DIV23t	DIV23t
Duct Smoke detectors	DIV28	DIV23m	DIV28	DIV28
Interlocks between HVAC fans and damper operators	---	---	DIV26	DIV23t

DIV23m = Mechanical Contractor

DIV23t = Temperature Controls Sub-Contractor

DIV26 = Electrical Contractor

DIV28 = Electronic Safety and Security

END OF DOCUMENT 230015

DOCUMENT 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL S

1.1 SUMMARY

- A. This Section includes limited scope general construction materials and methods for application with mechanical installations as follows:

1. Access panels and doors in walls, ceilings, and floors for access to mechanical materials and equipment.
2. Mechanical equipment nameplate data.
3. Concrete for bases and housekeeping pads.
4. Non-shrink grout for equipment installations.
5. Sleeves for mechanical penetrations.
6. Drip Pans with detection.
7. Miscellaneous metals for support of mechanical materials and equipment.
8. Wood grounds, nailers, blocking, fasteners, and anchorage for support of mechanical materials and equipment.
9. Joint sealers for sealing around mechanical materials and equipment.

- B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 07 Section "Penetration Firestopping" for material and methods for firestopping systems.
2. Division 23 Section "Basic Piping Materials and Methods," for materials and methods for mechanical sleeve seals.
3. Division 23 Section "Direct Digital Controls for HVAC" for integration with building automation system of leak detection system "Water Present" alarm.
4. Division 26 Section "Common Work Results for Electrical" required electrical devices.
5. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.2 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 23 Section General Mechanical Requirements.
 - 1. Product data for the following products:
 - a. Access panels and doors.
 - b. Joint sealers.
 - 2. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for mechanical materials and equipment.
 - 3. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.
 - 4. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
 - a. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."
 - 5. Through and Membrane Penetration Firestopping Systems Product Schedule: Submit a schedule for each piping system penetration that includes UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.
 - a. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.3 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
 - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- B. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.
 - 1. Provide UL Label on each fire-rated access door.

- C. Through and Membrane Penetration Firestopping Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

PART 2 - PRODUCTS

2.1 ACCESS TO EQUIPMENT

A. Manufacturers:

1. Bar-Co., Inc.
2. Elmdor Stoneman.
3. JL Industries
4. Jay R. Smith Mfg. Co.
5. Karp Associates, Inc.
6. Milcor
7. Nystrom Building Products
8. Wade
9. Zurn

B. Access Doors:

1. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
2. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
 - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.
 - b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.

- c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.
- 3. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
- 4. Locking Devices: Flush, screwdriver-operated cam locks.
- 5. Locking Devices: Where indicated on the drawings or where access panels are installed in locations accessible to the public, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

2.2 MECHANICAL EQUIPMENT NAMEPLATE DATA

- A. For each piece of power operated mechanical equipment, provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance's, and similar essential data. Locate nameplates in an accessible location.

2.3 CONCRETE EQUIPMENT BASES/HOUSEKEEPING PADS

- A. Provide concrete equipment bases and housekeeping pads for various pieces of floor mounted mechanical equipment. Concrete equipment bases/housekeeping pads shall generally conform to the shape of the piece of equipment it serves with a minimum 4" margin around the equipment and supports.
- B. Form concrete equipment bases and housekeeping pads using framing lumber or steel channel with form release agent. Chamfer top edges and corners. Trowel tops and sides of each base/pad to a smooth finish, equal to that of the floors.
- C. Concrete equipment bases and housekeeping pads shall be made of a minimum 28 day, 4000 psi concrete conforming to American Concrete Institute Standard Building Code for Reinforced Concrete (ACI 318-99) and the latest applicable recommendations of the ACI standard practice manual. Concrete shall be composed of cement conforming to ASTM C 150 Type I, aggregate conforming to ASTM C33, and potable water. All exposed exterior concrete shall contain 5 to 7 percent air entrainment.
- D. Unless otherwise specified or shown on the structural drawings, reinforce equipment bases and housekeeping pads with No. 4 reinforcing bars conforming to ASTM A 615 or 6x6 – W2.9 x W2.9 welded wire mesh conforming to ASTM A185. Reinforcing bars shall be placed 24" on center with a minimum of two bars each direction.
- E. Provide galvanized anchor bolts for all equipment placed on concrete equipment bases and housekeeping pads or on concrete slabs. Anchor bolts size, number and placement shall be as recommended by the Manufacturer of the equipment.
- F. Concrete equipment bases and housekeeping pads shall have height as specified on the drawings or minimum height if not specified in accordance with the following table:

Equipment	Minimum Height
Furnaces, Exterior Equipment Less than or equal to 20 tons and Other Equipment Not Listed	3-1/2"

NOTES:

1. Height of equipment bases applies to equipment installed on slab-on-grade. For equipment installed on floors above grade and/or roof, reference the drawings.

2.4 GROUT

- A. Provide nonshrink, nonmetallic grout conforming to ASTM C 1107, Grade B, in premixed and factory-packaged containers.
- B. Grout shall have post-hardening, volume-adjusting, dry, non-staining, non-corrosive, non-gaseous, hydraulic-cement characteristics and shall be as recommended by manufacturer for interior and exterior applications.
- C. Grout shall have 5,000 psi, 28-day compressive strength design mix.

2.5 PENETRATIONS

- A. Sleeves:
 1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.
 2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.
- B. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

2.6 DRIP PANS

- A. Drip pans for pipes in protected areas shall be 20 gauge galvanized steel with 2" lapped and soldered joints. Drip pan shall have a depth of 2" and a width of 6" in addition to the diameter of the associated pipe. Provide 3/4" galvanized pipe with male NPT outlet at low point of drip pan. Connect 3/4" type "L" copper indirect drain line to drip pan outlet. Route and discharge to receptor with air gap outside of the protected area.
- B. Drip pan supports shall be 1/4" X 2" galvanized bar stock welded to the drip pan without holes. Provide 1/4" galvanized threaded rods through bar stock on each side of the drip pan and attached with 2 nuts per rod. Attach rods to structure with MSS SP-58 compliant components.

- C. Flood Detector: Flood detector switch utilizing hydrophilic pad and stainless steel sensor array to detect moisture. Switch shall be provided with integral feet to prevent pad from contacting the pan. Provide with solid state electronics and double throw relay to allow switch to shut down unit and provide an auxiliary alarm output.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Diversitech
 - b. RCT/Aquaguard
 - c. Approved equivalent

2.7 MISCELLANEOUS METALS

- A. Steel plates, shapes, bars, and bar grating: ASTM A 36.
- B. Cold-Formed Steel Tubing: ASTM A 500.
- C. Hot-Rolled Steel Tubing: ASTM A 501.
- D. Steel Pipe: ASTM A 53, Schedule 40, welded.
- E. Fasteners: Zinc-coated, type, grade, and class as required.

2.8 MISCELLANEOUS LUMBER

- A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.
- B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 15/32 inches.

2.9 JOINT SEALERS

- A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- B. Colors: As selected by the Architect from manufacturer's standard colors.
- C. Nonacid Curing Sealer: One-part, nonacid-curing, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.

1. Manufacturers:
 - a. Dow Corning, Dowsil 790.
 - b. Dow Corning, Dowsil 795.
 - c. GE, Silglaze II SCS 2350.
 - d. GE, Silpruf SCS 2000.
 - e. Owens Corning, Energy Complete.
 - f. Pecora, 864 NST.
 - g. Tremco, Spectrem 1.
 - h. Tremco, Spectrem 2.
- D. High Humidity Sealer: One-part, mildew-resistant, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.
 1. Manufacturers:
 - a. Dow Corning, Dowsil 786.
 - b. GE, Momentum SCS1700.
 - c. Pecora, 898 Silicone NST.
- E. Hybrid Joint Sealer: One-part, non-sag, paintable complying with ASTM C920, Type S, Grade NS, Class 50, recommended for exposed applications on interior and exterior locations involving joint movement of not more than plus or minus 50 percent.
 1. Manufacturers:
 - a. BASF, MasterSeal NP 100.
 - b. Pecora, DyanTrol I-XL.
 - c. Tremco, Dymonic FC.
- F. Acrylic Latex Joint Sealer: One-part, non-sag, mildew-resistant, paintable acrylic latex or siliconized acrylic latex, complying with ASTM C834, Type OP, Grade NF, recommended for

exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.

1. Manufacturers:
 - a. Pecora, AC-20
 - b. Sherwin Williams 950A
 - c. Tremco, Tremflex 834

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install products in accordance with manufacturer's instructions.

3.2 INSTALLATION OF ACCESS DOORS

- A. Provide access doors for all concealed equipment and duct and piping accessories that require service where indicated or as required, except where above lay-in ceilings. Refer to Section "Identification for HVAC Piping and Equipment" for labeling of access doors.
- B. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
- C. Access doors must be of the proper construction for type of construction where installed.
- D. The exact location of all access doors shall be verified with the Architect prior to installation.
- E. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- F. Adjust hardware and panels after installation for proper operation.

3.3 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS "Structural Welding Code."

3.4 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

- B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.5 PREPARATION FOR JOINT SEALERS

- A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
- B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.6 APPLICATION OF JOINT SEALERS

- A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
 - 1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
 - 2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.
- B. Tooling: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.7 PENETRATIONS:

- A. New Construction:
 - 1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support piping or ductwork penetrations.
- B. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.
- C. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.
- D. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.

- E. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.
- F. All sleeves shall be of ample size to allow for movement of conduit, duct or pipe and insulation through the sleeves without damage to the insulation.
- G. Cut sleeves to length for mounting flush with both surfaces of walls.
- H. Extend sleeves installed in floors 2 inches above finished floor level.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry.
- J. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.
- K. All circular and oval openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 23 Section "Basic Piping Materials and Methods". All rectangular openings through underground exterior walls shall be flanged and flashed with non-corrosive material on each side and the gap sealed with weatherproof sealant.

3.8 DRIP PANS

- A. Provide drip pans in locations indicated on drawings.
- B. Provide drip pans under piping or equipment that is installed in spaces that have sensitive electronics/electrical equipment such as electrical, IT/AV, telecom, data equipment, elevator machinery rooms, etc. Obtain approval from the Architect prior to installation.
- C. Provide drip pans, only with written approval obtained prior to installation, installed beneath piping above electrical rooms, telecom rooms, data rooms, servers or any other protected area not clearly indicated by drawings.
- D. Provide drip pan supports every 4'-0".
- E. Place flood detector in the lowest location in the drip pan. Interlock detector with the HVAC equipment per manufacturer's recommendations.
- F. Wire flood detector to remote alarm, Diversitech Universal Alarm or equivalent. Coordinate location of the remote alarm with building owner prior to installation.
- G. Coordinate interlock of "Water Present" alarm and "Cable Fault" alarm with building automation system. Refer to Division 23 Section "Direct Digital Controls for HVAC" for integration with building automation system and low voltage power wiring.
- H. HVAC Piping:

1. Provide a steel sleeve cast or grouted into the structure. The internal diameter of the sleeve shall be 2 inches larger than the external diameter of the pipe passing through it. After all of the piping is installed in that area, verify the specified clearance and correct it, if necessary, to within 1/2 inch. Pack the void full depth with packing material sealed at both ends, 1 inch deep, with non-hardening sealant backed by foam rod.
2. Provide factory fabricated split seal clamp around the pipe filled with closed-cell neoprene sponge insulation, thickness as required to match adjacent insulation, minimum 3/4 inch. Cast or grout the sleeve into the structure. Provide fiberglass insulation if the pipe is subject to temperatures greater than 225 degrees F. Provide Mason Industries Type SWS or approved equal.

END OF DOCUMENT 230500

DOCUMENT 230510 - BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Joining materials.
- B. Escutcheons.
- C. Nipples.
- D. Unions.
- E. Dielectric unions.
- F. Dielectric waterway fittings.
- G. Dielectric flanges and flange kits.
- H. Mechanical sleeve seals.
- I. Pipe roof curbs.

1.2 SUBMITTALS

- A. Refer to Division 01 and Division 23 Section "General Mechanical Requirements" for administrative and procedural requirements for submittals.
- B. Product Data, including, rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, and installation instructions.
- C. Quality Assurance Submittals: Submit welders' certificates specified in Article "Quality Assurance" below.
- D. Piping Schedule: Submit a piping schedule that states the material being proposed for each piping system application in the project including manufacturer's catalog information, pipe materials, sizes, fittings, Type, Grade, Schedule, applicable ASTM standard, and connection method(s).
- E. Submit a schedule of dissimilar metal joints and dielectric flanges, flange kits, unions, or waterway fittings. Include proposed product, joint type materials, and connection method to isolate dissimilar metals. Refer to the individual Division 23 piping system specification sections for piping materials and fittings relative to that particular system and additional requirements.
- F. Submit certification that fittings and specialties are manufactured in plants located in the United States or certified that they comply with applicable ANSI and ASTM standards.
- G. Manufacturer's Installation Instructions: Indicate hanging and support methods and joining procedures.
- H. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

- I. Shop Drawings: Include detailed fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure.
- J. Coordination Drawings: Include piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Other building services.
 - 3. Structural members.
- K. As-built drawings for each piping system in electronic and PDF format.
- L. Refer to the individual piping system specification sections in Division 23 for additional requirements.

1.3 QUALITY ASSURANCE

- A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code (BPVC), Section IX, "Welding, Brazing, and Fusing Qualifications."
- B. Comply with ASME B31.9 - Building Services Piping, most recent edition.
- C. Comply with American Welding Society (AWS), Welding Handbook, most recent edition.
- D. Soldering and Brazing procedures shall conform to ANSI B9.1 Safety Code for Mechanical Refrigeration.
- E. Pipe freeze protection system shall be listed and classified by Underwriter's Laboratories, Inc. as suitable for purpose intended.
- F. Pipe specialties and fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM, ASME, and ANSI standards.
- G. Refer to the individual piping system specification sections in Division 23 for additional requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
- C. Refer to the individual piping system specification sections in Division 23 for additional requirements.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. Refer to the individual piping system specification sections in Division 23 for specifications on piping and fittings relative to that particular system.

2.2 JOINING MATERIALS

- A. Refer to individual Division 23 Piping Sections for special joining materials not listed below.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.
- C. Welding Materials: Comply with AWS D10.12 and Section II, Part C, ASME BPVC for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.
- D. Brazing Filler Metals: Comply with SFA-5.8, Section II, ASME BPVC for brazing filler metal materials appropriate for the materials being joined.

- 1. AWS A5.8, Classification BAg-5:

- a. Silver (Ag) 44.0 – 46.0 percent.
- b. Zinc (Z) 23.0 – 27.0 percent.
- c. Copper (Cu) 29.0 – 31.0 percent.

- 2. AWS A5.8, Classification BCuP-5:

- a. Phosphorus (P) 4.8 - 5.2 percent.
- b. Silver (Ag) 14.5 - 15.5 percent.
- c. Copper (Cu) remainder.

- E. Soldering Filler Metals: ASTM B32, 95-5 Tin-Antimony and water flushable flux in accordance with ASTM B813.

- F. Plastic Pipe Solvent Cement:

- 1. PVC: ASTM D2564.
- 2. CPVC: ASTM F493.

- G. Gaskets for Flanged Joints: ASME B16.21, full-faced for cast-iron flanges and raised-face for steel flanges. Select material, thickness, and type to suit the service of the piping system in which installed and which conform to their respective ASME Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.3 ESCUTCHEONS

A. Manufacturers:

1. AWI Manufacturing.
2. Keeney Manufacturing Company.
3. Wal-Rich Corp.
4. Jones Stephens Corp.
5. Approved equal.

B. Chrome-plated, stamped-steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

2.4 NIPPLES

A. Steel: ASTM A733, made of ASTM A53, Schedule 40, black steel; Type S seamless for pipe sizes 2 inch and smaller, Type E electric-resistance welded for pipe sizes 2-1/2 inch and larger.

2.5 UNIONS:

A. Manufacturers:

1. Anvil International.
2. Hart Industries.
3. Mueller Streamline Co.
4. Victaulic Company of America.
5. Watts Regulator Co.
6. Approved equal.

B. Hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

1. Malleable-iron: ASME B16.39, class as specified in section "Hydronic Piping" for the piping system used.
2. Bronze: ASME B16.15, cast bronze body meeting ASTM B62, class as specified in section "Hydronic Piping" for the piping system used.
3. Copper: ASME B16.22 wrought copper body.
 - a. For hydronic systems, provide class as specified in section "Hydronic Piping" for the piping system used.

- b. For refrigerant systems, provide pressure rating as required for the refrigerant type used.

2.6 DIELECTRIC UNIONS

A. Manufacturers:

- 1. Hart Industries.
- 2. Victaulic Company of America.
- 3. Watts Regulator Co.
- 4. Approved equal.

- B. Factory-fabricated with cast bronze body meeting ASTM B584 and galvanized or black steel body with plastic dielectric gasket, class 125 for low pressure service and class 250 for high pressure service, and appropriate end connections for the pipe materials in which installed (screwed or soldered) to effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

2.7 DIELECTRIC WATERWAY FITTINGS

A. Manufacturers:

- 1. Grinnell Mechanical Products.
- 2. Victaulic Company of America (Sweat and threaded connections only).
- 3. Approved equal.

- B. Electroplated steel, brass, bronze, or nylon encapsulated nipple, with an inert and non-corrosive, thermoplastic lining, and appropriate end connections for the pipe materials in which installed (screwed, soldered, grooved, or flanged) to effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

2.8 DIELECTRIC FLANGES AND FLANGE KITS

A. Manufacturers:

- 1. Advance Products & Systems, Inc.
- 2. Calpico, Inc.
- 3. Pipeline Seal & Insulator, Inc.
- 4. Tampa Rubber & Gasket Co. Inc.
- 5. Watts Water Technologies.
- 6. Approved equal.

- B. Full-faced gasket with same outside diameter and bolt hole arrangement as the flange. Conform to ANSI B16.5. Pressure rating of 200 psi for low pressure service and 400 psi for high pressure service at a continuous operating temperature of 180F.
- C. Steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.
- D. Flanges: Cast bronze meeting ASTM B584, class 125 solder type or cast iron meeting ASTM A536, class 125 threaded type for low pressure service, bronze class 250 solder type or cast iron class 250 threaded type for high pressure service.

2.9 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 - 1. Thunderline/Link Seal.
 - 2. Calpico, Inc.
 - 3. Metraflex Co.
 - 4. Approved equal.
- B. Sleeves: Refer to Division 23 Section "Common Work Results for HVAC" for sleeve materials.
- C. Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.10 PIPE ROOF CURBS

- A. Manufacturers:
 - 1. AES Industries.
 - 2. Custom Curb, Inc.
 - 3. Pate Company.
 - 4. Thybar.
- B. Provide factory-fabricated, pipe roof curbs with the following features:
 - 1. Factory installed treated wood nailer.
 - 2. Welded, 18 gauge galvanized steel shell, base plate and flashing.
 - 3. 1-1/2 inch thick, 3 pound rigid insulation.
 - 4. Fully mitered 3-inch raised cant.

5. Cover of weather-resistant, weather-proof material.
6. Pipe collar of weather-resistant material with stainless steel pipe clamps.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.2 INSTALLATION, GENERAL

- A. Install products in accordance with manufacturer's instructions.
- B. Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.
- C. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view. Install escutcheons at each wall, floor and ceiling penetration in exposed finished locations. Provide deep pattern escutcheons where required to conceal protruding pipe fittings.
- D. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.
- E. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.
- F. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
- H. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.
- I. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4 inch ball valve, and short 3/4 inch threaded nipple and cap.
- J. Verify final equipment locations for roughing in.
- K. Use fittings for all changes in direction and all branch connections.

- L. Remake leaking joints using new materials.
- M. Install components with pressure rating equal to or greater than system operating pressure.
- N. Piping Protection:
 - 1. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
 - 2. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

3.3 PENETRATIONS

- A. Mechanical penetrations occur when piping or ductwork penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies. Reference Division 23 Section "Common Work Results for HVAC" for additional penetration requirements.
- B. Above Ground, Exterior Wall Penetrations:
 - 1. Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2 inch of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.
 - 2. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.
- C. Elevated Floor Penetrations of Waterproof Membrane:
 - 1. Provide cast-iron sleeves, extend top of sleeve minimum 1 inch above finish floor. Size sleeve for minimum 1/2 inch annular space between pipe and sleeve.
 - 2. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.
 - 3. Pack with mineral wool and seal both ends with minimum of 1/2 inch of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.
 - 4. Secure waterproof membrane flashing between clamping flange and clamping ring. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."
 - 5. Extend bottom of sleeve below floor slab as required and secure underdeck clamp to hold sleeve rigidly in place.
- D. Interior Penetrations of Non-Fire-Rated Walls:
 - 1. Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of

1/2 inch of sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

2. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.

3.4 PIPE JOINT CONSTRUCTION

A. Threaded Joints:

1. Provide tapered pipe threads for field cut threads. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full inner diameter.
3. Note the internal length of threads in fittings or valve ends and proximity of internal seat or wall to determine how far pipe should be threaded into joint.
4. Align threads at point of assembly.
5. Apply appropriate tape or thread compound to the male pipe threads except where dry seal threading is specified.
6. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded. Tighten joint to leave not more than 3 threads exposed.
7. Damaged Threads: Do not use pipe or pipe fittings with threads which are corroded or damaged.

B. Flanged Joints:

1. Select appropriate gasket material, size, type, and thickness for service application.
2. Install gasket concentrically positioned.
3. Align flanges surfaces parallel.
4. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible.
5. Use suitable lubricants on bolt threads.
6. Tighten bolts gradually and uniformly using torque wrench.

C. Welded Joints:

1. Comply with the requirement in ASME Code B31.9, "Building Services Piping."
2. Damaged Welds: Do not use pipe sections that have cracked or open welds.

D. Brazed and Soldered Joints:

1. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."
2. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
3. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.
4. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts at piping specialties before brazing.
5. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making joint.
6. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.
7. Copper-to-copper joints shall be made using BCuP-5 brazing filler metal without flux.
8. Dissimilar metals such as copper and brass shall be jointed using an appropriate flux with either BCuP-5 or BAg-5 brazing filler metal. Apply flux sparingly to the clean tube only and in a manner to avoid leaving any excess inside the completed joint.
9. Continuously purge the pipe and fittings during brazing with an inert gas (i.e., dry nitrogen or carbon dioxide) to prevent formation of scale. Maintain purge until the joint is cool to the touch.
10. Heat joints using oxy-acetylene torch. Heat to proper and uniform temperature.
11. Provide temporary cap or cover on completed joints with open ends to prevent entry of contaminating materials.

E. Mechanical Refrigerant Pipe Joints: Flared compression fittings may be used for refrigerant lines 3/4 inch and smaller.

F. Socket Joints:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. Prepare surfaces to be solvent cemented by wiping with a clean cloth moistened with acetone or methylethyl ketone.
3. CPVC Joints: Solvent cement joints in accordance with ASTM D2846.
4. PVC Joints: Solvent cement joints in accordance to ASTM D2672.

G. Joints for other piping materials are specified within the respective piping system Sections.

3.5 UNIONS

- A. Install unions on pipes 2 inch and smaller, adjacent to each valve, at final connections to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

3.6 DIELECTRIC UNIONS

- A. Install dielectric unions for piping 2 inch and smaller to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum) for the following conditions:
 - 1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.
- B. Install dielectric unions for piping 2 inch and smaller to connect piping materials of dissimilar metals in wet piping systems (water, steam) for the following conditions:
 - 1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.
 - 2. Install waterway fittings where installation is concealed. Do not install dielectric unions in concealed spaces.

3.7 DIELECTRIC WATERWAY FITTINGS

- A. Install dielectric waterway fittings for piping 2 inch and smaller for copper or brass pipe connections to carbon steel equipment connections.

3.8 DIELECTRIC FLANGES AND FLANGE KITS

- A. Install dielectric flanges for piping 2-1/2 inch and larger to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum) for the following conditions:
 - 1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.
- B. Install dielectric flanges for piping 2-1/2 inch and larger to connect piping materials of dissimilar metals in wet piping systems (water, steam) for the following conditions:
 - 1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.
 - 2. Install waterway fittings where installation is concealed. Do not install dielectric flanges in concealed spaces.
- C. Provide brass nipples between the equipment connection and dielectric flange for screwed connections. Provide an iron flange for the equipment side and a bronze flange for the copper or brass piping side of the joint.
- D. Provide a bronze flange for the copper or brass piping connection to a cast iron, ductile iron or steel flange.
- E. Provide full face gasket with pressure rating equal to system served.
- F. At each bolt provide steel washers, thermoplastic washers, and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.

3.9 PIPE FIELD QUALITY CONTROL

- A. Testing: Refer to individual piping system specification sections.

END OF DOCUMENT 230510

DOCUMENT 230513 - COMMON MOTOR REQUIREMENT FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. General construction and requirements.
- B. Applications.
- C. Single phase electric motors.
- D. Three phase electric motors.
- E. Electronically Commutated Motors (ECM).
- F. Capacitors.

1.2 REFERENCE STANDARDS

- A. ABMA STD 9 – Load Ratings and Fatigue Life for Ball Bearings; most recent edition.
- B. IEEE 112 – IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; most recent edition.
- C. NEMA MG 1 – Motors and Generators; most recent edition.
- D. NFPA 70 – National Electrical Code; most recent edition adopted by the Authority Having Jurisdiction, including all applicable amendments and supplements.

1.3 SUBMITTALS

- A. Conform with the submittal procedures in Division 01.
- B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements. Provide nameplate data and ratings, mounting arrangements, size and location of winding termination lugs, overload relays, conduit entry, grounding lug, and coatings.
- C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
- D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
- E. Operation Data: Include instructions for safe operating procedures.
- F. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.

- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.5 DELIVERY STORAGE AND HANDLING.

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.6 WARRANTY

- A. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Baldor Electric Company.
- B. General Electric.
- C. Gould.
- D. Marathon.
- E. Regal-Beloit Corporation (Century).
- F. Westinghouse

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Electrical Service: All motors shall be supplied in accordance with the following voltage and phase unless noted otherwise on the Drawings.
 - 1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.
 - 2. Motors 3/4 HP and Larger: Voltage as scheduled, three phase, 60 Hz.
- B. Construction:
 - 1. Open drip-proof except where noted otherwise.
 - 2. Design for continuous operation in 104 degrees F environment.
 - 3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - 4. Motors with frame sizes 254T and larger: Energy Efficient Type.
- C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

D. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
2. For fractional horsepower motors where connection is made directly, provide flexible conduit connection in end frame. Maximum length of flexible conduit shall be five feet.

2.3 APPLICATIONS

- A. Exception: Motors less than 250 Watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.
- B. Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.
- C. Single phase motors for fans, pumps, blowers and air compressors: Capacitor start type.
- D. Single phase motors for fans less than 1 hp and greater than 1/12 hp: Electronically commutated type.
- E. Motors located in exterior locations, air cooled condensers, humidifiers and explosion proof environments: Totally enclosed fan cooled type.

2.4 SINGLE PHASE POWER - SPLIT PHASE MOTORS

- A. Starting Torque: Less than 150 percent of full load torque.
- B. Starting Current: Up to seven times full load current.
- C. Breakdown Torque: Approximately 200 percent of full load torque.
- D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, pre-lubricated sleeve or ball bearings.
- E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, pre-lubricated ball bearings.

2.5 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

- A. Starting Torque: Exceeding one fourth of full load torque.
- B. Starting Current: Up to six times full load current.
- C. Multiple Speed: Through tapped windings.
- D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.6 SINGLE PHASE POWER - CAPACITOR START MOTORS

- A. Starting Torque: Three times full load torque.

- B. Starting Current: Less than five times full load current.
- C. Pull-up Torque: Up to 350 percent of full load torque.
- D. Breakdown Torque: Approximately 250 percent of full load torque.
- E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated ball bearings.
- G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.7 ELECTRONICALLY COMMUTATED MOTORS (ECM)

- A. Minimum efficiency: 70 percent when rated in accordance with NEMA Standard MG 1 at full load rating conditions.
- B. Motor shall be permanently lubricated with heavy-duty ball bearings to match the equipment load and prewired to the specific voltage and phase.
- C. Internal motor circuitry shall convert AC power supplied to the equipment to DC power to operate the motor.
- D. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC signal.

2.8 CAPACITORS

- A. Furnish capacitors for power factor correction as specified herein on motors furnished under Division 23 that are not connected to variable frequency drives. KVAR size shall be as required to correct motor power factor to 90 percent or better and shall be installed on all motors 1 horsepower and larger, that have an uncorrected power factor of less than 85 percent at rated load.
- B. Features:
 - 1. Individual unit cells.
 - 2. All welded steel housing.
 - 3. Each capacitor internally fused.
 - 4. Non-flammable synthetic liquid impregnated.
 - 5. Craft tissue insulation.
 - 6. Aluminum foil electrodes.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install securely on firm foundation.
- C. Check line voltage and phase and ensure agreement with nameplate.
- D. Install motor overload relays in a common enclosure adjacent to the variable frequency drive

3.2 NEMA OPEN MOTOR SERVICE FACTOR SCHEDULE

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6-1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5-150	1.15	1.15	1.15	1.15

3.3 PERFORMANCE SCHEDULE: THREE PHASE - OPEN DRIP-PROOF

HP	RPM(Sync)	NEMA Frame	Minimum Percent Efficiency	Minimum Power Factor
1	1200	145T	80	72
1-1/2	1200	182T	84	73
2	1200	184T	85.5	75
3	1200	213T	86.5	60
5	1200	215T	87.5	65
7-1/2	1200	254T	88.5	73
10	1200	256T	90.2	74
15	1200	284T	90.2	77
20	1200	286T	91	78
25	1200	324T	91.7	74
30	1200	326T	92.4	78
40	1200	364T	93	77
50	1200	365T	93	79
1	1800	143T	82.5	84
1-1/2	1800	145T	84	85
2	1800	145T	84	85
3	1800	182T	86.5	86
5	1800	184T	87.5	87
7-1/2	1800	213T	88.5	86
10	1800	215T	89.5	85
15	1800	256T	91	85
20	1800	256T	91	86
25	1800	284T	91.7	85
30	1800	286T	92.4	88
40	1800	324T	93	83

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1-1/2	3600	143T	82.5	85
2	3600	145T	84	87
3	3600	145T	84	85
5	3600	182T	85.5	86
7-1/2	3600	184T	87.5	88
10	3600	213T	88.5	86
15	3600	215T	89.5	89
20	3600	254T	90.2	89
25	3600	256T	91	92
30	3600	284T	91	91
40	3600	286T	91.7	92
50	3600	324T	92.4	89

3.4 PERFORMANCE SCHEDULE: THREE PHASE-ENERGY EFFICIENT, TOTALLY ENCLOSED, FAN COOLED

HP	RPM(Sync)	NEMA Frame	Minimum Percent Efficiency	Minimum Power Factor
1	1200	145T	80	72
1-1/2	1200	182T	85.5	65
2	1200	184T	86.5	68
3	1200	213T	87.5	63
5	1200	215T	87.5	66
7-1/2	1200	254T	89.5	68
10	1200	256T	89.5	75
15	1200	284T	90.2	72
20	1200	286T	90.2	76
25	1200	324T	91.7	71
30	1200	326T	91.7	79
40	1200	364T	93	78
50	1200	365T	93	81
1	1800	143T	82.5	84
1-1/2	1800	145T	84	85
2	1800	145T	84	85
3	1800	182T	87.5	83
5	1800	184T	87.5	83
7-1/2	1800	213T	89.5	85
10	1800	215T	89.5	84
15	1800	254T	91	86

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20	1800	256T	91	85
25	1800	284T	92.4	84
30	1800	286T	92.4	86
40	1800	324T	93	83
1-1/2	3600	143T	82.5	85
2	3600	145T	84	87
3	3600	182T	85.5	87
5	3600	184T	87.5	88
7-1/2	3600	213T	88.5	86
10	3600	215T	89.5	86
15	3600	254T	90.2	91
20	3600	256T	90.2	89
25	3600	284T	91	92
30	3600	286T	91	92
40	3600	324T	91.7	91
50	3600	326T	92.4	92

END OF DOCUMENT 230513

DOCUMENT 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Support and attachment components.
- B. Horizontal piping hangers and supports.
- C. Saddles and shields.
- D. Vertical piping clamps.
- E. Pipe alignment guides.
- F. Pipe anchors.
- G. Anchors and fasteners.
- H. Miscellaneous materials.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
- 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
- 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
- 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
- 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

- 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.3 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each type of hanger and support. Include a hanger and support schedule showing manufacturer's figure number, size, location, and features for each hanger and support. Submit style and type to Structural Engineer for approval prior to installation.

- B. Product Certificates: Signed by the manufacturer of hangers and supports certifying the products meet the specified requirements.
- C. Welder Certificates: Signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.
- D. Maintenance Data: For inclusion in Operating and Maintenance manual specified in Division 01 and Division 23 Section "General Mechanical Requirements."
- E. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution. Include dimensions, weights, required clearances, and method of assembly.
 - 1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.
- F. Installer's Qualifications: Include evidence of compliance with specified requirements.
- G. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.4 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Installer Qualifications for Field-Welding:
 - 1. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."
 - 2. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
 - 3. Qualify welding processes and welding operators in accordance with ASME BPVC Section IX, "Welding and Brazing Qualifications."
- D. Flame/Smoke Ratings: Provide hangers and supports with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

1.6 DEFINITIONS

- A. Terminology used in this Section is defined in MSS SP-90.

PART 2 - PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:

1. Comply with MSS SP-58.
2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of work.
3. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
6. Materials: Products and materials listed in this specification are based on indoor, dry locations. Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Provide painted carbon steel, galvanized steel or zinc-plated steel. Where supports will be field painted in exposed locations, provide carbon steel.
 - b. Indoor Damp or Wet Locations: Galvanized steel or type 304 stainless steel.
 - c. Outdoor Locations: Galvanized steel or Type 304 stainless steel.
 - d. Dielectrics Barriers: Provide dielectric barriers between metallic supports and metallic piping and associated items of dissimilar type. Acceptable barriers include rubber, or copper-plated coatings where attachments are in direct contact with copper.
 - e. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - f. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
 - g. Stainless Steel: Type 304 or 316 in accordance with ASTM A240.

- B. Metal Channel (Strut) Framing Systems:

1. Manufacturers:
 - a. Cooper B-Line.
 - b. Ferguson Enterprises/FNW.
 - c. PHD Manufacturing.
 - d. Thomas & Betts Corporation.
 - e. Unistrut, a brand of Atkore International Inc.
 - f. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 2. Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 3. Comply with MSS SP-58, Type 59, MSS SP-89, and . Welds shall comply with AWS D1.1.
 4. Channel Material:
 - a. Indoor Dry Locations: Provide carbon steel, galvanized steel or zinc-plated steel. Where supports will be field painted in exposed locations, provide carbon steel .
 - b. Indoor Damp or Wet Locations: Galvanized steel or Type 304 stainless steel.
 - c. Outdoor Locations: Galvanized steel or Type 304 stainless steel.
 - d. All nuts, brackets, and clamps shall have the same finish as the channel.
 5. Minimum Channel Thickness: Steel sheet, 14 gage, 0.0747 inch.
 6. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height with factory-punched attachment holes.
 7. Provide plastic galvanic isolators for connecting bare copper pipe for use with pre-engineered support strut system where indicated.
- C. Hanger Rods:
1. Material:
 - a. Indoor Dry Locations: Zinc-plated steel.
 - b. Indoor Damp or Wet Locations or Outdoor Locations: Zinc-plated steel or type 304 stainless steel.
 2. Threaded both ends or continuously threaded.

3. Minimum Size: Reference piping specification sections for rod thicknesses.
4. Threaded Rods: Threaded rods are not allowed for floor supports except when the maximum length of the rod is less than 12". Threaded rod sizes shall be the same size diameter as specified for pipe hanger rods based upon pipe size being supported. Refer to system piping specification sections for rod size requirements.

2.2 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. Manufacturers:

1. Armacell.
2. ASC Engineered Solutions.
3. Cooper B-Line, Inc.
4. Elite Components.
5. ERICO/Michigan Hanger Co./Caddy
6. Ferguson/FNW.
7. Halfen-DEHA.
8. Hilti.
9. National Pipe Hanger Corporation.
10. PHD Manufacturing.
11. Piping Technology and Products, Inc.
12. Power-Strut.
13. Unistrut.

B. Single Hangers:

1. Band Hanger: Carbon steel, adjustable band, adjustable swivel.
2. Split Ring: Carbon steel, adjustable swivel, split ring type.
3. Clevis Hanger: Carbon steel, adjustable, clevis type.
4. Roll Support Hanger: Adjustable steel yoke, cast iron roll.

C. Trapeze and Strut-mounted Supports:

1. Two-piece clamp: Designed for use with channel strut, held in place at channel shoulder when clamp attachment nut is tightened.

2. Roll Support: Adjustable cast iron roll attached to metal channel strut framing system with brackets and nuts.
- D. Hangers and strut-mounted supports with pre-manufactured polymer inserts:
1. Manufacturers:
 - a. ASC Engineered Solutions.
 - b. Holdrite.
 - c. Klo-Shure.
 2. Strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts designed to receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation. Metal shields are not required with clevis hangers of this type.
- E. Spring Hangers:
1. Reference Section "Vibration Isolation for HVAC Piping and Equipment" for spring isolation hangers.
- F. Wall Supports:
1. Two-hole strap, galvanized steel or copper to suit pipe material. Provide rigid insulation between strap and pipe to maintain continuous insulation and vapor barrier where required.
 2. Welded steel bracket reinforced with angle or strut. Support pipe from bracket using horizontal pipe hanger or support appropriate for the pipe type.
- 2.3 SADDLES AND SHIELDS
- A. Pipe Covering Protection Saddles:
1. Manufacturers: Same as hanger and Supports.
 2. Meet MSS SP-58 Type 39A or B, 100-psi average compressive strength, with center rib for pipes 12 inches and larger. Saddles shall cover approximately one sixth of the circumference of the pipe and shall be 12 inches long.
- B. Insulation Protection Shield:
1. Sheet metal construction, meeting MSS SP-58 Type 40, of 18 gauge for 5-1/2 inches inside dimension and smaller, 16 gauge for 6-1/2 inches to 10-3/4 inches inside dimension, 14 gauge for 11-3/4 inches to 17 inches inside dimension, and 12 gauge for 18 inches to 28 inches inside dimension.
 2. Shield shall cover half of the circumference of the pipe and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

3. Lengths for pipes greater than 2 inches: Minimum 8 inch long section at each support.
4. For pipes 2 inch and smaller without pre-insulated supports, provide insulation protection shields installed between hanger and pipe which meets the following minimum length requirements:

Pipe Size (NPS)	Insulation Thickness (inches)	Minimum Shield Length, (in)					
		5	6	7	8	9	10
		Hanger Spacing, (ft)					
≤ 1	0.5	5	6	8	-	-	-
	1	3	5	5	-	-	-
	1.5	3	5	5	-	-	-
	2	3	3	3	-	-	-
	3	3	3	3	-	-	-
≤ 2	0.5	8	8	11	11	12	14
	1	5	6	8	9	11	11
	1.5	5	6	8	8	9	9
	2	5	5	6	6	8	8
	3	5	5	6	6	6	8

C. 360 Degree Insulation Protection Shield:

1. Shield shall cover all of the circumference of the pipe with two half circumference sections held together with bolts and nuts and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

D. Plastic Saddles and Shields:

1. Manufacturers:
 - a. Armacell.
 - b. Eaton.
 - c. Hydra-Zorb.
 - d. PHD Manufacturing.
 - e. Zsi Foster.
2. Polymer-based, snap-on or clip-on design, with non-adhesive surface and lip to allow lateral movement of piping without damaging insulation, field-paintable.

2.4 VERTICAL-PIPING SUPPORTS

A. Manufacturers:

1. ASC Engineered Solutions.
2. Cooper B-Line, Inc.
3. Halfen-DEHA.

4. Hilti.
5. ERICO/Michigan Hanger Co.
6. National Pipe Hanger Corporation.
7. PHD Manufacturing.
8. Piping Technology and Products, Inc.
9. Power-Strut.
10. Unistrut.

B. Components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.

1. Components shall have galvanized coatings where installed for piping and equipment that will not have factory applied or field-applied finish.
2. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.
3. Components as listed below shall be made of 304 stainless steel where installed in corrosive environments and/or where indicated on the drawings.

C. Riser Clamps with pre-manufactured polymer insert:

1. Manufacturers:
 - a. Hydra-Zorb; Titan Riser Clamp.
 - b. National Pipe Hanger.
 - c. Pipe Hangers, Inc.
2. Riser clamp with pre-manufactured polymer inserts designed to withstand vertical loading and receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation.

2.5 PIPE ALIGNMENT GUIDES

A. Factory fabricated, constructed of cast semi-steel or heavy fabricated steel when applied to steel pipe and copper when applied to copper. Guide shall consist of bolted two-section outer cylinder and base with two-section guiding spider that bolts tightly to pipe. Length of guides shall be as recommended by manufacturer to allow indicated travel.

1. Pipe Diameter 8 inches and Smaller: Spider or sleeve type.

2.6 PIPE ANCHORS

- A. Anchor Clamps: Assembly with multi-piece clamp, constructed of compatible material with piping or with dielectric barrier.

2.7 ANCHORS AND FASTENERS

- A. Manufacturers:

- 1. Hilti, Inc.
- 2. Illinois Tool Works, Inc.
- 3. Phillips.
- 4. Powers Fasteners, Inc.
- 5. Rawl.
- 6. Simpson Strong-Tie Company Inc.

- B. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

- 1. Concrete: Use preset concrete inserts or expansion anchors.
- 2. Solid or Grout-Filled Masonry: Use expansion anchors.
- 3. Hollow Masonry: Use toggle bolts.
- 4. Hollow Stud Walls: Use toggle bolts.
- 5. Steel: Use beam clamps.
- 6. Sheet Metal: Use sheet metal screws.
- 7. Wood: Use wood screws.
- 8. Plastic and lead anchors are not permitted.
- 9. Hammer-driven anchors and fasteners are permitted only as follows:
 - a. Nails are permitted for attachment of nonmetallic boxes to wood frame construction.
 - b. Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction.

- C. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.

- 1. Comply with MFMA-4.

2. Channel Material: Use galvanized steel.
 3. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch minimum base metal thickness.
 4. Spot Inserts: Carbon steel with zinc plating or galvanized steel body and base plate, with protective sleeve for anchor rod insert, sized to accommodate anchor rod dimensions.
 5. Manufacturers:
 - a. Same as manufacturer of metal channel (strut) framing system.
 - b. DeWalt "Bang-It" concrete inserts.
- D. Post-Installed Concrete and Masonry Expansion Anchors:
1. Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
 2. Self-drilling, drilled flush or shell type. Size inserts to suit threaded rods.
- E. Beam Clamps: MSS SP-58 C-Type or adjustable, Types 19 through 23, 25 or 27 through 30 based on required load.
1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.
 2. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
- F. Vibration Isolation Anchors: Reference Section "Vibration Isolation for HVAC Piping and Equipment" for vibration isolation anchors.
- 2.8 MISCELLANEOUS MATERIALS
- A. Steel Plates, Shapes, and Bars: ASTM A 36.
 - B. Malleable Iron: ASTM A47
 - C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION, GENERAL

- A. Install products in accordance with manufacturer's instructions.
- B. Provide hangers and supports according to the Pipe Hanger and Support Schedule below.
- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- D. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- H. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.
- I. Provide vibration isolators at hangers and supports where specified in Section "Vibration Isolation for HVAC".

3.3 INSTALLATION OF HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58 unless indicated otherwise.
- B. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
- C. Space attachments within maximum piping span length specified in Division 23 piping sections.
- D. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- E. Install hangers, supports, clamps and attachments to support piping properly from building structure.
- F. Do not attach to ceilings, equipment, ductwork, conduit and other non-structural elements such as floor and roof decking.
- G. Hanger and clamps sizing:
 - 1. Cold Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.
 - 2. Hot Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.

3. Vertical Piping: Provide clamps sized for the pipe outside diameter and extend clamp through insulation.
 4. Refer to Section "HVAC Insulation" for definition of hot and cold piping and required insulation thickness.
- H. Where several pipes can be installed in parallel and at the same elevation, Contractor has option to provide metal channel strut framing. Install supports with maximum spacing specified within Division 23 piping sections.
1. Space strut framing at the required distance for the smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.
 2. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.
 - a. Uninsulated Copper Pipe: Install with plastic galvanic isolators
 - b. Insulated Tube or Pipe: Install with 360° insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Section "HVAC Insulation".
- I. Install building attachments within concrete or to structural steel.
1. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping as specified in Division 23 piping sections.
 2. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.
- J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Provide two nuts on threaded supports to securely fasten the support.
- K. Install appropriate types of hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
- L. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.
- N. Insulated Piping: Comply with the following installation requirements.
1. Riser Clamps: Attach riser clamp to piping with riser clamps projecting through insulation. Do not use riser clamps to support horizontal, insulated piping. Seal insulation for hot piping and protect vapor barrier for cold piping as specified in Division 23 Section "HVAC Insulation".

- a. Contractor's Option: Provide riser clamps with pre-manufactured polymer insert.
 2. Pipe Covering Protection Saddles: Install pipe covering protection saddles where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
 - a. If insulation protection shields are used instead of protection saddles on hot piping where vapor barrier is not required, provide high density insulation insert sized for the insulation thickness used as specified in Division 23 Section "HVAC Insulation".
 3. Insulation Protection Shield: Install insulation protection shield with high density insulation insert, sized for the insulation thickness used as specified in Division 23 Section "HVAC Insulation". Do not use polymer-based shields for hot piping.
 - a. Exception for 2 inch and smaller horizontal piping with cellular glass, flexible elastomeric, or polyisocyanurate insulation: High density insulation insert is not required. Provide insulation protection shield over the insulation with length specified for pipe size and insulation thickness to prevent puncture or other damage.
 4. Contractor's Option: Provide pre-engineered thermal hanger inserts for piping insulated with flexible elastomeric insulation at pipe supports for piping 2-1/2 inches and larger.
 5. Contractor's Option: Provide strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts.
- O. Strut Framing Systems: Channel strut systems can be used at the Contractors option in lieu of individual hangers for horizontal pipes. Arrange for grouping of parallel runs of horizontal piping. Space channel strut systems at the required distance for the smallest pipe supported. Provide channel gauge and hanger rods per the manufacturer's recommendations for the piping supported. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.
1. Uninsulated Copper Pipe: Install with plastic galvanic isolators
 2. Insulated Tube or Pipe: Install with 360 degree insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 23 Section "HVAC Insulation".
- P. Vertical Piping Risers:
1. Reference Section "Vibration Isolation for HVAC Piping and Equipment" for piping riser supports.
- Q. Wire Rope Hanging Systems:
1. Install in accordance with manufacturer's instructions.
 2. Supported load shall not exceed manufacturer's recommended load rating.
 3. Applications for Pipe Supports:

- a. 3 inch and smaller.
- b. Wire rope hanging system is not allowed for steam or steam condensate piping.
- 4. Do not support pipe by wrapping the rope around the pipe.
- 5. Provide appropriate hanger or support compatible with the wire rope hanging system adjustable fastener as specified in the Pipe Hanger and Support Schedule.
- 6. Install cast-in-place concrete inserts in elevated concrete slabs.
- 7. Install bream clamps for attachment to structural beams as required.

3.4 INSTALLATION OF PIPE ALIGNMENT GUIDES

- A. Install pipe alignment guides on piping that adjoins expansion joints, as required by expansion joint manufacturer, and elsewhere as indicated on plans and specification sections to eliminate binding and torsional stress on piping systems. Install guides per ASME B31.9 unless noted otherwise. Install pipe insulation at guide to not interfere with movement of pipe within the guide.
- B. Install guide to accommodate 1/2 the thermal movement at the adjacent expansion joint.
- C. Anchor to building substrate.

3.5 INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.
- C. Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.6 INSTALLATION OF ROOF EQUIPMENT SUPPORTS

- A. Attach roof equipment support to the roof structure according to the manufacturer's installation instructions.
- B. Provide multiple single rail equipment supports to uniformly support the equipment.
- C. Provide rigid backing material (e.g., insulation, wood, etc.) to maintain cant slope.
- D. Install supports to maintain continuous insulation on roof.
- E. Provide vibration isolators between roof equipment support and equipment according to Division 23 Section "Vibration Isolation for HVAC."

3.7 EQUIPMENT SUPPORT AND ATTACHMENT

- A. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
- B. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls.
- C. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
- D. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- E. Preset Concrete Inserts and Expansion Anchors: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
 - 1. Where concrete slabs form finished ceiling, locate anchors flush with slab surface.
- F. Secure fasteners according to manufacturer's recommended torque settings.
- G. Remove temporary supports.
- H. Fabricate structural steel supports to suspend equipment from structure above or support equipment from floor.
- I. Grouting: Place grout under supports for piping and equipment.

3.8 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours welded surfaces to match adjacent contours.

3.9 FIELD QUALITY CONTROL

- A. Examine support and attachment components for damage and defects.
- B. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces. Comply with Division 09 Section "Painting."
 - 1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- E. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.
- F. Correct deficiencies and replace damaged or defective support and attachment components.

3.10 PIPE HANGER AND SUPPORT SCHEDULE

- A. Additional hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Provide the following acceptable hangers and supports for each type of piping system. Hangers and supports may be single type or strut-mounted:
- C. Single Hangers:
 - 1. All pipe sizes 1-1/2 inch and less:
 - a. Band hanger.
 - b. Swivel split ring.
 - c. Clevis hanger.
 - 2. Cold and Hot pipe sizes 2 inches and greater where pipes are in stationary position: Clevis hanger.
 - 3. Cold and Hot pipe sizes 2 inches and greater for pipes in the following locations: Roll support hanger.
 - a. Axial movement due to thermal expansion or contraction generates swing angles in excess of 4 degrees.
 - b. Between anchor locations shown on the drawings.

D. Trapezes and Strut-mounted Supports:

1. Pipes in stationary position: Two-piece clamp, strut clamp or U-bolts.
2. Cold and Hot pipe sizes 2 inches and greater in the following locations: Roll support.
 - a. Axial movement due to thermal expansion or contraction generates swing angles in excess of 4 degrees.
 - b. Between anchor locations shown on the drawings.

E. Wall Supports:

1. Pipe sizes 3 inches and less:
 - a. Two-hole strap mounted to wall.
 - b. Welded steel bracket with reinforced angle or strut.

F. Floor Supports:

1. Pipes in stationary position: Pipe saddle.
2. Cold and Hot pipe sizes 2 inches and greater in the following locations: Roll support.
 - a. Axial movement due to thermal expansion or contraction is greater than one inch.
 - b. Between anchor locations shown on the drawings.

END OF DOCUMENT 230529

DOCUMENT 230550 - VIBRATION ISOLATION FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Vibration isolation requirements.
- B. Vibration-isolated equipment support bases.
- C. Vibration isolators.

1.2 COORDINATION

A. Contractor's Responsibility:

1. Verify the completeness of the isolation installation and the overall suitability of the equipment to meet the intent of this specification. Any additional equipment needed to meet the intent of this specification, even if not specifically mentioned herein or in the Contract Documents, shall be supplied by the Contractor without claim for additional payment.
2. Performance or waiving of inspection, testing or surveillance for any portion of the Work shall not relieve the Contractor of the responsibility to conform strictly with the Contract Documents. The Contractor shall not construe performance or waiving of inspection, testing or surveillance by the Owner or Architects to relieve the Contractor from total responsibility to perform in strict accordance with the Contract Documents.
3. Coordinate selection and arrangement of vibration isolation components with the actual equipment to be installed.
4. Coordinate the work with other trades to provide additional framing and materials required for installation.
5. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
6. Sequencing:
 - a. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

B. Manufacturer's Responsibility:

1. Determine vibration isolation types for all equipment and systems in accordance with the local governing code.

2. Calculate the static deflection requirements for all equipment and systems to provide uniform deflection based on distributed operating weight of actual installed equipment.
3. Select the vibration isolation systems to provide static deflection indicated on the Vibration Isolation Schedule and as specified below. Determine the mounting sizes and layout.
4. Guarantee specified isolation system deflection.
5. Select and size vibration isolators to not exceed the recommended loading of the isolators.
6. Provide installation instructions, drawings and field supervision to ensure proper installation and performance.
7. Verify that all equipment to be isolated has sufficient support structure to distribute equipment loads onto isolators.

1.3 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.
 1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification method for spring element load capacities. Include clearly outlined procedures for installing and adjusting the isolators.
- B. Shop Drawings:
 1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators on each piece of isolated equipment. Indicate equipment weights and static deflections.
 2. Vibration-Isolated Equipment Support Bases: Include base weights, including concrete fill where applicable. Indicate equipment mounting provisions.
 3. Piping isolators shown and identified on piping layout drawings.
 4. Concrete foundations, supports, and required reinforcing and forms. These appurtenances shall be provided by another trade. This trade shall furnish the shop drawings, including the following:
 - a. Concrete reinforcing steel details and templates for all foundations and supports.
 - b. Required hanger bolts.
 - c. All other appurtenances necessary for proper installation of equipment.
- C. Vibration Isolation System Schedule: Include the following for each isolation element:

1. Manufacturer, isolator type, model number, size.
2. Height when uncompressed and static deflection.
3. Spring constant.
4. Spring outside diameter, free operating, and solid heights.
5. Design of supplementary bases.
6. Details of attachment to load-bearing structure or supplementary framing.

D. Post-Installation Inspection Report:

1. Vibration isolation vendor notice of inspection of all vibration isolators.
2. Vibration isolation vendor notice of approval that all vibration isolators have been properly installed and conform to the specification.
3. Itemized list of deficiencies.
4. Vibration Isolation System Schedule.
5. For each isolator containing steel springs, record the following:
 - a. Size.
 - b. Uncompressed height.
 - c. Design static deflection.
 - d. Measured static deflection.

1.4 QUALITY ASSURANCE

- A. All vibration isolation equipment shall be furnished by one manufacturer unless specifically approved otherwise in writing by the Engineer.
- B. All vibration isolation equipment and materials shall be new and manufactured specifically for the purpose intended.
- C. Maintain at the project site a copy of each reference document that prescribes execution requirements.
- D. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Kinetics Noise Control.
- B. Mason Industries, Inc.
- C. Thybar Corporation.
- D. Vibration Eliminator Co., Inc.
- E. Vibration Mounting and Controls.
- F. Vibro-Acoustics.

2.2 VIBRATION ISOLATION REQUIREMENTS

- A. Construct vibration isolators out of resilient materials resistant to oil, ozone, and oxidant.
- B. Select vibration isolators to provide the static deflection as specified in Part 2 "Products" unless otherwise specified for the application listed in Part 3 "Execution."
- C. Where a pipe run connects multiple equipment, select the pipe isolators for the entire run to suit the connected equipment of greatest static deflection.
- D. Vibration isolators shall have either known undeflected heights or calibration markings so that the amount of deflection can be verified after adjustment to determine that the load is within the proper range of the device and that the correct degree of vibration isolation is provided according to the design.
- E. Vibration isolators, base frames, and inertia bases shall provide uniform deflection and stability under all operating loads.
- F. Isolators for fans shall be sized so that thrust restraints (which would act against turning moment caused by static pressure) are not required.
- G. Lateral restraining isolators shall have the same static deflection as the vertical isolators for the equipment being isolated.
- H. The theoretical vertical natural frequency for each support point based upon load per isolator and isolator stiffness shall not differ from the design objectives for the equipment as a whole by more than plus/minus 10 percent.

- I. All elastomeric mountings shall have a Shore hardness of 30 to 60 plus/minus 5 after minimum aging of 20 days or corresponding over-aging, or as specified herein.
- J. Elastomeric isolators that will be exposed to temperatures below 32 degrees F shall be fabricated of natural rubber instead of neoprene.
- K. Equipment mounted on vibration isolated bases shall have minimum operating clearance of 1 inch between the base and floor or support beneath unless noted otherwise.
- L. Vibration Isolator Assemblies with Steel Springs:
 - 1. Housed or caged spring isolators are not acceptable.
 - 2. Assemblies shall use bare springs, color coded or otherwise identify springs to indicate load capacity.
 - 3. Spring diameter shall not be less than 0.8 of the loaded operating height of the spring.
 - 4. The ratio of the horizontal to vertical spring constant shall be between 1 and 2.
 - 5. Springs shall be sized to be non-resonant with equipment forcing frequencies or support structure natural frequencies.
 - 6. Assembly shall be designed and installed so that the ends of the spring remain parallel during and after the spring installation.
 - 7. Springs shall operate in the linear portion of their load versus deflection curve over a deflection range of not less than 50 percent above the design deflection.
- M. Vibration isolators exposed to weather and other corrosive environments shall be protected with factory corrosion resistance.
 - 1. Exterior applications:
 - a. Springs: Cadmium-plated and neoprene coated.
 - b. Nuts and bolts: Cadmium plated.
 - c. Other metal mounting parts: Hot-dip galvanized.
 - 2. Interior applications: Painted.

2.3 VIBRATION ISOLATED EQUIPMENT SUPPORT BASES

- A. Structural Rails (Type SR):

1. Assembly: Structural steel channels furnished with double-deflection neoprene mountings or spring isolators.
2. Base: All metal mounting parts shall be covered with neoprene to avoid corrosion and metal-to-metal contact.
3. Selection: Channel length and isolator type with deflection as required for proper isolation of equipment.
4. Type SR: Mason Industries Type RND or approved equal.

B. Vibration Isolation Roof Curb (Type CMB):

1. Description: Engineered, structural steel frame mounted directly to the structure with an upper floating section on adjustable steel springs. The upper frame shall provide continuous support for the equipment.
2. Steel springs shall rest on minimum 1/4 inch thick elastomeric pads and have a minimum static deflection of 2 inches.
3. All-directional elastomeric snubber bushings shall be minimum 1/4 inch thick.
4. Weatherproofing: Continuous galvanized flexible counterflashing nailed over the lower curb's waterproofing and joined at the corners by elastomeric bellows.
5. Access Ports: Provided for all spring locations with removable waterproof covers to allow for adjustment or replacement of springs.
6. Lower curbs shall have provision for 2 inches insulation.
7. Type CMB: Mason Industries Type RSC or approved equal.

2.4 VIBRATION ISOLATORS

A. Steel Spring Neoprene Mounts (Type SPNM):

1. Assembly: Single or multiple free-standing and laterally stable steel springs without a housing.
 - a. Light capacity base: Molded elastomeric neoprene load plate.
 - b. Heavy capacity base: Springs welded to the load plate assembly furnished with integral elastomeric pad.
 - c. Leveling Device: Rigidly connected to equipment or frame.
2. Selection:

- a. Minimum static deflection for equipment mounted on grade slabs shall be 1 inch unless specified otherwise.
 - b. Minimum static deflection for equipment mounted above grade (suspended) slabs shall be 2 inches unless specified otherwise.
 3. Type SPNM: Mason Industries Type SLFH or approved equal.
- B. Constrained Steel Spring Neoprene Mounts (Type CSNM):
1. Assembly: Single or multiple free-standing and laterally stable steel springs assembled into a factory-fabricated housing with integral leveling device and stops to limit vertical movement of the isolated equipment during a temporary weight reduction. Include rigid blocking to support equipment during rigging to maintain identical installed and operating heights of the isolator. Housing shall maintain a minimum clearance of 1 inch around restraining bolts and the spring so as not to interfere with the spring operation.
 - a. Leveling Device: Rigidly connected to equipment or frame. Limit stops shall provide minimum 1/4 inch clearance between housing and isolator base plate under normal operation.
 - b. Equipment Wind Loading Applications: Provide tapped hole in top and bottom plates for bolting to equipment and the roof or supporting structure with a neoprene mounting sleeve.
 2. Base: Minimum 1/4 inch thick neoprene pad under housing.
 3. Selection: Minimum static deflection of 2 inches unless specified otherwise.
 4. Type CSNM: Mason Industries Type SLR or approved equal.
- C. Neoprene Bushing (Type NR):
1. Assembly: Neoprene restraint, rubber-in-shear bushings for lightweight, suspended equipment supported from structure with all-thread rod and angle iron or Unistrut.
 2. Selection: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.15 inches.
 3. Type NR: Mason Industries Type HMIB or approved equal.
- D. Spring and Neoprene Hanger (Type SPNH)
1. Assembly: Steel hanger box containing a laterally stable, double deflecting, neoprene isolator in series with a steel spring.

- a. Housing: Include a neoprene bushing to prevent contact between the lower hanger rod and hanger box and short-circuiting the isolating function. Bottom opening sized to allow hanger rod to swing through a 30 degree arc.
 2. Selection:
 - a. Neoprene isolator: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.4 inches unless specified otherwise.
 - b. Spring isolator: Minimum static deflection of 2 inches unless specified otherwise.
 3. Type SPNH: Mason Industries Type 30N or approved equal.
- E. Neoprene Mounting Sleeves, Grommets, and Bushings: Designed to prevent steel-to-steel contact within vibration isolators.
- F. Flexible Connectors:
1. Pipe: Refer to Section "Hydronic Piping Specialties."
 2. Duct: Refer to Section "Air Duct Accessories."
- G. Pipe Riser Anchor (Type PRA)
1. Assembly: Telescoping arrangement of two sizes of steel tubing separated by minimum 1/2 inch thick, 60 durometer neoprene. Anchor shall include tapped hole on the top plate for bolt attachment to riser clamp. Anchor shall allow for all-directional movement.
 2. Selection: Static deflection of 0.1 inches, maximum allowable load on the isolation material shall not exceed 500 psi.
 3. Type PRA: Mason Industries Type ADAH or approved equal.
- H. Pipe Riser Guide (Type PRG):
1. Assembly: Telescoping arrangement of two sizes of steel tubing separated by minimum 1/2 inch thick, 60 durometer neoprene with set screw to prevent lateral movement. Guide shall include tapped hole on the top plate for bolt attachment to riser clamp.
 2. Type PRG: Mason Industries Type VSGH or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that mounting surfaces are ready to receive vibration isolation and associated attachments.

3.2 INSTALLATION - GENERAL

- A. Install in accordance with manufacturer's instructions.
- B. External spring isolators are not required if unit is provided with internal spring isolation. If external spring isolators are provided, internal spring isolation shall not be approved.
- C. Mount or suspend all equipment, piping, ductwork, etc. from approved foundations and supports as specified herein or as shown on the drawings.
- D. Secure fasteners according to manufacturer's recommended torque settings.
- E. Support piping, ductwork, conduit, and mechanical equipment from the building structure. Do not support from other equipment, piping, or ductwork.
- F. Install isolators to prevent short-circuiting of the isolation.
- G. All wiring connections to mechanical equipment on isolators shall have a minimum 18 inch long flexible conduit in a "U" shaped loop. Coordinate with Division 26.
- H. Flexible Connectors: Install flexible connectors sized to match equipment connections and to provide sufficient slack for vibration isolation as required.
- I. Equipment connected to water or other fluid piping shall be erected on isolators or isolated foundations at correct operating heights prior to connection of piping. Block-up equipment with temporary shims to final operating height. When the system is assembled full load is applied, adjust the isolators shall be adjusted to allow shim removal.

3.3 INSTALLATION OF VIBRATION ISOLATED EQUIPMENT SUPPORT BASES

- A. All floor-mounted equipment shall be erected on housekeeping pads. Refer to Section "Common Work Results for HVAC" for concrete housekeeping pad requirements.
- B. Maintain minimum 4 inches clearance between isolated equipment and the walls, ceiling, floors, columns, and any other equipment not installed on vibration isolators.
- C. Set steel bases for one inch clearance between housekeeping pad and base.
- D. Adjust equipment to be level.
- E. Verify no material is left to short-circuit the isolator.
- F. Type CMB:
 - 1. Attach roof equipment support to the roof structure according to the manufacturer's installation instructions.

2. Provide flexible duct connector using a foam rubber gasket to seal against the unit bottom.
3. Provide rigid backing material (e.g., insulation, wood, etc.) to maintain cant slope on roof equipment support bases.
4. Install roof equipment support bases to maintain continuous insulation on roof.

3.4 INSTALLATION OF VIBRATION ISOLATORS

- A. Neoprene Mounting Sleeves, Grommets, and Bushings: Install on vibration isolators to prevent any metal to metal contact.
- B. Spring Isolators:
 1. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
 2. Install springs so that the ends of springs remain parallel and all springs are installed with adjustment bolts.
 3. Locate isolation hangers at the top of hanger rods.
 4. Type SPNM: Unless otherwise specified, isolators need not be bolted to the floor for indoor installations.
 5. Type SPNH and DDNH: Install the hanger box to allow it to rotate a full 360 degrees without encountering any obstruction.
- C. Isolating Pipe Anchors:
 1. Weld anchor base to support steel or bolt base plate to structure. Weld or bolt pipe clamp or bracket to anchor.

3.5 EQUIPMENT ISOLATION

- A. Packaged Rooftop Units:
 1. Roof-mounted, up to 20 ft span: Type CMB with 0.75 inch static deflection.
 2. Roof-mounted, span of 20 ft or more: Type CMB with 2 inch static deflection.
- B. Air-Cooled Condensers and Condensing Units:
 1. Roof-mounted: Type RES base, Type CSNM isolation with 2 inch static deflection.
- C. Fan Coil Units:

1. Floor-mounted (Concealed): Housekeeping pad base, Type SPNM isolation with 0.75 inch static deflection.

D. Fans

1. Suspended:
 - a. Fans 1 hp and less: Type NR isolation with 0.15 inch static deflection.
 - b. Fans greater than 1 hp: Type SPNH isolation with 2 inch static deflection.

- E. All other equipment not specifically identified in this specification that contains rotating or vibrating elements and any associated electrical apparatus installed by this division that contains transformers or inductors shall be installed on Type DDNM or RNM neoprene isolators as appropriate.

3.6 PIPING ISOLATION

A. Provide isolation supports on the following HVAC pipe:

1. Piping within 20 feet of the following suspended equipment: Provide Type SPNH isolators. The first isolator both upstream and downstream of equipment on springs shall have a static deflection equal to that of the equipment isolators, up to a maximum of 2 inches. The static deflection of the remaining pipe isolators shall be 0.75 inch.
 - a. Pipes connected without flexible connectors to suspended equipment that is installed with spring vibration isolators.
 - b. Pipes connected without flexible connectors to suspended in-line pumps.

- B. Provide flexible connectors for piping system connections on equipment side of shutoff valves for all pumps, mechanical equipment supported or suspended by spring isolators, and where indicated on Drawings.

- C. Provide resilient diagonal mountings or other approved devices as required to limit piping motion due to equipment startup or shut down to a maximum of 1/8 inch.

D. Vertical Piping Riser Supports:

1. Do not exceed pipe stresses allowed by ASME B31.9.
2. Provide multiple supports along riser so that each isolator support is loaded for 50 psi maximum. Provide tapped hole in top of support for rigid attachment of pipe riser clamp to support.
3. Riser Supports: Pipe clamp on top of Type DP or Type WP.

4. Risers Subject to Thermal Expansion:

- a. Support vertical pipe risers subjected to thermal expansion and/or contraction with spring isolators, anchors, and guides designed to ensure loading within design limits at support points. Perform design calculations for sizing the riser supports incorporating the initial load, initial deflection, change in deflection, final load and change in load at support locations. Design calculations must include anchor loads when installed, cold filled and at operating temperature and pipe stress at end connections and branch locations. Design system for an initial spring deflection of at least 4 times the thermal movement. Design must be stamped and signed by a licensed professional engineer.
- b. Spring Isolators: Type SPNH, DDNH, or PRSA.
- c. Anchors: Type PRA.
- d. Guides: Type PRG.
- e. Reference Section "Expansion Fittings and Loops for HVAC Piping" for expansion joints.

3.7 DUCT ISOLATION

- A. Connect ducts to equipment, fans, fan casings, and fan plenums with flexible connectors.

3.8 FIELD QUALITY CONTROL

- A. Arrange for inspection of all isolation and noise control equipment by the vibration isolation vendor and submit post-installation inspection report.
- B. The installation of all vibration isolation systems shall be under the supervision of the manufacturer's representative.
- C. Guarantee: If, in the actual installation, any equipment fails to meet the vibration control requirements specified herein, that equipment shall be corrected or replaced without claim for additional payment, inclusive of all labor and material costs. Such corrective measures shall be done within a time schedule specified by the Owner.

END OF DOCUMENT 230550

DOCUMENT 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Adhesive-backed duct markers.
- D. Stencils.
- E. Pipe markers.
- F. Ceiling tacks.
- G. Engraved plastic-laminate signs.

1.2 SUBMITTALS

- A. Custom Signage: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- B. Valve Tag Schedule: Submit 8-1/2 x 11 inch typewritten valve schedule. Furnish one extra copy for each maintenance manual. Include the following information in the schedule:
 - 1. Valve tag number.
 - 2. Piping system and system abbreviation as shown on tag.
 - 3. Location of valve (room or space).
 - 4. Variations for identification (if any).
 - 5. Function. Specially mark valves which are intended for emergency shut-off and similar special uses in margin of schedule.
 - 6. Valve manufacturer's name and model number.
- C. Product Data: Submit manufacturer's technical product data for each product required.
- D. Manufacturer's Installation Instructions: Indicate special procedures and installation for each product required.

1.3 SPARE PARTS

- A. Furnish minimum of 5 percent extra stock of each mechanical identification material required for each system that uses the identification material.
- B. Furnish not less than 3 additional numbered valve tags for each piping system.
- C. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock along with stenciling paints and applicators.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Advanced Graphic Engraving, LLC.
- B. Brady Corporation.
- C. Brimar Industries, Inc.
- D. Craftmark.
- E. Industrial Safety Supply Co., Inc.
- F. Kolbi Pipe Marker Co.
- G. MIFAB, Inc.
- H. Seton Identification Products, a Tricor Direct Company..

2.2 IDENTIFICATION APPLICATIONS AND REQUIREMENTS

- A. General:
 - 1. Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than a single type is specified for application, selection is the installer's option, but provide single selection for each product category.
 - 2. Lettering: Coordinate names, abbreviations, and other designations used in mechanical identification work with the corresponding designations shown on the drawings, scheduled, and specified. If not otherwise indicated, provide numbering, lettering, and wording as recommended by the manufacturer or as required for proper identification, operation, and maintenance of mechanical systems and equipment.

3. Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (e.g., Boiler No. 3, Air Supply No. 1H, etc.).
- B. Automatic Controls: Tags, use the same naming convention coordinated with the building automation system.
- C. Control Panels: Nameplates.
- D. Dampers: Ceiling tacks where located above lay-in ceiling. Do not use ceiling tacks in a gyp ceiling.
- E. Ductwork: Adhesive-backed duct markers. Stencils are only acceptable for concealed ductwork, exterior ductwork, or in mechanical rooms.
- F. Fans: Nameplates, stencils, or engraved plastic laminate signs.
- G. Instrumentation: Tags.
- H. Piping: Pipe Markers.
- I. Relays: Tags.
- J. Thermostats: Nameplates.
- K. General Signs: Engraved plastic laminate signs.

2.3 NAMEPLATES

- A. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
 1. Name and mark number.
 2. Equipment service.
 3. Design capacity.
 4. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.
- B. Size: 2-1/2 inch x 4 inch for control panels and components, 4-1/2 inch x 6 inch for equipment.
- C. Letter Color: White.
- D. Letter Height: 1/4 inch.
- E. Background Color:

1. Cooling equipment: Green.
2. Combination cooling and heating equipment: Yellow/Green.
3. Equipment and components that do not meet any of the above criteria: Blue.

F. Plastic: Conform to ASTM D709.

2.4 TAGS

- A. Plastic Laminate Tags: Laminated three-layer plastic, minimum 3/32 inch thick, with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter and 5/32 inch hole for fastener.
- B. Solid Plastic Tags: Solid plastic, minimum 3/32 inch thick, with printed black letters on white color. Tag size minimum 1-1/2 inch diameter and 5/32 inch hole for fastener.
- C. Metal Tags: Provide 19-gauge polished brass with stamped letters. Tag size minimum 1-1/2 inch diameter with smooth edges and 5/32 inch hole for fastener. Fill tag engraving with black enamel paint.
- D. Accident Prevention Tags: Pre-printed or partially pre-printed, of plasticized card stock with matte finish suitable for writing, minimum 3-1/4 inch x 5-5/8 inch size, with brass grommet in hole for fastener. Order with appropriate pre-printed wording (e.g., DANGER, CAUTION, DO NOT OPERATE, etc.).
- E. Tag Fasteners: Solid brass chain (wire link or beaded type), or solid brass S-hooks of the size required for proper attachment of tags to valves, manufactured specifically for that purpose.
- F. Letter Height:
 1. System Abbreviation: Minimum 1/4 inch.
 2. Valve Number: Minimum 1/2 inch.

2.5 ADHESIVE-BACKED DUCT MARKERS

- A. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.
- B. Style: Individual label.
- C. Nomenclature: Include air handling unit identification number, duct size, service, and arrows indicating direction of flow.
- D. Color: Yellow background with black lettering or blue background with white lettering.

2.6 STENCILS

- A. Stencils: With clean cut symbols and letters of following size, complying with ASME A13.1:
 - 1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
 - 2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
 - 3. Ductwork and Equipment: 2-1/2 inch high letters.
 - 4. Access Doors: 3/4 inch high letters.
 - 5. Operational Instructions: 3/4 inch high letters.
 - 6. Provide arrows indicating direction of flow.
- B. Stencil Paint: Oil based, alkyd enamel, either brushing grade or pressurized spray-can form and grade, black color, except for piping. For piping systems use colors conforming to ASME A13.1.

2.7 PIPE MARKERS

- A. Semi-rigid Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- B. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings, minimum 3 mil thick.
 - 1. Width: 1-1/2 inch for pipes less than 6 inches (including insulation), 2-1/2 inch for pipes 6 inches and larger (including insulation).
- C. Pipe Marker with Insulation: 1 inch thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F or greater. Insulation shall extend 2 inches beyond each end of plastic pipe marker.
- D. Nomenclature: Manufacturer's standard pre-printed nomenclature which best describes piping system. Differentiate between supply and return. In the case of a variance, provide nomenclature as selected by the Engineer.
- E. Arrows: Provide pipe markers with integral arrows indicating direction of flow or as a separate unit of plastic.
- F. Letter Height: Minimum 1/2 inch for pipes up to 3 inch, minimum 1 inch for larger pipes.

2.8 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color coded head.

B. Color:

1. HVAC Equipment: Yellow.

2.9 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Engraving stock melamine plastic laminate, engraved with manufacturer's standard letter style, black with white core letter color except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: 1/16 inch thick for units up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger units.

C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

D. Nomenclature: When used to identify equipment, match terminology on schedules, including the following:

1. Name and mark number.

2. Equipment service.

3. Design capacity.

E. Access Panel Markers: Laminated three-layer plastic, minimum 1/16 inch thick and 1/8 inch hole for fastener, with abbreviations and numbers corresponding to concealed valve.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Division 09 for stencil painting.

3.2 GENERAL INSTALLATION

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

- B. Install products in accordance with manufacturer's instructions.
- C. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- D. Install tags on piping 3/4 inch diameter and smaller.
- E. Install in clear view and align with axis of piping.
- F. Apply stencil painting in accordance with Division 09.
- G. Identify service, flow direction, and pressure.

3.3 PIPING IDENTIFICATION

- A. General: Install identification on the most obviously visible portion of the pipe from the point of access.
- B. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- C. Pipes less than 6 inches diameter (including insulation);, Provide full-band pipe markers with 360 degree coverage.
- D. Location: Install piping identification where piping is exposed to view, concealed by a removable ceiling system, located in accessible maintenance spaces (shafts, tunnels, plenums, etc.) and exterior non-concealed locations as follows:
 - 1. Within 5 feet of each valve, tee, and control device.
 - 2. Within 5 feet of each branch, excluding branches less than 25 feet in length to fixtures or terminal heating and cooling units.
 - 3. Within 5 feet of each side of a penetration of a wall, floor, ceiling, structure, or enclosure.
 - 4. At access doors, manholes and similar access points which permit view of concealed piping.
 - 5. Within 5 feet of equipment outlets and other points of origination and termination.
 - 6. Spaced intermediately at a maximum spacing of 50 feet along each riser and run. Reduce spacing to 25 feet in congested areas where there are more than two piping systems or pieces of equipment.

3.4 DUCTWORK IDENTIFICATION

- A. Install identification on the most obviously visible portion of the duct from the point of access.

- B. Location: Install ductwork identification where ductwork is exposed to view, concealed by a removable ceiling system, located in accessible maintenance spaces (shafts, tunnels, plenums, etc), and exterior non-concealed locations as follows:
 - 1. Within 5 feet of each control damper or balancing damper, excluding balancing dampers installed in duct take-offs to individual grilles, registers, or diffusers that are less than 25 feet in lengths and installed in the same space as the air device.
 - 2. Within 5 feet of each branch duct, excluding branch ducts that are less than 25 feet in length and located in the same space as the main duct.
 - 3. Within 5 feet of each side of a penetration of a wall, floor, ceiling, structure, or enclosure.
 - 4. Spaced intermittently at a maximum spacing of 50 feet along each duct run. Reduce spacing to 25 feet in congested areas when there are more than two types of duct systems or pieces of equipment.
 - 5. Within 5 feet of equipment outlets and other points of origin or termination.
 - 6. Install marker on the most obviously visible portion of the duct from point of access.

3.5 ACCESS DOOR IDENTIFICATION

- A. Provide identification on each access door, indicating purpose of access, maintenance and operating instructions, and appropriate safety and procedural information.
- B. Where access doors are concealed above a removeable ceiling system or similar concealment, tags may be used in lieu of specified identification.

3.6 CEILING TACK INSTALLATION

- A. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

3.7 EQUIPMENT IDENTIFICATION

- A. Install nameplates and engraved plastic laminate signs for identification of equipment. Provide additional signs and lettering as follows:
 - 1. To distinguish between multiple units in close proximity.
 - 2. To inform operator of operational requirements.
 - 3. To indicate safety and emergency precautions.
 - 4. To warn of hazards and improper operations.
- B. Adjust lettering size based on viewing distance from normal location of identification:

1. Less than 2 feet: Minimum 1/4 inch.
 2. Up to 6 feet: Minimum 1/2 inch.
 3. Greater than 6 feet: Proportionally increase letter size based on recommendations above.
 4. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.
 5. Stencils may be used in lieu of nameplates when lettering greater than 1 inch is needed for proper identification because of distance from normal location of required identification.
- C. Where equipment to be identified is concealed above acoustical ceilings or similar removeable concealment, equipment tags may be installed in the concealed space to reduce the amount of text in exposed sign.

END OF DOCUMENT 230553

DOCUMENT 230593 - TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. General testing, adjustment, and balancing requirements.
- B. Testing, adjustment, and balancing of air systems.
- C. Testing, adjustment, and balancing of domestic water systems.
- D. Sound and vibration measurement of equipment operating conditions.
- E. This section excludes:
 - 1. Specifications for materials for patching mechanical systems;
 - 2. Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.
 - 3. Requirements and procedures for piping and ductwork systems leakage tests.

1.2 DEFINITIONS

- A. TAB: Testing, adjusting, and balancing.
- B. Test: To determine quantitative performance of equipment.
- C. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).
- D. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.
- E. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.
- F. Report forms: Data sheets arranged for collecting test data in logical order for submission and review. Data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.
- G. Terminal: The point where the controlled fluid enters or leaves the distribution system. Examples include inlets and outlets on water terminals, inlets and outlets from air terminal units, and inlets and outlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.

- H. Main: Duct or pipe containing the major or entire fluid flow of the system.
- I. Submain: Duct or pipe containing part of the system capacity and serving two or more branch mains.
- J. Branch main: Duct or pipe serving two or more terminals.
- K. Branch: Duct or pipe serving a single terminal.

1.3 SUBMITTALS

- A. Qualifications:
 - 1. Submit qualifications of TAB agency.
 - 2. Submit qualifications of TAB supervisor.
- B. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
- C. Sample Forms: Submit sample forms if they are other than the standard forms available from the certification association followed for the project.
- D. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- E. Progress Reports.
- F. Certified TAB Reports:
 - 1. General:
 - a. Submit within two weeks after completion of testing, adjusting, and balancing.
 - b. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - c. Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 2. Draft Report: Submit draft copies of report for review prior to final acceptance of Project. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.

3. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports. The final report shall be certified proof of the following:
 - a. The systems have been tested, adjusted, and balanced in accordance with the referenced standards.
 - b. The report reflects an accurate representation of how the systems have been installed.
 - c. The report reflects a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures.
 - d. The report is an accurate record of all final quantities measured to establish normal operating values of the systems.
 4. Report Format: Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, and cover identification at front and side. Include set of reduced size drawings indicating air outlets, equipment, and thermostat locations identified to correspond with report forms. Divide the report into the following divisions:
 - a. General Information and Summary
 - 1) Include project name, location, altitude, and date.
 - 2) Identify TAB agency, contractor, owner, architect, and engineer.
 - 3) Include addresses, contact names, and telephone numbers.
 - 4) Include certification sheet containing the seal, name, address, telephone number, and signature of the certified TAB Supervisor.
 - 5) Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - b. Air Systems
 - c. Temperature Control Systems
 5. Report Forms: Standard forms prepared by the TAB certification standard being followed for each respective item and system to be tested, adjusted, and balanced. If not specified, follow ASHRAE 111.
 6. Units of Measure: Report data in I-P (inch-pound) units only.
- G. Project Record Documents: Provide drawings that record actual locations of flow measuring stations and balancing devices.

1.4 QUALITY ASSURANCE

- A. Comply with ASHRAE Standard 111, Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
- B. Comply with ASHRAE Handbook, HVAC Applications Volume, Chapter "Testing, Adjusting, and Balancing", most current edition.
- C. TAB Agency Qualifications:
 - 1. Act as the single source of responsibility for TAB of the HVAC systems.
 - 2. Staff the project at all times by qualified personnel.
 - 3. Have a minimum of 5 years documented experience on projects with TAB requirements similar to those required for the project.
 - 4. Certified by one of the following Certification Associations:
 - a. AABC (NSTSB): Associated Air Balance Council, National Standards for Total System Balance.
 - b. NEBB: National Environmental Balancing Bureau, Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
 - c. TABB: Testing, Adjusting, and Balancing Bureau, SMACNA TAB Procedural Guide.
- D. TAB Supervisor and Technician Qualifications:
 - 1. Certified by the same organization as TAB agency.
 - 2. TAB Supervisor shall be a professional engineer licensed in the state in which the project is located.
- E. Pre-Qualified TAB Agencies:
 - 1. AccuTech
 - 2. Doyle Field Services.
 - 3. Precisionaire of the Midwest.
 - 4. Pro Balance.
 - 5. Total Air Balance.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Begin work after systems to be tested, adjusted, or balanced are fully operational, duct systems are sealed, piping systems have been tested for leaks, and equipment is operational. Complete work prior to Substantial Completion of the project.
- B. Test, adjust, and balance the air systems before refrigerant systems.
- C. Coordinate with Division 22 drawings for testing, adjusting, and balancing scope of work.
- D. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- E. Submit progress reports at least once a week to the General Contractor to communicate status of work so that the TAB work is completed in a timely manner.
- F. Notice of Tests: Provide seven days advance notice for each test. Include scheduled test dates and times.
- G. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- H. All required instrumentation shall be calibrated to tolerances specified in the referenced standards within a period of six months prior to starting the project.

3.2 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Motors and bearings are lubricated.

5. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 6. Duct systems are clean of debris.
 7. Fans are rotating correctly and belts have tension.
 8. Fire, smoke, fire/smoke, and volume dampers are in place and open.
 9. Air coil fins are cleaned and combed.
 10. Volume dampers are installed at locations needed for balancing the air systems.
 11. Access doors are closed and duct end caps are in place.
 12. Air outlets are installed and connected.
 13. Visually inspect duct systems to ensure they are sealed and leakage is minimized.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

- A. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a coordination meeting with all installers whose work will be tested, adjusted, or balanced.
- B. Furnish all instruments required for testing, adjusting, and balancing operations.
1. Verify all instruments have been calibrated.
 2. Furnish instruments as recommended by the manufacturer for the TAB application.
 3. Furnish instruments that are best suited to the function being measured.
 4. Furnish instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.
- C. Furnish additional balancing devices as required for TAB to the appropriate contractor for installation.
- D. Obtain copies of approved shop drawings of air handling equipment, terminal outlets, and temperature control diagrams.

- E. Obtain manufacturer's fan and terminal device outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.
- F. Determine best locations in main and branch ductwork for most accurate duct traverses.
- G. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.

3.4 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Balance main ducts and equipment to within plus or minus 5 percent of design airflow.
- B. Air Outlets and Inlets: Balance branch ducts and terminal devices to within plus or minus 10 percent of design airflow.

3.5 AIR SYSTEM TESTING, ADJUSTMENT, AND BALANCING PROCEDURE

- A. Check filters for cleanliness.
- B. Check dampers (both volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.
- C. Verify volume dampers are installed at locations needed for balancing the air systems.
- D. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.
- E. Determine best locations in main and branch ductwork for most accurate duct traverses.
- F. Place outlet dampers in the full open position.
- G. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.
- H. Lubricate all motors and bearings.
- I. Check fan belt tension.
- J. Check fan rotation.
- K. Energize fan motors and adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude. Replace fan and motor pulleys as required to achieve design conditions.

- L. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- M. Measure air quantities at air inlets and outlets.
- N. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- O. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Affect volume control by duct internal devices such as dampers and splitters.
- P. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- Q. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- R. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- S. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- T. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- U. Where modulating dampers are provided, take measurements and balance at design conditions. Balance variable volume systems at design air flow rate and at minimum air flow rate.
- V. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship to maintain building pressure setpoint.
- W. Procedure for establishing minimum and absolute minimum outdoor air damper position on air handling units:
 - 1. Open the minimum outdoor air damper and return air damper fully. Close the economizer air damper.
 - 2. Operate supply fan at design speed and measure the outdoor airflow.
 - 3. If the outdoor airflow is above the scheduled minimum ventilation airflow, adjust the damper linkage on the minimum outdoor air damper so that outdoor airflow equals the scheduled minimum ventilation airflow with damper fully stroked.
 - 4. If outdoor airflow is below the scheduled minimum ventilation airflow, adjust the damper linkage on the return air damper so that outdoor airflow equals the schedule minimum ventilation airflow with the damper fully stroked.

5. Convey the measured setpoint and/or damper position to the BAS installer and note on air balance report.
6. Repeat this procedure to determine damper position for absolute minimum ventilation.

3.6 DOMESTIC WATER SYSTEM TESTING, ADJUSTMENT, AND BALANCING PROCEDURE

A. Before balancing the system perform these steps:

1. Open valves to full open position.
2. Examine plumbing system and equipment installations to verify that indicated balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices and balancing valves and fittings are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
3. Remove and clean all strainers.
4. Check pump rotation.
5. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
6. Lubricate all motors and bearings.

3.7 TESTING FOR SOUND AND VIBRATION

- #### A. Test and adjust mechanical systems for sound and vibration in accordance with the detailed instructions of the referenced standards:
1. ASHRAE: ASHRAE Handbook, HVAC Applications Volume, Chapter "Sound and Vibration Control", most current edition.
- #### B. Other than sound data, failure of an item includes a deviation of more than 10 percent from setpoint. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report.
1. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
- #### C. Prepare and submit report of recommendations for correcting any sound or vibration levels that are outside of manufacturer's tolerances, ASHRAE standards and/or values specified in the contract documents.

END OF DOCUMENT 230593

DOCUMENT 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping Insulation.
- B. External Ductwork Insulation.
- C. Equipment Insulation.

1.2 RELATED REQUIREMENTS

- A. Division 23 Section "Hangers & Supports for HVAC Piping & Equipment," for insulation shields, pipe saddles, and high-density insulation inserts.
- B. Division 23 Section "Metal Ducts" for duct liner insulation.

1.3 DEFINITIONS

- A. Cold Pipe: Piping that carries fluid with a minimum operating temperature less than 60 degrees F.
- B. Hot Pipe: Piping that carries fluid with a minimum operating temperature greater than 105 degrees F.
- C. Cold Duct: Ductwork that carries airflow with a minimum operating temperature less than 65 degrees F temperature.
- D. Hot Duct: Ductwork that carries airflow with a minimum operating temperature greater than 75 degrees F temperature.
- E. Neutral Ductwork: Ductwork that carries airflow with temperatures between the defined cold and hot temperatures.
- F. Cold Equipment: Equipment that carries fluids with a minimum operating temperature less than 60 degrees F.
- G. Hot Equipment: Equipment that carries fluids with a minimum operating temperature greater than 105 degrees F.
- H. Exposed: Insulation that is visible from the occupied space.
- I. Exposed to Weather: Insulation that is exposed to potential damage caused by weather, including sunlight, moisture, wind, and solar radiation.

- J. Exterior: Locations outside of or within the building envelope (walls, roof, floors, etc) as defined by the architectural drawings and specifications.
- K. Unconditioned Spaces: An enclosed space within a building that is not provided with mechanical heating or cooling.

1.4 SUBMITTALS

- A. Product Data: Submit technical product data, thermal characteristics, and materials for each type of mechanical insulation.
- B. Insulation Schedule: Include product name, conductivity k-value, thickness, and furnished accessories for each service.
- C. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.
- D. Manufacturer's Instructions: Include installation instructions for storage, handling, protection, examination, preparation, and installation of the product.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualification: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.
- B. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- C. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.
 - 1. Exception: Exterior mechanical insulation may have flame spread index of 75 and smoke developed index of 150.
 - 2. Exception: Industrial mechanical insulation that will not affect life safety egress of building may have flame spread index of 75 and smoke developed index of 150.
 - 3. Exception: Polyisocyanurate insulation that is not installed in a return air plenum may have a flame spread index of 25 and smoke developed index of 450.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage; store in original wrapping.

1.7 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 - PRODUCTS

2.1 PIPING INSULATION MATERIALS

- A. Polyisocyanurate:

- 1. Manufacturers:

- a. Dyplast Products.
 - b. Johns Manville.
 - c. Approved equal.

- 2. Insulation: ASTM C591, Grade 2, Type IV for ASTM E84 25/50 compliance, Type I for ASTM E84 25/450 compliance; rigid molded, pre-formed for the application.

- a. K-value: ASTM C518 or C177, maximum 0.2 at 75 degrees F.
 - b. Minimum Service Temperature: Minus 297 degrees F
 - c. Maximum Service Temperature: 300 degrees F.
 - d. Density: Maximum 6 pounds per cubic feet.

- B. Flexible Elastomeric:

- 1. Manufacturers:

- a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.

- 2. Insulation: ASTM C534, Grade I, flexible elastomeric cellular rubber insulation, pre-formed for the application.

- a. K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.
 - b. Minimum Service Temperature: Minus 297 degrees F
 - c. Maximum Service Temperature: 220 degrees F for Grade I, 300 degrees F for Grade II.
3. Factory Applied Jacket:
- a. Polymeric Coating: Multi-ply, polymeric blend coating, 16 mils thick, designed to prevent damage to underlying insulation from sunlight, installation, and physical abuse, with water vapor permeance of 0.03 perms. Reference Piping Jacket Schedule in Part 3 of this specification for application of this jacket.

C. Field-Applied Jacket:

1. Semi-rigid PVC: One-piece, pre-molded PVC cover conforming to ASTM D1784, including factory-furnished, pre-cut insulation blanket inserts for fittings.
 - a. Outdoor Applications: Provide minimum 30 mils thickness and UV protection.
 - b. Manufacturers:
 - 1) Johns Manville Zeston PVC Jacketing and 2000 Series Fitting Covers
 - 2) Proto Corp LoSmoke PVC Jacketing and Pro Fitting Covers.
 - 3) Or approved equal.
2. Rigid Aluminum Shell: One-piece, pre-formed cover conforming to ASTM C1729 with weather-proof construction. Shell shall have the following minimum thickness based on the outer insulation diameter:

Outer Insulation Diameter (in)	Minimum Aluminum Jacket Thickness, (in)		
	Non-Rigid Insulation	Rigid Insulation	Finish
≤ 8	0.016	0.016	Stucco

Note 1: Use corrugated finish for non-rigid insulation. Use stucco finish for rigid insulation.

- a. Banding:
 - 1) For piping less than or equal to 8 inches, provide 0.020 inch thick, 3/4 inch wide aluminum bands.
 - 2) For piping larger than 8 inches, provide 0.020 inch thick, 3/4 inch wide stainless steel bands.
3. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW, or approved equal.

- a. Water Vapor Transmission: 0.0 perms per ASTM E96.
 - b. Puncture Resistance: Minimum 65 pounds per ASTM D1000.
- D. Adhesives, Sealers, Mastics, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.
1. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36, Childers CP-50AHV2, or equal.
 2. Weather Barrier Breather Mastic: Permeance shall be 1.0 perms or less at 62 mils dry per ASTM E96, Procedure B. Provide Foster 46-50, Childers CP-10/11 or equal.
 3. Solvent-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 35 mils dry per ASTM F 1249.
 4. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance in accordance with ASTM C755 for insulation application. Provide Foster 30-80, Childers CP-38, or equal.

Table: Recommended Maximum Permeance of Water Vapor Retarders (Note 1)

Insulation Application	Insulation Permeability, Less than 4.0 perm-in.	Insulation Permeability, 4.0 or greater perm-in.
	(Note 2)	(Note 2)
	Vapor Retarder perms	Vapor Retarder perms
Pipe and vessels (33 F to ambient)	0.05	0.05
Pipe and vessels (-40 F to 32 F)	0.02	0.02
Ducts (40 F to ambient)	1.0	0.03

Notes:

1. Water vapor permeance of the vapor retarder in perms when tested in accordance with Test Methods E96.
 2. Water vapor permeability of the insulation material when tested in accordance with Test Methods E96.
- E. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.
- F. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.
- G. High Density Insulation Billets:
1. Calcium Silicate: ASTM C533 and C795.

2. Flexible elastomeric: ASTM C534, Type 1.
3. Polystyrene: ASTM C578, Type XIII.
4. Phenolic: ASTM C1126, Type III, Grade 1.

2.2 EXTERNAL DUCTWORK INSULATION MATERIALS

A. Flexible Mineral Fiber (rock, slag, or glass):

1. Manufacturers:
 - a. CertainTeed Corp.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Owens Corning.
2. Insulation: ASTM C553, Type I or II, flexible mineral fiber blanket.
 - a. K-value: ASTM C518 or C177, maximum 0.31 at 75 degrees F.
 - b. Minimum Service Temperature: Minus 20 degrees F
 - c. Maximum Service Temperature: 450 degrees.
 - d. Density:
 - 1) 1.5 pounds per cubic foot.
3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.
 - a. Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms and 2 inch stapling tab.
 - b. Polypropylene Scrim Kraft (PSK): Kraft paper with glass fiber yarn and bonded to metalized polypropylene, water vapor permeance of 0.02 perms and 2 inch stapling tab.
 - c. Color: White.

B. Rigid Mineral Fiber (rock, slag, or glass):

1. Manufacturers:

- a. Johns Manville.
 - b. Knauf Insulation.
 - c. Owens Corning.
 2. Insulation: ASTM C612, Type IA or IB, rigid mineral fiber board.
 - a. K-value: ASTM C518 or C177, maximum 0.25 at 75 degrees F.
 - b. Minimum Service Temperature: 0 degrees F
 - c. Maximum Service Temperature: 450 degrees.
 - d. Density:
 - 1) 3.0 pounds per cubic foot.
 3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.
 - a. All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms.
 - b. Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms.
 - c. Polypropylene Scrim Polyester (PSP): Polyester paper with glass fiber yarn and bonded to polypropylene, water vapor permeance of 0.02 perms.
 - d. Color: White.
- C. Cellular Glass:
1. Manufacturers:
 - a. Owens Corning.
 2. Insulation: ASTM C552, Type I, Grade 6, rigid closed glass cells, block form.
 - a. K-value: ASTM C518 or C177, maximum 0.31 at 75 degrees F.
 - b. Minimum Service Temperature: Minus 450 degrees F.
 - c. Maximum Service Temperature: 800 degrees F.
 - d. Density: Minimum 6 pounds per cubic feet.

D. Polyisocyanurate:

1. Manufacturers:
 - a. Dyplast Products.
 - b. Johns Manville.
 - c. Approved equal.
2. Insulation: ASTM C591, Grade 2, Type IV for ASTM E84 25/50 compliance, Type I for ASTM E84 25/450 compliance; rigid board.
 - a. K-value: ASTM C518 or C177, maximum 0.2 at 75 degrees F.
 - b. Minimum Service Temperature: Minus 297 degrees F
 - c. Maximum Service Temperature: 300 degrees F.
 - d. Density: Maximum 6 pounds per cubic feet.

E. Flexible Elastomeric:

1. Manufacturers:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
2. Insulation: ASTM C534, Grade 1, flexible elastomeric cellular rubber insulation, sheet form.
 - a. K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.
 - b. Minimum Service Temperature: Minus 40 degrees F
 - c. Maximum Service Temperature: 180 degrees F.
3. Factory Applied Jacket:
 - a. Flexible Metal Cladding: Metallic factory-laminated cladding, 17.5 mils thick, designed to prevent damage to underlying insulation from sunlight, installation, and physical abuse, with water vapor permeance of 0.00 perms. Provide ArmaTuff or

equal. Reference Duct Jacket Schedule in Part 3 of this specification for application of this jacket.

F. Field-Applied Jacket:

1. Canvas: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
2. Aluminum: ASTM B209, 3003 alloy, H-14 temper, with 3-mil thick polyfilm moisture barrier to interior surface.
 - a. Thickness: 0.032 inch sheet.
 - b. Finish: Smooth or Stucco. Reference Part 3 for jacket applications.
 - c. Joining: Longitudinal slip joints and 2 inch laps.
 - d. Fittings: 0.032 inch thick die shaped fitting covers with factory attached protective liner.
 - e. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel.
3. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW, or approved equal.
 - a. Water Vapor Transmission: 0.0 perms per ASTM E96.
 - b. Puncture Resistance: Minimum 65 pounds per ASTM D1000.

G. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, pins with insulation retaining washers, anchors, corner angles and other appurtenances as recommended by insulation manufacturer for applications indicated.

H. Adhesives, Sealers, Mastics, and Protective Finishes: Provide cements, adhesives, coatings, sealers, mastics, protective finishes, and similar compounds as recommended by insulation manufacturer for applications indicated.

1. Mineral Fiber Lagging Adhesive: Comply with ASTM C916, Type 2 or MIL-A-3316C, Class 2, Grade A. Provide Foster 85-60, Childers CP-127, or equal water-based adhesive.
2. Vapor Barrier Tape: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber-based adhesive.
3. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 47 mils dry per ASTM E96. Provide Fosters 30-80, Childers CP-38, Design Polymerics 3040, or equal.

4. Solvent-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 35 mils dry per ASTM F 1249.
5. Tie Wire: Annealed steel, 16 gauge, 0.0508 inch diameter.

2.3 EQUIPMENT INSULATION MATERIALS

A. Flexible Mineral Fiber (rock, slag, or glass):

1. Manufacturers:
 - a. CertainTeed Corp.
 - b. Johns Manville.
 - c. Knauf Insulation.
 - d. Owens Corning.
2. Insulation: ASTM C553, Type I and II or ASTM C547 Type II, flexible mineral fiber blanket.
 - a. K-value: ASTM C518 or C177, maximum 0.31 at 75 degrees F.
 - b. Minimum Service Temperature: Minus 20 degrees F
 - c. Maximum Service Temperature: 450 degrees F for ASTM C553 Types I and II, 1200 degrees F for ASTM C547 Type II.
 - d. Density: Minimum 1.5 pounds per cubic foot.
3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.
 - a. Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms and 2 inch lap.
 - b. Color: White.

B. Rigid Mineral Fiber (rock, slag, or glass):

1. Manufacturers:
 - a. Johns Manville.
 - b. Knauf Insulation.

- c. Owens Corning.
- 2. Insulation: ASTM C612, Type IA or IB, rigid mineral fiber board.
 - a. K-value: ASTM C518 or C177, maximum 0.25 at 75 degrees F.
 - b. Minimum Service Temperature: 0 degrees F
 - c. Maximum Service Temperature: 450 degrees.
 - d. Density: Minimum 3.0 pounds per cubic foot.
- 3. Factory Applied Vapor Barrier Jacket: ASTM C1136, Type II.
 - a. All-Service Jacket (ASJ): Paper/Foil/Scrim, water vapor permeance of 0.02 perms.
 - b. Foil Scrim Kraft (FSK): Kraft paper with glass fiber yarn and bonded to aluminized film, water vapor permeance of 0.02 perms.
 - c. Color: White.
- C. Cellular Glass:
 - 1. Manufacturers:
 - a. Owens Corning.
 - 2. Insulation: ASTM C552, Type I, Grade 6, rigid closed glass cells, block form.
 - a. K-value: ASTM C518 or C177, maximum 0.31 at 75 degrees F.
 - b. Minimum Service Temperature: Minus 450 degrees F.
 - c. Maximum Service Temperature: 800 degrees F.
 - d. Density: Minimum 6.12 pounds per cubic feet.
- D. Flexible Elastomeric:
 - 1. Manufacturers:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.

2. Insulation: ASTM C534, Grade I or II, flexible elastomeric cellular rubber insulation, sheet form.
 - a. K-value: ASTM C518 or C177, maximum 0.28 at 75 degrees F.
 - b. Minimum Service Temperature: Minus 40 degrees F
 - c. Maximum Service Temperature: 220 degrees F for Grade I, 300 degrees F for Grade II.

E. Field-Applied Jacket:

1. Canvas: UL listed, minimum 8 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
2. Aluminum: ASTM B209, 3003 alloy, H-14 temper, with 3-mil thick polyfilm moisture barrier to interior surface.
 - a. Thickness: 0.032 inch sheet.
 - b. Finish: Smooth.
 - c. Joining: Longitudinal slip joints and 2 inch laps.
 - d. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel.
3. Stainless Steel: ASTM A666, Type 304 stainless steel.
 - a. Thickness: 0.010 inch sheet.
 - b. Finish: Smooth.
 - c. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.
4. Multilayer Laminate Vapor Barrier Cladding: UV-resistant multi-ply outer layer and cold weather acrylic adhesive. Provide VentureClad Plus 1579 CW, or approved equal.
 - a. Water Vapor Transmission: 0.0 perms per ASTM E96.
 - b. Puncture Resistance: Minimum 65 pounds per ASTM D1000.
5. Rubberized Asphalt Vapor Barrier Cladding: UV-resistant aluminum outer layer, multi-ply cross-laminated polyethylene film, and rubberized asphalt formulated for use on faced insulation. Provide Polyguard Products, Inc. Alumaguard 60 mils thick cladding, Alumaguard Low Temp (LT) 35 mils thick cladding, or approved equal.

6. Interior Vapor Barrier Membrane: Multi-ply, composite membrane of aluminum foil with polyester films on each side to protect the aluminum foil. Membrane shall be reversible to provide a clean, white finish on one side or smooth silver finish on the other side. Provide Polyguard Products, Inc. ZeroPerm or approved equal.
 - a. Water Vapor Transmission: 0.0 perms per ASTM E96.
 - b. Puncture Resistance: Minimum 10 pounds per ASTM D1000.
- F. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors, stud pins, and other appurtenances as recommended by insulation manufacturer for applications indicated.
- G. Adhesives, Sealers, Mastics, and Protective Finishes: Provide cements, adhesives, coating, sealers, mastics, and protective finishes as recommended by insulation manufacturer for applications indicated.
 1. Mineral Fiber Lagging Adhesive: Comply with ASTM C916, Type 2 or MIL-A-3316C, Class 2, Grade A. Provide Foster 85-60, Childers CP-127, or equal water-based adhesive.
 2. Water-Based Vapor Barrier Mastic: Comply with MIL-PRF-19565C, Type II, with water vapor permeance 0.05 perms or less at 47 mils dry per ASTM E96. Provide Foster 30-80, Childers CP-38, Design Polymeric 3040, or equal.
 3. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36. Childers CP-50AHV2 or equal.
 4. Tie Wire: Annealed steel, 16 gauge, 0.0508 inch diameter.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Test piping and ductwork for design pressure, liquid tightness, and continuity prior to applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 PROTECTION AND REPLACEMENT

- A. Provide all required protection for insulation (installed and uninstalled) throughout the duration of construction to avoid exposure to plaster, dust, dirt, paint, moisture, deterioration, and physical damage.
- B. Repair existing mechanical insulation that is damaged during this construction period. Use insulation of same type and thickness as existing insulation. Install new jacket lapping and sealed over existing.

- C. Replace damaged insulation which cannot be repaired satisfactorily at no additional expense to the Owner, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installation of new insulation that replaces the damaged or wet insulation.

3.3 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.

3.4 PIPING SYSTEM INSULATION INSTALLATION

- A. Maintain continuous thermal and vapor-retarder integrity throughout entire installation and protect it from puncture and other damage.
- B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
- D. Exposed Piping: Locate insulation and cover seams in least visible locations.
- E. Cold Pipe Insulation:
 - 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
 - 2. Provide vapor barrier jacket according to the Piping Jacket Schedule.
 - 3. Provide high density insulation material under supports or pre-insulated supports. Protect insulation with shields to prevent puncture or other damage. Refer to Section "Hangers & Supports for HVAC Piping & Equipment" for pre-insulated supports and insulation shields. and for exception where high density insulation inserts are not required.
 - 4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
 - 5. Secure all-service jacket with self-sealing longitudinal laps.
 - 6. Butt pipe insulation tightly at insulation joints. Apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.
- F. Hot Pipe Insulation:

1. Insulate entire system, including fittings, valves, unions flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Provide jackets without vapor barrier according to the Piping Jacket Schedule. Jackets with vapor barrier are allowed.
3. Provide high density insulation material or pre-insulated supports where supports are installed outside of the insulation. Protect insulation with shields to prevent puncture or other damage. Refer to Section "Hangers & Supports for HVAC Piping & Equipment" for pre-insulated supports and insulation shields and for exception where high density insulation inserts are not required.
4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.
5. Secure all-service jacket with self-sealing longitudinal laps.
6. Butt pipe insulation tightly at insulation joints and wrap insulation around supports. Apply 3 inch wide vapor barrier tape or band over joint.

G. Insulation of Fittings, Valves, Strainers, Flanges, and Unions:

1. Insulate fittings, joints, and valves with molded insulation of like material, vapor barrier coating, and thickness as adjacent pipe. Provide pre-formed insulation pieces, segmented insulation, or sectional pipe insulation for the application. Provide the same insulation jacket as adjoining pipe.
2. Sectional pipe insulation: Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Hold sectional cuts in place with tie wire or bands. Wire and bands shall be compatible with insulation and jacket.
3. Segmented pipe insulation: Cover segmented insulated surfaces with a layer of finishing cement and finish with a coating or mastic. Reinforce the mastic with fabric-reinforcing mesh. Trowel the coating or mastic to a smooth and well-shaped contour.
4. Butt each insulation piece tightly against adjoining piece of insulation. Bond pieces together according to Cold Pipe or Hot Pipe installation instructions.
5. Insulate valves up to and including the bonnets, valve stuffing-box studs, bolts, and nuts with a removeable insulation cover. Sectional valve insulation covers shall divide the section along the vertical center line of the valve body.
6. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover.

7. Insulate flanges and unions with a removeable insulation cover. Sectional pipe insulation covers shall divide the section along the center line of pipe.
 8. When removeable covers are made from sectional block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, around the insulated device with tie wire. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 9. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation. PVC fitting covers with end caps are also acceptable. Tape PVC covers to adjoining insulation facing using PVC tape.
 10. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- H. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- I. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated. Maintain vapor barrier through the penetration.
- J. Exterior Piping and Piping Exposed to Weather:
1. General: Provide piping jacket around insulation as scheduled in the Piping Jacket Schedule. Jacket material shall be approved by the jacket manufacturer for use with the specific insulation material that it covers. Locate longitudinal seams of outer shell (aluminum, flexible elastomeric, or cladding as applicable) at bottom of pipe. Provide insulation shields so that the piping supports cannot puncture, cut or break the jacket.
 2. Paintable Coating: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
 3. Polymeric Coating: Provide insulation shields so that the piping supports do not puncture, cut or break the jacket.
 4. Rigid aluminum shell: Space attachment bands 12 inches on center and directly centered over end joints.
 5. Multilayer Laminate Vapor Barrier Cladding: Install cladding only when ambient temperature is above 50 degrees F. Provide low-temp products for installation in low ambient temperatures down to 10 degrees F.
 6. Rubberized Asphalt Vapor Barrier Cladding: Install cladding for use in ambient temperatures as low as minus 10 degrees F.

3.5 PIPING SYSTEM INSULATION SCHEDULE

- A. Reference Pipe Insulation Thickness Schedule at the end of this specification for thickness requirements based on insulation conductivity.
- B. Do not apply insulation to piping that operates outside of the minimum and maximum service temperature range.
- C. Exterior Piping: Insulate all exterior HVAC piping with one of the following:
 - 1. Flexible elastomeric, use high temperature formula for systems with operating temperatures above 220 F. (not acceptable for steam, steam condensate or hot water piping systems with temperatures above 300 F).
- D. Variable Refrigerant Flow (VRF) Piping:
 - 1. Service:
 - a. All refrigerant piping in cooling only, heat pump, or heat recovery VRF systems.
 - 2. Acceptable Insulation:
 - a. Flexible elastomeric.
- E. Warm Temperature Piping (105 degrees to 140 degrees F (40 to 94 degrees C)):
 - 1. Service:
 - a. Refrigerant hot gas lines between the compressor and condensing unit.
 - b. Refrigerant liquid lines between the condensing unit and expansion valve.
 - 2. Insulate each piping system specified above with one of the following types of insulation.
 - a. Mineral fiber.
 - b. Cellular glass.
 - c. Polyisocyanurate.
 - d. Flexible elastomeric.

3.6 PIPE INSULATION THICKNESS SCHEDULE

- A. IECC – 2018 Requirements, Pipe Insulation

Minimum Pipe Insulation Thickness

Fluid Operating Temp. Range (°F) And Usage	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
	Conductivity, Btu·in./(hr·ft ² ·°F)	Mean Rating Temp., °F.	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
	Insulation Thickness, in.						
>350°F	0.32–0.34	250	4.5	5.0	5.0	5.0	5.0
251°F–350°F	0.29–0.32	200	3.0	4.0	4.5	4.5	4.5
201°F–250°F	0.27–0.30	150	2.5	2.5	2.5	3.0	3.0
141°F–200°F	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105°F–140°F	0.21–0.28	100	1.0	1.0	1.5	1.5	1.5
40°F–60°F	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0
<40°F	0.20–0.26	50	0.5	1.0	1.0	1.0	1.5

Notes:

- a. For piping smaller than 1-1/2 inch and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less than 1 inch.
- b. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r[(1 + t/r)^{(K/k)} - 1]$ where
 - 1) T = minimum insulation thickness (in.),
 - 2) r = actual outside radius of pipe (in.),
 - 3) t = insulation thickness listed in the table for applicable fluid temperature and pipe size,
 - 4) K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in./hr·ft²·°F); and
 - 5) k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.
- c. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.
- d. For piping that shall be installed below grade, reference Division 23 section "Underground Hydronic and Steam Piping."
- e. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat

transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

3.7 PIPING JACKET SCHEDULE

- A. Exposed piping within mechanical rooms (below 10 feet):
 - 1. Semi-rigid PVC.
 - 2. Rigid aluminum shell.
- B. Exposed piping within mechanical rooms (above 10 feet):
 - 1. Semi-rigid PVC.
 - 2. Rigid aluminum shell.
- C. Exposed piping:
 - 1. All-service jacket.
 - 2. Semi-rigid PVC.
- D. Piping within return air plenums:
 - 1. All-service jacket.
- E. Exterior piping and piping exposed to weather:
 - 1. Paintable coating (flexible elastomeric insulation only.)
 - 2. Polymeric Coating (flexible elastomeric insulation only).
 - 3. Semi-rigid PVC for outdoor application(flexible elastomeric insulation on refrigerant piping only).
 - 4. Rigid aluminum shell.
 - 5. Multilayer laminate vapor barrier cladding.
 - 6. Rubberized asphalt vapor barrier cladding.

3.8 DUCTWORK INSULATION SYSTEM INSTALLATION

- A. Maintain continuous thermal and vapor-barrier integrity throughout entire installation and protect it from puncture and other damage.

- B. Install insulation on duct systems subsequent to painting, testing, and acceptance of tests.
- C. Install insulation materials with smooth and even surfaces.
- D. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- E. Install insulation without sag on underside of duct. Where rectangular ducts are 24 inches in width or greater, secure external insulation to the bottom of the duct with mechanical fasteners, spaced on 18 inches on center (maximum). Fasteners shall include 2-inch square self-sticking galvanized carbon-steel base plates with minimum 0.106-inch diameter zinc-coated, low carbon steel, fully annealed shank spindle, length to suit depth of insulation. Secure insulation to spindles with self-locking washers incorporating a spring steel insert to ensure permanent cap retention. Lift duct off trapeze hangers and insert spacers to avoid insulation compression.
- F. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- G. Corner Angles: Except for oven and hood exhaust duct insulation, install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.
- H. Lined Ductwork: At interface of lined and wrapped ductwork, overlap lined ductwork by 2 feet (minimum) with wrapped insulation.
- I. Cold Ducts:
 - 1. Insulate entire system, including fittings, joints, flanges, expansion joints, and air duct accessories.
 - 2. Provide vapor barrier jacket according to the Ductwork Jacket Schedule.
 - 3. Seal joints with vapor barrier mastic.
 - 4. Continue insulation, including vapor barrier, through walls, sleeves, hangers, and other duct penetrations.
 - 5. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 - 6. Where cold ducts are installed in mechanical rooms or non-conditioned spaces (excludes return air plenums), prevent condensation from forming on the duct supports by providing one or more of the following:
 - a. Install thermal break such as rigid board insulation between the support and duct.
 - b. Wrap support that is in contact with the duct with external duct wrap insulation to prevent condensation. Wrap shall extend a minimum of 12 inches from point of

contact of the support with the duct. Tape joints to provide a thermal and vapor barrier. Coat all taped joints, punctures and seams with 4 inch wide coating of vapor barrier mastic.

- c. If a support device similar to Unistrut is used, foam fill or stuff tube.

J. Hot and Neutral Ducts:

1. Insulate entire system, including fittings, joints, flanges, expansion joints, and air duct accessories.
2. Provide jackets with or without vapor barrier according to the Ductwork Jacket Schedule.
3. Secure joints with staples, tape, or wires.
4. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

K. Exterior Ductwork and Ductwork Exposed to Weather:

1. Slope ductwork to ensure that water cannot pond anywhere on the duct. Do not vary the insulation thickness to achieve drainage.
2. Jackets shall be approved by the jacket manufacturer for use with the specific insulation material it covers.
3. Locate longitudinal seams of jacket at bottom of duct. Install jacket in strict conformance with cladding manufacturer's instructions.
4. Seal joints with vapor barrier mastic and reinforcing mesh as recommended by manufacturer or protective jacket as specified.
5. Install aluminum jacket with three metal jacket bands per section.
6. Multilayer Laminate Vapor Barrier Cladding: Install cladding only when ambient temperature is above 50 degrees F. Provide low-temp products for installation in low ambient temperatures down to 10 degrees F.
7. Rubberized Asphalt Vapor Barrier Cladding: Install cladding for use in ambient temperatures as low as minus 10 degrees F.
8. Cover seams in flexible metal cladding with ArmaTuff seal tape or equal.

3.9 DUCTWORK SYSTEM INSULATION SCHEDULE

- A. Omit insulation on the following:

1. Fibrous glass ductwork (ductboard).
2. Lined ductwork.
3. Ductwork with sound absorbing linings.

B. Prohibited insulation:

1. Polyisocyanurate installed within a return air plenum.

C. Outdoor Air:

1. Service:
 - a. Interior untreated outdoor air intake ducts.
 - b. Combustion air intake ducts.
2. Acceptable Insulation:
 - a. Flexible mineral fiber.
 - b. Rigid mineral fiber.
 - c. Cellular glass.
 - d. Polyisocyanurate.
 - e. Flexible elastomeric.

D. Supply Air:

1. Service:
 - a. Supply ducts from air handling equipment.
 - b. Insulate neck and bells of supply diffusers.
2. Acceptable Insulation:
 - a. Flexible mineral fiber.
 - b. Rigid mineral fiber.
 - c. Cellular glass.

- d. Polyisocyanurate.
- e. Flexible elastomeric.

E. Return Air:

- 1. Service:
 - a. Interior ductwork within 10 feet of exterior roof or wall penetrations.
 - b. Interior ductwork routed through or from unconditioned spaces and plenums.
- 2. Acceptable Insulation:
 - a. Flexible mineral fiber.
 - b. Rigid mineral fiber.
 - c. Cellular glass.
 - d. Polyisocyanurate.
 - e. Flexible elastomeric.

F. Exhaust Air.

- 1. Service:
 - a. Interior ductwork within 10 feet of exterior roof or wall penetrations.
 - b. Interior ductwork routed through conditioned spaces (excludes ductwork routed in shafts) that is exhausting from unconditioned spaces (such as loading docks, garages, etc.).
- 2. Acceptable Insulation:
 - a. Flexible mineral fiber.
 - b. Rigid mineral fiber.
 - c. Cellular glass.
 - d. Polyisocyanurate.
 - e. Flexible elastomeric.

G. Exterior Ductwork:

1. Service:
 - a. Supply ductwork.
 - b. Return ductwork.
2. Acceptable Insulation:
 - a. Rigid mineral fiber.
 - b. Cellular glass.
 - c. Polyisocyanurate.
 - d. Flexible elastomeric.

3.10 DUCT SYSTEM INSULATION THICKNESS SCHEDULE

A. Flexible Mineral Fiber:

1. Interior Ductwork:
 - a. 1.5 pounds per cubic foot density:
 - 1) 2 inch thick, minimum R-6.0.
2. Meet R-value installed at maximum 25% compression, application limited to concealed locations.

B. Rigid Mineral Fiber:

1. Interior Ductwork:
 - a. 1.5 pounds per cubic foot density:
2. 1) 1-1/2 inch thick, minimum R-6.0. Ductwork installed in machine, fan, and mechanical equipment rooms:
 - a. 2 inch thick, minimum R-8.0.
 - b. 3. Exterior Ductwork or Ductwork Exposed to Weather, or Ductwork: 3 inch thick, minimum R-12.0.

3. Ductwork in an Unconditioned Space:
 - a. 1-1/2 inch thick, minimum R-6.0.

C. Cellular Glass:

1. Interior Ductwork:
 - a. 2 inch thick, minimum R-6.0.
2. Exterior Ductwork or Ductwork Exposed to Weather, or Ductwork:
 - a. 3-1/2 inch thick, minimum R-12.0.
3. Ductwork in an Unconditioned Space:
 - a. 2 inch thick, minimum R-6.0.

D. Flexible Elastomeric:

1. Interior Ductwork:
 - a. 1-1/2 inch thick, minimum R-6.0.
2. Exterior Ductwork or Ductwork Exposed to Weather:
 - a. Two layers of 1-1/2 inch thick, minimum R-12.0.
3. Ductwork in an Unconditioned Space:
 - a. 1-1/2 inch thick, minimum R-6.0.

3.11 DUCTWORK JACKET SCHEDULE

- A. Omit jacket on internally lined ductwork.
- B. Exposed ductwork within mechanical rooms (below 10 feet):
 1. Foil Scrim Kraft (FSK).
 2. Polypropylene Scrim Kraft (PSK).
 3. All-Service Jacket (ASJ).
 4. Polypropylene Scrim Polyester (PSP).

5. Flexible Metal Cladding (flexible elastomeric only).
 6. Aluminum with smooth finish.
- C. Exposed ductwork within mechanical rooms (above 10 feet):
1. Foil Scrim Kraft (FSK).
 2. Polypropylene Scrim Kraft (PSK).
 3. All-Service Jacket (ASJ).
 4. Polypropylene Scrim Polyester (PSP).
 5. Flexible Metal Cladding (flexible elastomeric only).
- D. Exposed ductwork:
1. Foil Scrim Kraft (FSK).
 2. Polypropylene Scrim Kraft (PSK).
 3. All-Service Jacket (ASJ).
 4. Polypropylene Scrim Polyester (PSP).
 5. Flexible Metal Cladding (flexible elastomeric only).
 6. Aluminum with smooth finish.
- E. Ductwork within return air plenums:
1. Foil Scrim Kraft (FSK).
 2. Polypropylene Scrim Kraft (PSK).
 3. All-Service Jacket (ASJ).
 4. Polypropylene Scrim Polyester (PSP).
 5. Flexible Metal Cladding (flexible elastomeric only).
- F. Ductwork in an unconditioned space:
1. Foil Scrim Kraft (FSK).

2. Polypropylene Scrim Kraft (PSK).
3. All-Service Jacket (ASJ).
4. Polypropylene Scrim Polyester (PSP).
5. Flexible Metal Cladding (flexible elastomeric only).

G. Exterior ductwork and ductwork exposed to weather:

1. Flexible Metal Cladding (flexible elastomeric only).
2. Aluminum with stucco finish.
3. Multilayer Laminate Vapor Barrier Cladding.
4. Rubberized Asphalt Vapor Barrier Cladding.
5. Heavy duty multilayer composite (polyolefin insulation only).

3.12 EQUIPMENT INSULATION INSTALLATION

- A. Install insulation subsequent to painting, testing, and acceptance of tests.
- B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.
- C. Protect insulation to prevent puncture and other damage.
- D. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- E. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.
- F. Do not apply insulation to equipment, breechings, or stacks while hot.
- G. Do not insulate flanges and unions of equipment carrying fluids less than 105 degrees F.
- H. Provide neatly beveled edge at interruptions of insulation.
- I. Fasten insulation to equipment with studs, pins, clips, adhesives, wires, or bands.
- J. Stagger insulation joints for both single and double layer application, where feasible. Apply each layer of insulation separately. Tape all joints using glass cloth or a suitable, matching acrylic adhesive tape; minimum 3 inches wide.

- K. Coat insulated surfaces of calcium silicate with layer of insulating cement, troweled in workmanlike manner, leaving a smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.
- L. Cover insulated surfaces with jacketing, factory or field applied, neatly fitted and firmly secured. Lap seams at least 2 inches. Apply over vapor barrier where applicable. Tape all joints using glass cloth or a suitable, matching acrylic adhesive tape; minimum 3 inches wide.
- M. Cold Equipment:
 - 1. Insulate entire system, including flanges and unions. Maintain continuous vapor-barrier integrity throughout entire installation and protect it from puncture and other damage.
 - 2. Provide vapor barrier jacket, factory or field applied over mineral fiber insulation. Finish with glass cloth or vapor barrier adhesive.
 - 3. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
- N. Hot Equipment:
 - 1. Insulate entire system, including flanges and unions.
 - 2. Provide jacket, with or without vapor barrier, factory or field applied over mineral fiber insulation. Finish with glass cloth or vapor barrier adhesive.

3.13 EQUIPMENT INSULATION SCHEDULE

- A. Omit Insulation on the following:
 - 1. Boiler manholes, handholes, cleanouts, ASME stamp, and manufacturer's nameplates.
 - 2. Factory pre-insulated equipment.
- B. Do not apply insulation to equipment that operates outside of the minimum and maximum service temperature range.
- C. Provide flexible removable and reusable blanket insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.
- D. Coils
 - 1. Application Requirements: Insulate the following coils that are installed in cold ducts:
 - a. Refrigerant coils.

2. Acceptable Insulation:
 - a. For ducts with exterior wrap, apply the same insulation as installed on the duct.
 - b. For ducts with interior duct liner, apply one of the following:
 - 1) Flexible Mineral Fiber: 1-1/2" thick, minimum R4.2.
 - 2) Rigid Mineral Fiber: 1" thick, minimum R-4.2.
 - 3) Cellular Glass: 1-1/2" thick, minimum R-4.2.
 - 4) Flexible Elastomeric: 1" thick, minimum R-4.2.

3.14 EQUIPMENT JACKET SCHEDULE

- A. Omit jacketing on equipment pre-insulated and jacketed from the factory.
- B. Interior Equipment (all except flexible elastomeric insulation):
 1. Aluminum.
 2. Stainless steel.
- C. Equipment in unconditioned spaces (all except flexible elastomeric insulation):
 1. Aluminum.
 2. Stainless steel.

END OF DOCUMENT 230700

DOCUMENT 230800 - COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Commissioning process requirements for HVAC systems, assemblies, and equipment.

1.2 SUMMARY

- A. Commissioning Authority

- 1. Retain the services of a third-party registered design professional or approved agency that is regularly engaged in conducting commissioning to perform the duties of the Commissioning Authority including development of the commissioning plan, supporting documentation, and reports.

- B. This section covers the Contractor's responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned shall be responsible for the commissioning activities relating to that system or equipment item.

- C. The Commissioning Authority (CxA) shall direct and coordinate all commissioning activities and provide Prefunctional Checklists and Functional Test Procedures for Contractor's use.

- D. The entire HVAC system and its appurtenances shall be commissioned, including controls, ductwork, piping, noise and vibration control devices, specialty systems (e.g., smoke control systems), and other systems identified elsewhere in the Contract Documents.

- E. The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

1.3 RELATED REQUIREMENTS

- A. Division 01 Commissioning requirements that apply to all types of work.

1.4 REFERENCE STANDARDS

- A. ASHRAE Guideline 0 – The Commissioning Process, most current edition.
- B. - The HVAC Commissioning Process; most current edition.

1.5 DEFINITIONS

- A. Refer to Division 01 “General Commissioning Requirements” for additional abbreviations and definitions.

- B. BAS: Building Automation System.
- C. Basis of Design (BOD): A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
- D. Commissioning Authority (CxA): An entity who coordinates the commissioning team to implement the Commissioning Process.
- E. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the Commissioning Process.
- F. Commissioning Process: A quality-focused process for enhancing the delivery of a project. The process focuses on verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the OPR. Commissioning is intended to achieve the following objectives:
 - 1. Verify that applicable systems and equipment are designed and installed according to the manufacturer's recommendations and to industry accepted minimum standards.
 - 2. Verify that applicable systems and equipment receive adequate operational checkout by installing contractors.
 - 3. Verify and document proper performance of equipment and systems.
 - 4. Verify that O&M documentation provided to the Owner is complete.
 - 5. Verify that the Owner's operating personnel are adequately trained.
- G. Commissioning Report: A report that includes the following:
 - 1. Results of final functional performance tests. Organize equipment and components specified by other Divisions in separate sections for independent review.
 - 2. List of functional performance testing procedures used during commissioning, including measurable criteria for test acceptance.
 - 3. Itemization of resolved deficiencies found during preliminary commissioning.
 - 4. List of deferred tests that cannot be performed at the time of final commissioning report preparation because of climatic conditions.
- H. Functional Performance Test (FPT): A test that verifies the equipment or item being tested performs in the manner intended.

- I. Owner's Project Requirements (OPR). A document that details the functional requirements of a project and the expectations of how it will be used and operated, including the following:
 - 1. Project goals.
 - 2. Ventilation requirements.
 - 3. Project documentation requirements
 - 4. Facility functions.
 - 5. Hours of operation and any need for after-hours operation.
 - 6. Equipment and system expectations.
 - 7. Building envelope performance expectations.
 - 8. Measurable performance criteria.
 - 9. Cost considerations.
 - 10. Benchmarks.
 - 11. Success criteria
 - 12. Supporting information.
 - J. Operations and Maintenance Manual (O&M): A system-focused composite document that includes the operation manual, maintenance manual, and additional information of use to the Owner during the occupancy and operation of the building.
 - K. Pre-Functional Checklist (PFC): A checklist that verifies all components and accessories related to a system that will be subjected to an FPT are present and functional.
 - L. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
 - M. TAB: Testing, Adjusting, and Balancing.
- 1.6 SUBMITTALS
- A. Updated Submittals: Keep the Commissioning Authority informed of all changes to the HVAC system documentation made during installation, and startup; revise and resubmit when substantial changes are made.
 - B. Submit a commissioning plan that includes the following:

1. General project information and commissioning goals.
 2. Commissioning team information.
 3. Narrative description of commissioning process activities, schedules, responsibilities, and personnel required during commissioning.
 4. List of equipment and systems to be tested with description of tests to be performed. Include an explanation of the original design intent.
 5. List of functions to be tested, including calibration and economizer controls.
 6. List of conditions under which the tests shall be performed.
 7. List of measurable criteria for performance.
- C. Draft Prefunctional Checklists and Functional Test Procedures for Control System: Detailed written plan indicating the procedures to be followed to test, checkout and adjust the control system prior to full system Functional Testing; include at least the following for each type of equipment controlled:
1. System name.
 2. List of devices.
 3. Step-by-step procedures for testing each controller after installation, including:
 - a. Process of verifying proper hardware and wiring installation.
 - b. Process of downloading programs to local controllers and verifying that they are addressed correctly.
 - c. Process of performing operational checks of each controlled component.
 - d. Plan and process for calibrating valve and damper actuators and all sensors.
 - e. Description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
 4. Copy of proposed log and field checkout sheets to be used to document the process; include space for initial and final read values during calibration of each point and space to specifically indicate when a sensor or controller has "passed" and is operating within the contract parameters.
 5. Description of the instrumentation being used for testing.

6. Indicate the tests required on each system that should be completed prior to TAB using the control system for TAB work. Coordinate with the Commissioning Authority and TAB contractor for this determination.
- D. Submit startup reports pre-functional tests, and trend logs for review by the Commissioning Authority.
- E. Submit a copy of the preliminary commissioning report. Preliminary commissioning report shall include the following:
1. Results of preliminary functional performance tests. Organize equipment and components specified by other Divisions in separate sections for independent review.
 2. List of functional performance testing procedures used during commissioning, including measurable criteria for test acceptance.
 3. Completed Commissioning Compliance Checklist.
 4. Itemization of deficiencies found during testing that have not been corrected at the time of preliminary commissioning report preparation.
 5. List of deferred tests that cannot be performed at the time of preliminary commissioning report preparation because of climatic conditions.
 6. List of climatic conditions required for the performance of the deferred tests.
- F. Submit a final commissioning report that includes the following:
1. Results of final functional performance tests. Organize equipment and components specified by other Divisions in separate sections for independent review.
 2. List of functional performance testing procedures used during commissioning, including measurable criteria for test acceptance.
 3. Itemization of resolved deficiencies found during preliminary commissioning.
 4. Submit report to the Engineer and Owner within 90 days of the date of receipt of the certificate of occupancy.
- G. Project Record Documents:
1. Submit as-built drawings indicating changes that occurred during the construction phase.
 2. Submit updated version of control system documentation, for inclusion with operation and maintenance data.
 3. Show actual locations of all sensors on project record drawings.

- H. O&M Manual: The O&M manual shall expand upon the more traditional operating and maintenance documentation to include information gathered during the commissioning process. Include the following for each system:
1. Manufacturer information.
 2. Equipment specifications and recommendations.
 3. Programming procedures and data points.
 4. Narratives.
 5. Other means of illustrating to the Owner how the building, equipment, and systems are intended to be installed, maintained, and operated.
 6. Label that includes required regular maintenance actions for equipment and systems.
 - a. Include in the label the title or publication number for the O&M manual for the model and type of product.
 7. As-built control schematics for each commissioned system.
 8. As-built control sequences for each commissioned system, including final setpoints and list of all control points.
 9. Final parameters of all peripheral equipment (e.g., final parameters resident in a VFD.)
 10. Recommended operating procedures for each piece of primary equipment
 11. Instructions for integrated building systems.
 12. Instructions for basic troubleshooting.
 13. Recommended schedule of maintenance requirements and frequency, troubleshooting guidelines, and emergency procedures.
 14. Site equipment inventory and maintenance notes.
 15. Site events log.
 16. Copy of all special inspection verifications required by the enforcing agency or standards.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing. Unless otherwise noted such testing equipment will NOT become the property of Owner.
- B. If not otherwise specified, provide test equipment certified and calibrated within the past year of use. Meet the following minimum accuracy requirements:
 - 1. Temperature sensors and thermometers: Accuracy of plus/minus 0.5 degrees F and resolution of plus/minus 0.1 degrees F.
 - 2. Pressure sensors: Accuracy of plus/minus 2.0 percent of value within the range of values being measured (not full range of sensor).
- C. Equipment-Specific Tools: Where special testing equipment, tools, and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work. Such equipment, tools, and instruments shall become the property of Owner.

PART 3 - EXECUTION

3.1 COMMISSIONING PROCESS OVERVIEW

- A. The following narrative provides a brief overview of the typical commissioning tasks performed during the design, construction, acceptance, and post-occupancy phases and the general order in which they occur. Coordinate with the CxA to comply with the commissioning requirements of the project.
 - 1. Owner furnishes documentation to support the OPR and BOD to the design team and CxA.
 - 2. The design team prepares construction documents to meet the OPR and BOD.
 - 3. The CxA develops the commissioning plan.
 - 4. The CxA conducts a construction document checklist review.
 - 5. Plans are permitted and construction-related submittals for all commissioned equipment are provided to the CxA during the normal submittal process.
 - 6. The CxA develops specific equipment PFCs and furnishes them to the contractor.
 - 7. The CxA conducts a kick-off meeting early during construction and presents the commissioning process for the project.

8. The Contractor coordinates project construction and prepares the project for inspecting, acceptance testing, and PFCs.
9. The Contractor coordinates with the CxA to execute and document the PFCs. The CxA reports on the PFC process including an issues report.
10. PFCs are completed before start-up, testing and balancing, and functional testing.
11. The Contractor and responsible subcontractors shall document equipment start-up and initial checkout with assistance from manufacturer's technicians. The CxA may request copies of the manufacturer's or contractor's field start-up reports.
12. The CxA develops specific FPT plans for review by the Engineer, Contract Administrator and responsible subcontractors.
13. The Contractor coordinates TAB for the project.
14. Testing, adjusting and balancing of completed HVAC systems is completed and verified by the CxA.
15. The Contractor and responsible subcontractors complete the installation and checkout of all building control systems.
16. The CxA coordinates and executes the FPTs with the assistance of responsible subcontractors. The CxA reports on the testing process including all observed deficiencies.
17. The CxA develops a preliminary commissioning report.
18. Testing of other commissioned systems not requiring formal functional testing is completed.
19. The CxA reviews close-out documentation and schedules deferred testing.
20. The Contractor and CxA coordinate to compile the O&M manual.
21. The CxA verifies training as required by the Contract Documents is completed.
22. The CxA develops a final commissioning report.

3.2 PREPARATION

- A. Cooperate with the Commissioning Authority in development of the Prefunctional Checklists and Functional Test Procedures.
- B. Furnish additional information requested by the Commissioning Authority.

- C. Prepare a preliminary schedule for use by the Commissioning Authority. Develop the following schedules and update the schedule as appropriate during the course of construction:
 - 1. Leakage testing of duct systems.
 - 2. Pressure testing of piping systems.
 - 3. Flushing and cleaning piping systems.
 - 4. Equipment startup.
 - 5. Testing, adjusting, and balancing systems.
- D. Notify the Commissioning Authority when scheduled tests shall occur. When commissioning activities not yet performed or not yet scheduled will delay construction, notify ahead of time and be proactive in seeing that the Commissioning Authority has the scheduling information needed to efficiently execute the commissioning process.
- E. Put all HVAC equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.
 - 1. Include cost of sheaves and belts that may be required for testing, adjusting, and balancing.
- F. Provide test holes in ducts and plenums where directed to allow air measurements and air balancing; close with an approved plug.
- G. Provide temperature and pressure taps in accordance with the contract documents.
 - 1. Provide a pressure/temperature plug at each water sensor that is an input point to the control system.

3.3 INSPECTING AND TESTING - GENERAL

- A. Refer to the latest adopted edition of the applicable energy code for more information.

3.4 PREFUNCTIONAL CHECKOUT

- A. Submit startup plans, startup reports, and PFCs for each item of equipment or other assembly to be commissioned.
- B. PFCs shall demonstrate the commissioned equipment is properly installed and ready for startup and initial operation.
- C. Perform the PFCs directed by the CxA for each item of equipment or other assembly to be commissioned.
- D. Document items from the PFCs and startup that were not completed successfully.

- E. Complete and submit all PFC forms and provide notice that the equipment is ready for testing, adjusting, and balancing.
- F. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.5 TESTING AND BALANCING COORDINATION

- A. Coordinate commissioning schedule with TAB schedule.
- B. Notify the CxA at least 7 days in advance of testing and balancing work. Provide access for the CxA to witness test TAB work.
- C. Review the TAB plan to determine the capabilities of the control system toward completing TAB.
- D. All required Prefunctional Checklists, calibrations, startup, and component Functional Tests of the system shall be completed and approved by the CxA prior to starting TAB.
- E. Coordinate with the BAS and TAB Contractor to make available technicians, instrumentation, and tools to assist the CxA in verification of data points associated with TAB of HVAC systems.

3.6 FUNCTIONAL PERFORMANCE TESTING

- A. The CxA shall furnish FPT procedures to the subcontractors and equipment manufacturers for review for feasibility, safety, equipment, and warranty protection.
- B. Perform the FPTs directed by the CxA for each item of equipment or other assembly to be commissioned, including equipment, controls, and economizers. FPTs shall demonstrate the following:
 - 1. The operation, function, and maintenance serviceability for each commissioned equipment, component, and system is confirmed according to the approved plans and specifications.
 - 2. The sequence of operations, including modes, backup modes (if applicable), alarms, and mode of operation upon a loss of power and restoration of power for each control device, equipment, component, and system. Reference section Control System Functional Testing below for more information.
 - 3. Control devices, components, equipment, and systems are calibrated, adjusted, and operate in accordance with the approved plans and specifications.
 - 4. Air economizers operated in accordance with manufacturer's specifications and specified sequence of operation.
 - 5. Terminal units: For multiples of like equipment (VAV terminal units, unit heaters, etc.), commission a minimum of 50 percent of total number of units.

- C. Coordinate with the responsible sub-contractors to provide trained technicians to perform commissioning tests and/or coordinate with equipment manufacturers to make available authorized technicians for the same purpose.
- D. Test equipment under design conditions when possible. Impose simulated design conditions using an artificial load when it is not practical to test under design conditions. Provide additional equipment to impose simulated loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
 - 1. The CxA may direct that set points be altered when simulating conditions is not practical.
 - 2. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- E. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- F. If the Commissioning Plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.
- G. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.7 DEFERRED AND SEASONAL TESTING

- A. If any PFC or FPT cannot be completed due to an unforeseen condition not within control of the Contract Administrator, defer execution of the PFC or FPT based on the recommendation of the CxA and approval of the Owner. Complete the affected testing as soon as practical.
- B. During the warranty period, complete tests purposely delayed until weather conditions are closer to the system's design conditions. The CxA shall coordinate this activity. Any final adjustments to the O&M manuals and/or as-built drawings due to the testing shall be made by the CA.

3.8 OPERATION AND MAINTENANCE MANUALS

- A. See Division 01 and Section "General Mechanical Requirements for HVAC" for additional requirements.
- B. Add design intent documentation furnished by Architect to manuals prior to submission to Owner.
- C. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.
- D. Commissioning Authority will add commissioning records to manuals after submission to Owner.

3.9 DEMONSTRATION AND TRAINING

- A. See Division 01 for additional requirements.
- B. Complete all related commissioning requirements prior to final inspections.
- C. Demonstrate operation and maintenance of HVAC system to Owner' personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.
- D. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Authority during Functional Testing.
- E. Provide classroom and hands-on training of Owner's designated personnel on operation and maintenance of the HVAC system, control system, and all equipment items indicated to be commissioned.
- F. Provide the services of manufacturer representatives to assist instructors where necessary.
- G. Provide the services of the HVAC controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
- H. Document systems operations training in the commissioning report.

END OF DOCUMENT 230800

DOCUMENT 230913 - INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Control panels.
- B. Control dampers.
- C. Operators.
- D. Flow measuring apparatus.
- E. Humidistats.
- F. Input/Output sensors and transmitters.
- G. Output control devices.
- H. Power Supplies.
- I. Thermostats.
- J. Time clocks.
- K. Weather stations.

1.2 DEFINITIONS

- A. BAS: Building Automation System.
- B. Control Wiring: Includes conduit, wire and wiring devices to install complete control systems including motor control circuits, interlocks, thermostats, EP and IP switches and like devices. Includes all wiring from Intelligent Devices and Controllers to all sensors and points defined in the input/output summary shown on the drawings or specified herein and required to execute the sequence of operations
- C. Cv: Design Valve Flow Coefficient.
- D. DDC: Direct Digital Control.
- E. EPDM: Ethylene Propylene Diene Monomer.
- F. High voltage: 50 volts or higher.
- G. Low voltage: Below 50 volts.
- H. PTFE: Polytetrafluoroethylene.
- I. TEFZEL: A modified ETFE (ethylene tetrafluoroethylene) fluoroplastic.

1.3 CONTRACTOR RESPONSIBILITIES

- A. Reference Division 23 Section "Electrical Coordination for Mechanical Equipment" for contractor responsibilities.
- B. BAS Contractor:
 - 1. Installation of the BAS shall be by the BAS Contractor or their subcontractors.
 - 2. Low voltage control wiring.
 - 3. Coordinate high voltage control wiring to instrumentation and control devices with Division 26. Where high voltage power is required for instrumentation and control devices that is in addition to what is shown on the drawings, the BAS contractor shall cover the cost of providing this wiring.
 - 4. All interlock wiring regardless of voltage (e.g., exhaust fan interlocked to supply fan).
 - 5. Coordinate with Division 26 that motor starters are provided with auxiliary contacts as required for interlocks.
 - 6. Coordinate power wiring to BAS controllers and instrumentation and control devices with Division 26.
 - 7. Coordinate installation of back-box rough-in for wall-mounted control devices sensors, etc. with Division 26. Coordinate with mechanical contractor all locations, quantities, and sizes required for installation by Division 26.
 - 8. Perform startup and demonstration services as specified in Section "Direct Digital Control for HVAC".
- C. Sheet Metal Contractor:
 - 1. Installation of automatic control dampers, smoke control dampers, and necessary blank off plates.
 - 2. Access doors where and as required.
- D. Mechanical Contractor:
 - 1. Coordinate conduit and wall box rough-in, power wiring and magnetic starter requirements for controls and mechanical equipment with Division 26.

1.4 SUBMITTALS

- A. Refer to Division 01 for submittal procedures.
- B. Product Data: Provide description and engineering data for each control system component. Include dimensions, capacities, size, performance characteristics, electrical characteristics, and finishes of materials.

- C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
 - D. Schedule for control valves and actuators, including the following:
 - 1. Tag.
 - 2. Quantity.
 - 3. Model number.
 - 4. Equipment served.
 - 5. Flow at project design conditions.
 - 6. Maximum close-off pressure.
 - 7. Line Size.
 - 8. Actuator Signal Type (Open/Close, Modulating 0-10 Vdc, 2-10 Vdc, 4-20 mA, etc.)
 - 9. Selected actuator maximum torque output.
 - E. Manufacturer's Instructions: Provide for all manufactured components.
 - F. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
 - G. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
 - H. Warranty: Submit manufacturer warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- 1.5 QUALITY ASSURANCE
- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
 - B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.
 - C. Control valves shall be manufactured in plants located in the United States or certified to meet the specified ASTM, ANSI and MSS standards.
 - D. Measurement devices and sensors shall be calibrated using NIST traceable standards.

1.6 WARRANTY

- A. Correct defective Work within a one year period after Substantial Completion.
- B. Provide extended warranty for control devices and equipment as specified herein.

PART 2 - PRODUCTS

2.1 CONTROL PANELS

- A. Construction:
 - 1. Panel shall be UL 508A listed.
 - 2. NEMA 250, general purpose utility enclosures with enameled finished face panel.
 - 3. NEMA 4X utility enclosure for outdoor or wash-down applications.
 - 4. Provide common keying for all panels.

2.2 CONTROL DAMPERS

- A. Dampers shall be factory fabricated and sized as shown on drawings and as specified.
- B. Individual damper sections shall not be larger than 48 inches x 60 inches. Provide a minimum of one damper actuator per section.
- C. Performance: Test in accordance with AMCA 500-D.
 - 1. Pressure Drop: Unless otherwise scheduled or indicated on the Drawings, size control dampers as follows:
 - a. Modulating Dampers: Provide dampers with linear flow characteristics. Size modulating dampers based on the smaller of the following.
 - 1) Maximum velocity of 1,500 feet per minute.
 - 2) Maximum Full-open air pressure drop of 0.1 inches W.C.
 - b. Two Position Dampers: Dampers shall be full duct size and selected to minimize pressure drop.
 - 2. Leakage:
 - a. Motorized dampers for outdoor, exhaust and relief air and for shaft and stairway vents shall be Class I leakage and shall not exceed 4.0 CFM/square foot in full closed position at 1 inch W.G. pressure differential across damper.
 - b. Motorized dampers for other applications shall be Class II leakage.

- D. Frames: Galvanized steel, extruded aluminum, or stainless steel, welded or riveted with corner reinforcement.
 - 1. Use minimum 16 gauge for rectangular dampers.
 - 2. Use minimum 20 gauge for round dampers.
 - 3. For aluminum frames, use 1/8 inch thick material.
 - 4. All damper frames shall have a flange for duct mounting.
 - 5. Reference Part 3 Execution for application of the material type.
- E. Blades: Galvanized steel, extruded aluminum, or stainless steel, maximum blade size 6 inches wide, 48 inches long, attached to minimum 1/2 inch shafts with set screws.
 - 1. Use minimum 16 gauge for rectangular dampers.
 - 2. Use minimum 16 gauge for round dampers.
 - 3. For aluminum blades, use 1/8 inch thick material.
 - 4. The blades shall be suitable for the air velocities to be encountered in the system.
 - 5. Dampers longer than the maximum blade length shall be fabricated in sections.
 - 6. Reference Part 3 Execution for application of the material type.
- F. Blade Seals: Synthetic elastomeric inflatable or Neoprene, mechanically attached, field replaceable.
 - 1. Installed along the top and bottom of the frame and on all mating surfaces.
- G. Jamb Seals: Spring stainless steel.
 - 1. Installed inside the frame sides.
- H. Shaft Bearings: One of the following as recommended by manufacturer for the application:
 - 1. Oil impregnated sintered bronze.
 - 2. Graphite impregnated nylon sleeve with thrust washers at bearings.
 - 3. Lubricant free, stainless steel, single row, ground, flanged, radial, antifriction type with extended inner race.
 - 4. Molded synthetic bearings.
- I. Linkage Bearings: One of the following as recommended by manufacturer for the application:

1. Oil impregnated sintered bronze
 2. Graphite impregnated nylon.
- J. Maximum Pressure Differential: 6 inches wg.
- K. Temperature Limits: -40 to 200 degrees F.
- L. Manufacturers:
1. Greenheck.
 2. CESCO.
 3. Pottorff.
 4. Nailor.
 5. Ruskin.
- M. Reference the Damper Schedule in Part 3 for basis of design damper model and material for the application.
- 2.3 OPERATORS
- A. General:
1. Voltage: Voltage selection shall be as required to achieve the required torque for the application.
 - a. Reference Part 3 for Damper Operator Voltage Schedule.
 2. Type: Motor operated, with or without gears. Motor type shall be continuous duty.
 3. Construction:
 - a. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
 - b. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.
 - c. For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.
 4. Field Adjustment:
 - a. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.

- b. Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.
- 5. Two-Position Actuators: Single direction, spring return or reversing type. End-switches shall be integral to the actuator to determine actuator status.
- 6. Modulating Actuators:
 - a. Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.
 - b. Control Input Signal:
 - 1) Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.
 - 2) Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10-Vdc or 2- to 10-Vdc and 4- to 20-mA signals.
 - 3) Pulse Width Modulation (PWM): Actuator drives to a specified position according to pulse duration (length) of signal from a dry contact closure, triac sink, or source controller.
 - c. Programmable Multi-Function:
 - 1) Control Input, Position Feedback, and Running Time: Factory or field programmable.
 - 2) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
 - 3) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.
- 7. Position Feedback:
 - a. Where indicated on the controls drawings, equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.
 - b. Where indicated on the controls drawings, equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.
 - c. Actuator shall contain position indicator and graduated scale indicating open and closed travel limits.
- 8. Integral Overload Protection:
 - a. Provide against overload throughout the entire operating range in both directions.

- b. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.
- 9. Attachment:
 - a. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to device without the need for connecting linkages.
 - b. Attach actuator to device drive shaft in a way that ensures maximum transfer of power and torque without slippage.
- 10. Temperature and Humidity:
 - a. Temperature: Suitable for operating temperature range encountered by application.
 - b. Humidity: Suitable for humidity range encountered by application, non-condensing.
- 11. Enclosure:
 - a. Suitable for ambient conditions encountered by application.
- 12. Stroke Time:
 - a. Coordinate with stroke time indicated on the control drawings.
 - b. Unless otherwise noted, select operating speed to be compatible with equipment and system operation.
- B. Damper Operators:
 - 1. Controls contractor shall size damper operator.
 - 2. Sizing: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
 - a. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
 - b. Provide one operator for maximum 20 sq ft damper section or maximum 7 in-lb/sq ft damper area.
 - 3. Fail Positions:
 - a. Spring return to normal position as indicated on freeze, fire, temperature, or loss of power protection. Normal positions are indicated on the control drawings.
 - 1) Return air damper, normally open.
 - 2) Outside air damper, normally closed.

3) Exhaust/Relief air damper, normally closed.

b. Operator shall fail in place for all other applications not listed under spring return.

2.4 FLOW MEASURING APPARATUS

A. Airflow Measuring Stations

1. Sensor quantity and spacing shall comply with the Equal-Area or Log-Tchebycheff method as defined in the ASHRAE Handbook of Fundamentals.
2. Element Construction: Non-corrosive material such as stainless steel, aluminum, or cadmium-plated.
3. Stations and insertion elements utilizing thermal dispersion technology shall utilize hermetically sealed thermistors for each sensor and shall be factory calibrated to NIST traceable standards.
4. Stations and insertion elements using velocity pressure shall be tested and certified in accordance with AMCA 611.
5. Air Inlet Measuring Stations:
 - a. Intended for location within an air inlet to equipment, such as a hood or louver.
 - b. Elements:
 - 1) Element constructed of 316 stainless steel, factory mounted in a circular puck constructed of 14 gauge galvanized steel. Housing shall meet NEMA 1.
 - 2) Element shall not induce a measurable pressure drop, adversely affect fan performance or amplify the sound level within the fan system by its presence in the airstream.
 - 3) Element shall not be affected by the presence of moisture, dirt, or debris in the airstream and shall be unaffected by gusting wind.
 - 4) Density corrected for ambient temperature variances and atmospheric pressure due to altitude.
 - c. Range: Minimum 100 to 2,400 fpm.
 - d. Accuracy: Plus/minus 5.0 percent of reading within the calibrated airflow range.
 - e. Manufacturers:
 - 1) Air Monitor Corporation.
 - 2) Approved equal.
6. Fan Inlet Air Flow Measuring Stations:

- a. Located in the fan cone inlet with a minimum of two sensing elements.
- b. Traverse Type Elements:
 - 1) The elements shall not induce a measurable pressure drop, adversely affect fan performance or amplify the sound level within the fan system by its presence in the airstream.
- c. Surface Mount Probes:
 - 1) Thermal Dispersion Type: Two surface mounted thermal dispersion probes mounted on opposite ends of the fan cone shall monitor the airflow.
 - 2) Velocity Pressure Type: The piezometer ring probes shall monitor the pressure difference between the largest and smallest diameters of the inlet cone venturi. High and low pressure sensors shall be connected to flow tubes extending to a termination plate mounted on the fan housing.
- d. Range: Minimum 100 to 10,000 fpm.
- e. Accuracy: Plus/minus 3.0 percent of the measured airflow range.
- f. Manufacturers:
 - 1) Air Monitor Corporation.
 - 2) Ebtron.
 - 3) Greenheck
 - 4) Johnson Controls.
 - 5) Paragon Controls.
 - 6) Ruskin.
 - 7) Sensacon.

2.5 HUMIDISTATS

A. Room Humidistats:

- 1. Performance Characteristics:
 - a. Throttling range: Adjustable 2 percent relative humidity.
 - b. Accuracy: Plus/minus 3 percent over the operating range.
 - 1) Accuracy shall include temperature effects.
 - c. Operating range: 20 to 80 percent.

- d. Drift: Less than 1 percent per year.
- 2. Construction:
 - a. Wall-mounted enclosure: Plastic, NEMA 250, Type 1.
 - b. Cover: Set point indication.
- 3. Output: Linear, proportional type over shielded cable pair, 4 - 20 mA or 0 – 10 Vdc signal..

2.6 INPUT/OUTPUT SENSORS AND TRANSMITTERS

A. General:

- 1. Performance Requirements:
 - a. Device must be compatible with project DDC controllers.
 - b. Elements used shall be general-purpose type.
 - c. Provide transmitters or transducers with sensors as required, with range suitable for the system encountered.
 - 1) Transmitters and transducers shall have offset and span adjustments.
 - 2) Shock and vibration shall not harm the transmitter or transducer.
 - 3) Transmitters and transducers shall have a zeroing capability of readjusting the transmitter zero.
 - d. Accuracy requirements shall include the combined effects of linearity, hysteresis, repeatability, and the transmitter.
- 2. Output: Linear, proportional type over shielded cable pair, 4 - 20 mA or 0 – 10 Vdc signal.
- 3. Input Power: Low voltage, nominal 24 Vdc.

B. Temperature Sensors:

- 1. General: Temperature sensing elements shall have characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy. Sensor shall be UL 873 listed for temperature equipment.
- 2. Performance Requirements:
 - a. Thermistor:
 - 1) Accuracy (All): Plus/minus 0.36 degrees F minimum.
 - 2) Temperature Differential Accuracy: Plus/minus 0.15 degrees F minimum.

- 3) Resolution: Plus/minus 0.2 degrees F minimum.
 - 4) Heat Dissipation Constant: 2.7 mW per degree C.
 - 5) Drift: 0.04 degree F after 10 years within temperature range.
 - b. RTD:
 - 1) Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F. 100 ohm platinum RTD is acceptable if used with project DDC controllers.
 - 2) Accuracy (All): Plus/minus 1 degree F minimum, unless otherwise noted below.
 - a) Room Sensor Accuracy: Plus/minus 0.5 degrees F minimum.
 - b) Chilled Water Accuracy: Plus/minus 0.5 degrees F minimum.
 - c) Temperature Differential Accuracy: Plus/minus 0.15 degrees F minimum.
 - 3) Resolution: Plus/minus 0.2 degree F.
 - 4) Drift: 0.04 degrees F after 10 years within temperature range.
 - c. Sensing Range:
 - 1) Provide limited range sensors if required to sense the range expected for a respective point.
 - d. Wire Resistance:
 - 1) Use appropriate wire size to limit temperature offset due to wire resistance to 1.0 degree F or use temperature transmitter when offset is greater than 1.0 degree F due to wire resistance.
 - 2) Compensate for wire resistance in software input definition when feature is available in the DDC controller.
3. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
4. Room Temperature Sensors:
 - a. Construct for surface or wall box, or enclosure with insulated backing suitable for exterior wall mounting.
 - b. Provide the following features:
 - 1) Setpoint reset slide switch, dial wheel, or push-button interface with an adjustable temperature range.

- 2) Momentary override request push button for activation of after-hours operation.
- 3) Locking cover where noted on the drawings.
- 4) Integral digital display with the following:
 - a) Indication of space temperature.
 - b) Setpoint adjustment to accommodate room setpoint.
 - c) Display and control fan operation status.
 - d) Manual occupancy override and indication of occupancy status.
 - e) Controller mode status.

C. Equipment Operation Sensors:

1. Status Inputs for Airside Equipment:

- a. Type: Fixed range differential pressure switch with adjustable setpoint.
- b. Performance Characteristics:
 - 1) Range: Not greater than two times the design fan static pressure.
- c. Construction:
 - 1) Enclosure: Comply with NEMA enclosure ratings, suitable for the ambient conditions encountered.
 - 2) Provide Insertion tube for use in duct configurations. Insertion length selected as appropriate for duct size.
 - 3) Contact Type: Single-pole, single-throw (SPST). Provide multiple poles or throw contacts to meet additional alarms required.

2. Status Inputs for Electric Motors:

- a. Analog Current Transducer:
 - 1) Type: Split core design, cable of being installed or removed without dismantling the primary bus cables.
 - 2) Performance Characteristics:
 - a) Accuracy: Plus/minus 2 percent of selected range.

- b) Range: Multi-range device, suitable for the amperage encountered with internal zero and span adjustment.
 - c) Analog output signal: Generate a proportional control signal relative to the amount of current through the primary bus cables.
- 3) Construction:
 - a) 24 V or Self-powered (passive).
 - b) Provide with integral command relay.
 - c) Device shall accept overcurrent up to twice its trip into range.
 - d) Enclosure: UL 94 approved thermoplastic, rated for V-0. No metal parts shall be exposed other than the terminals.
- b. Binary Current Sensing Relay:
 - 1) Type: Split core with current transformers, adjustable and set to 175 percent of rated motor current.
 - 2) Self-powered (passive) with solid-state circuitry and a dry contact output.
 - 3) Adjustable trip point.
 - 4) Contact Type: Single-pole, double-throw (SPDT).
 - 5) LED indicating the on or off status.
 - 6) A conductor of the load shall be passed through the window of the device.
 - 7) Device shall accept overcurrent up to twice its trip into range.

D. Leak Detection Sensors

- 1. Leak detection sensors shall be stand alone as described in Division 23 Section, Common Work Results for HVAC". Monitor leak detection sensors as noted on the drawings.

E. Carbon Dioxide Sensors:

- 1. General: Provide non-dispersive infrared (NDIR) CO2 sensors with integral transducers and linear output.
 - a. Linear, CO2 Concentration Range Display: 0 to 2000 ppm.
 - b. Full Scale Accuracy: Plus/minus 75 ppm at concentrations of both 600 and 1,000 ppm when measured at sea level at 77 degrees F.
 - c. Maximum Response Time: 1 minute.

- d. Analog Output: 0-10 Vdc or 4-20 mA.
- e. Rated Ambient Conditions:
 - 1) Air Temperature: Range of 32 to 122 degrees F.
 - 2) Relative Humidity: Range of 0 to 95 percent (non-condensing).
- 2. Calibration Characteristics:
 - a. Factory calibrated and certified by the manufacturer to require calibration not more frequently than once every 5 years.
 - b. Automatically compensating algorithm for sensor drift due to sensor degradation.
 - c. Sensor shall be temperature compensated throughout entire operating range.
 - d. Maximum Drift: 2 percent per year.
- 3. Construction:
 - a. Sensor Chamber: Non-corrosive material for neutral effect on carbon dioxide sample.
 - b. Duct Mounting: Provide duct mounted sensors with duct probe designed to protect sensing element from dust accumulation and mechanical damage.
 - c. Wall/Surface Mounting: Construct for surface or wall box or enclosure suitable for wall mounting.

2.7 OUTPUT CONTROL DEVICES

- A. Control Relays:
 - 1. Provide relay with contact rating, configuration, and coil voltage that is suitable for the application.
 - 2. Provide NEMA 1 enclosure when relay is not installed in a local control panel.
 - 3. Control relays shall be UL listed plug-in type with dust cover and LED "energized" indicator.
 - 4. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus/minus 200 percent minimum from setpoint.
- B. Fan Speed Controllers:
 - 1. Solid-state model providing field-adjustable proportional control of motor speed. Equip with filtered circuit to eliminate radio interference.
- C. Magnetic Door or Window Contact

1. Provide contact with rating and configuration that is suitable for the application by Interlogix or approved equal.
2. Contacts shall be UL listed and factory tested.
3. The magnetic contacts shall be designed for easy installation and shall be replaceable without damaging the door or window.

2.8 POWER SUPPLIES

- A. Reference Division 23 Section "Direct Digital Controls for HVAC" for DC power supply requirements.
- B. Control power transformers shall meet NEMA/ANSI standards.
- C. Control power transformers shall be UL listed for Class 2 current-limited service or provided with over-current protection on both primary and secondary circuits for Class 2 current-limited service.
- D. Connected load on the transformer shall not exceed 80 percent of the transformer's rated capacity.
- E. The core and windings shall be completely encased in a UL approved thermoplastic. No metal parts shall be exposed other than the terminals.
- F. Performance Characteristics:
 1. Accuracy: Plus/minus 1 percent at 5.0 A full scale output.
- G. Provide a disconnect switch for each transformer.

2.9 THERMOSTATS

- A. General:
 1. Programmable, with the following features:
 - a. LCD or LED display screen.
 - b. Button or touch-screen Interface.
 - c. 7-day programmable scheduling.
 - d. Temperature information display.
 - e. Setpoint display and adjust.
 - f. Operation mode display and adjust.
 - g. Fan switch setting (Off/Auto/Low/Med/High), configured with the fan system it serves.
 - h. Override.

- i. Remote temperature sensor interface terminal.
 - j. Lockout.
- 2. Performance Requirements:
 - a. Accuracy: Plus/minus 1.0 degree F minimum.
 - b. Resolution: Plus/minus 0.2 degrees F.
 - c. Range:
 - 1) Operating Temperature: 32 degrees F to 122 degrees F minimum.
 - 2) Operating Humidity: 0 percent to 95 percent relative humidity, non-condensing.
 - 3) Setpoint Control:
 - a) Cooling: 54 degrees to 100 degrees F.
 - b) Heating: 40 degrees to 90 degrees F.
 - d. Multi-stage as required to match unit cooling and heating stages scheduled on the drawings.
- B. Line Voltage Thermostats:
 - 1. Integral manual On/Off/Auto selector switch, single or two pole as required.
 - 2. Dead band: Maximum 2 degrees F.
 - 3. Covers: Locking with set point adjustment and indication.
 - 4. Setpoint functional range: 45 degrees F to 90 degrees F.
 - 5. Rating: Motor load.
- C. Room Thermostat Accessories:
 - 1. Thermostat Covers: Plastic.
 - 2. Insulating Bases: For thermostats located on exterior walls.
 - 3. Thermostat Guards: Locking transparent plastic mounted on separate base.
 - 4. Adjusting Key: As required for device.
 - 5. Aspirating Boxes: Where indicated for thermostats requiring flush installation.

6. Integrated sensors: At the contractor's option, the following sensors may be provided with the thermostat in a single device. Refer to the drawings where additional sensors are required. Refer to "Input/Output Sensors" section of this specification for language governing performance of the integrated sensors.
 - a. Occupancy sensor.
 - b. Humidity sensor.
 - c. Carbon dioxide sensor.

2.10 TIME CLOCKS

- A. Solid state programmable time control with owner designated quantity of separate programs, 24 hour battery carry over, duty cycling, individual on/off/auto switches for each program, 7 day programming, 365 day calendar with 20 programmable holidays.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that systems are ready to receive work.
- B. Beginning of installation means installer accepts existing conditions.
- C. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- D. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.2 INSTALLATION

- A. Cooperate with other contractors performing work on this project as necessary to achieve a complete and coordinated installation. Each Contractor shall consult the Drawings and Specifications for all trades to determine the nature and extent of others work.
- B. General Workmanship:
 1. Install equipment, piping, and wiring/raceway parallel to building lines wherever possible.
 2. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
 3. Install all equipment in readily accessible locations.
 4. All installations shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
 5. Install all products in accordance with manufacturer's instructions.

C. Sensors:

1. Mount sensors rigidly and adequately for the environment within which the sensor operates.
2. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing. Coordinate installation of room/space sensors with architect and other trades to ensure a neat and orderly installation.
3. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
4. Install outdoor air temperature sensors on north wall, complete with sun shield where shown on the plans. If not shown, locate sensors in an accessible location, a minimum of 15 feet away from exhaust or relief air locations.
5. Differential air static pressure.
 - a. Supply Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
 - b. Return Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor or the plenum.
6. Verify location and mounting height of thermostats, humidistats, and exposed control sensors with plans and room details before installation. Align with adjacent lighting switches and humidistats.
 - a. Install devices to meet ADA requirements unless otherwise noted on the plans.
7. Mount freeze protection thermostats using flanges and element holders.
 - a. Install thermostat completely across the surface the thermostat serves.
8. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.
9. Provide separable sockets for liquids and flanges for air bulb elements.
10. Provide thermostats in aspirating boxes in areas where flush mounting is required.
11. Provide guards on thermostats in areas indicated on the drawings.
12. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

D. Control Dampers:

1. Install dampers with extruded aluminum or stainless steel frames and blades in corrosive environments and areas with high humidity.
2. Install smooth transitions, not exceeding 30 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.
3. Clearance:
 - a. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
 - b. Install dampers with at least 24 inches of clear space on sides of dampers requiring service access.
4. Service Access:
 - a. Dampers and actuators shall be accessible for visual inspection and service.
 - b. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Division 23 Section, "Air Duct Accessories."
5. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting.
6. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.
7. Provide mixing dampers of parallel blade construction arranged to mix streams. Where shown on the drawings, provide separate minimum outside air damper section adjacent to return air dampers with separate damper motor.
8. Provide isolation (two position) dampers of parallel blade construction.
9. Provide opposed blade damper configuration for all other applications.
10. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
11. After installation of low-leakage dampers and seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

E. Operators:

1. Mount and link control damper actuators according to manufacturer's instructions.
 - a. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5 degrees open position, manually close the damper, and then tighten the linkage.

- b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 - c. Provide all mounting hardware and linkages for actuator installation.
- 2. Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5 degree available for tightening the damper seals.
- 3. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer.

F. Control Panels:

- 1. Install control panels where shown on the drawings and where required to house controllers for the controlled systems and equipment.
 - 2. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.
 - 3. Coordinate 120V power requirements with Division 26 to panels used for the building automation system and transformers for low voltage power to controllers.
- G. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
- H. Provide an insulation standoff on control devices, cables, and other items that do not require flush mounting to ductwork, piping, or equipment.

3.3 MAINTENANCE

- A. Refer to Division 01 closeout requirements for additional requirements relating to maintenance service.
- B. Provide service and maintenance of control system for one year from Date of Substantial Completion.
- C. Provide complete service of controls systems, including call backs, and submit written report of each service call.

3.4 STARTUP AND DEMONSTRATION

- A. Control Dampers:
 - 1. Stroke and adjust dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.
 - 2. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

3. For dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.
4. Verify that all two-position dampers operate properly and that the normal positions are correct.
5. Verify that all modulating dampers are functional, that the start and span are correct, that direction and normal positions are correct, and that they achieve proper closure.

3.5 DAMPER SCHEDULE

<u>SERVICE</u>	<u>RUSKIN MODEL</u>	<u>MATERIAL</u>
Outside, Exhaust and Relief Air Control, Stairway and Shaft Vents	CD-50	Aluminum
All Other	CD-356	Galvanized Steel

3.6 DAMPER OPERATOR VOLTAGE SCHEDULE

<u>SERVICE</u>	<u>VOLTAGE</u>
Interlocked with HVAC fans	120V
Multi-section dampers	120V
All other operators control wiring	24V

1. Note: Coordinate with Division 26 if 120V power is required for operator to achieve appropriate torque requirements for damper actuation.

END OF DOCUMENT 230913

DOCUMENT 230923 - DIRECT-DIGITAL CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. System Description.
- B. Operator Interface.
- C. Controllers.
- D. Electrical Control Power Wiring and Low Voltage Wiring.
- E. Local Area Network.
- F. System Software.
- G. Controller Software.

1.2 REFERENCE STANDARDS

- A. ANSI/CEA 709.1.D - Control Network Protocol Specification; 2014.
- B. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; most current edition.
- C. IEEE C37.90.1 – IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus, most current edition.
- D. IEEE C62.41.2 – IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits, most current edition.
- E. ISO 7498 – Information Processing Systems – Open System Interconnection – Basis Reference Model, International Standards Organization, most current edition.
- F. NEMA – National Electrical Manufacturers Association.
- G. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.4 DEFINITIONS

- A. ASC: Application Specific Controller. Examples include controllers for specific applications (e.g., FCU, VAV box, etc.) that can be configured through any network services software.

- B. ATU: Air Terminal Unit (e.g., VAV boxes, fan-powered boxes, fan coil units).
- C. BAS: Building Automation System.
- D. BTL: BACnet Testing Laboratories. Third party independent testing and listing program for devices which have been tested according to ASHRAE Standard 135.
- E. Control Wiring: Includes conduit, wire and wiring devices to install complete control systems including motor control circuits, interlocks, thermostats, EP and IP switches and like devices. Includes all wiring from Intelligent Devices and Controllers to all sensors and points defined in the input/output summary shown on the drawings or specified herein and required to execute the sequence of operations
- F. DDC: Direct Digital Control.
- G. EMT: Electrical Metallic Tubing
- H. High voltage: 50 volts or higher.
- I. IP: Internet Protocol.
- J. LAN: Local Area Network.
- K. VLAN: Virtual Local Area Network.
- L. Low voltage: Below 50 volts.
- M. NiCS: Niagara Compatibility Statement license.
- N. OSI: Open System Interconnection
- O. PC: Personal Computer.
- P. PICS: Protocol Implementation Conformance Statement.
- Q. Point: Point is a generic term used to describe a single item of information in a BAS. Points may be further described as input, output, digital, binary, discrete, analog, modulating, internal, external, virtual or global. Each unique point used by digital controllers, or in a BAS, is typically identified by an address.

1.5 CONTRACTOR RESPONSIBILITIES

- A. Reference the following sections for additional contractor responsibilities and coordination:
 - 1. Division 23 Section "Electrical Coordination for Mechanical Equipment."
 - 2. Division 23 Section "Commissioning for HVAC."
 - 3. Division 23 Section "Instrumentation and Control Devices for HVAC."
- B. Reference Part 3 for additional electrical contractor responsibilities for BAS controls.

1.6 SUBMITTALS

- A. Refer to Division 01 and Division 23 Section "General Mechanical Requirements" for submittal procedures.
- B. General:
 - 1. The drawings and specifications are not intended to show all details. The BAS contractor shall secure satisfactory information before submitting the proposal and include in the proposal a sum sufficient to cover all items of labor and material required for the complete installation for the devices and system described.
 - 2. Inform Engineer in writing of any deviation in the exhibits submitted from the requirements of the drawings, specifications, and sequences of operations.
- C. Product Data:
 - 1. Submit manufacturer technical data for each system component and software module required for a complete installation.
 - 2. Indicate dimensions, weights, and enclosure construction for all BAS distributed controllers.
 - 3. Submit technical data on all new software supplied including description of functions performed by software and location within the system where software shall reside. Include all software licensing agreements.
 - 4. Submit the PICS for each BACnet device used in the BAS.
 - 5. Submit the NiCS for each type of Niagara station in the BAS.
- D. Power and Communication Wiring Transient Protection:
 - 1. Submit catalog data sheets providing evidence that all BAS products offered by the manufacturer are tested and comply with IEEE C62.41.2.
 - 2. Testing shall include power and communication trunk wiring.
 - 3. Compliance with IEEE C62.41.2 shall imply conformance with IEEE C37.90.1 based on the stated position of ANSI and IEEE.
- E. Shop Drawings:
 - 1. Submit a trunk cable schematic showing locations of all programmable control units, controllers, and workstations, with associated network wiring.
 - a. Indicate equipment served by each controller on the diagram.
 - b. Indicate switches, power requirements to each controller, and daisy chained controllers.
 - 2. Submit detailed schematic control drawings for each controlled device and equipment.

- a. Reference all control components to manufacturer make and model number.
 - b. Include all control and power wiring with termination point (controller and terminal number).
 - c. Include clearly indicated and written sequences of operation referenced to specific control components (e.g., "shall modulate valve V-3").
 - d. Include default position (e.g., N.O., N.C., etc.) for all components where applicable.
 - e. Clearly differentiate between existing components and new components.
 - f. Include detailed wiring diagrams showing methods of connections to VFDs, motor starters, energy meters, and all other devices, and all other field wiring necessary for system installation.
 - g. The use of "typicals" will be allowed where appropriate.
3. Submit detailed drawings for each individual BAS distributed controller.
 - a. Include controller identification.
 - b. Include components included in the controller.
 - c. Include numbering of terminals and communications ports.
 - d. List connected data points, including connected control unit and input device.
 - e. Include type of cable connected to each terminal port.
 - f. Identify specific field devices wired to each terminal including identification of each field device and application.
 - g. Clearly differentiate between existing controllers and new controllers.
 - h. Indicate source (electrical panel ID) of 120V power to each panel to which 120V power is connected.
 - i. Indicate method of connecting controller to equipment supplied by others and to existing communications networks.
 - j. Indicate device instance and network number.
4. Submit floor plans that indicate the following:
 - a. Location of all new BAS distributed controllers and control panels.
 - b. Routing of all new building level network communications wiring not located in mechanical and electrical rooms.

- c. Routing of wiring to controllers, sensors, and control points not located in mechanical and electrical rooms.
 - d. Location of building system connection to Owner's campus wide data network.
- 5. Submit methods and materials used to integrate into existing networks.
- 6. All control drawings and schematics shall be generated using AutoCAD software or equivalent. All project drawings shall be supplied to the Owner in a format as desired by the Owner upon project completion.
- 7. Submit system identification nomenclature.
 - a. Nomenclature shall be consistent throughout the network and consistent with any existing networks that are integrated. If not defined, nomenclature shall be similar to the point names shown on the drawings.
 - b. Object name and ID number shall be unique within a control device.
 - c. Control device instance name and ID number shall be unique within the network.
 - d. Network number shall be unique for each unique electrical segment in the BAS.
- 8. Indicate system graphics indicating monitored systems, data (connected and calculated) and operator notations.
 - a. Submit example graphic visualizations and screenshots for the BAS. At a minimum, submit examples for major HVAC equipment components, including chillers, boilers, air handling units, fan coil units, heat pumps, fans, etc.
 - b. Font size and type shall be manufacturer standard.
 - c. Provide graphics demonstration package in a format as desired by the Owner.
- 9. Indicate description and sequence of operation of operating, user, and application software.
- F. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.
- G. Manufacturer's qualification statement.
- H. Installer's qualification statement.
- I. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
 - 1. Revise shop drawings to reflect actual installation and operating sequences.
 - 2. Include submittals data in final "Record Documents" form.

3. All additions or changes to the BAS during the course of construction shall be reflected upon the drawings and submitted to the Engineer before project close-out.
 - J. Testing and Commissioning Reports and Checklists: Submit completed versions of all reports and checklists, along with all trend logs, used to meet the requirements of Part 3, Startup and Demonstration.
 - K. Operation and Maintenance Data:
 1. Include maintenance data and recommended spare parts list for digital control equipment and control components.
 2. Include trouble-shooting maintenance guides.
 3. Include interconnection wiring diagrams showing complete field installed systems with identified and numbered system components and devices.
 4. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
 5. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 6. Include a maintenance manual which contains the information listed above, product data, shop drawings, final software code for sequences of operation and maintenance data in accordance with requirements of Division 01.
 7. Include logbook for documentation of software updates and patches applied BAS for the time period included in the software licensing agreement.
 8. Provide names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
 - L. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
 - M. Maintenance Materials:
 1. Refer to Division 01 for additional provisions.
 2. Extra Stock Materials: Two printer cartridges and cartons of printer paper.
- 1.7 QUALITY ASSURANCE
- A. Perform work in accordance with NFPA 70.
 - B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.
 - C. BACnet devices used in the BAS shall be BTL listed according to its device profile.

- D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- E. Installer Qualifications: Company specializing in performing the work of the type specified and with minimum documented experience as follows:
 - 1. All personnel of the BAS Contractor shall have a minimum of three years of experience within their appropriate trades.
 - 2. All subcontractors utilized by the BAS Contractor shall have a minimum of five years experience within their appropriate trades.

1.8 WARRANTY

- A. Refer to Division 01 for additional project warranty requirements.
- B. Labor and materials for the BAS specified shall be warranted free from defects in workmanship and material for a period of 1 year after Substantial Completion and system acceptance.
- C. BAS failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner.
- D. All work shall have a single warranty date, even when the Owner has received beneficial use due to an early system start-up. If the work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start date and period.
- E. Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.
- F. Provide five year manufacturer's warranty for field programmable micro-processor based units.
- G. Special warranty on instrumentation:
 - 1. All instrumentation shall be covered by manufacturer's transferable one-year "No Fault" warranty. If manufacturer warranty is not available, the BAS installer shall provide the same.

1.9 PROTECTION OF SOFTWARE RIGHTS

- A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:
 - 1. Limiting use of software to equipment provided under these specifications.
 - 2. Limiting copying.
 - 3. Preserving confidentiality.
 - 4. Prohibiting transfer to a third party.

- B. Software provider shall provide software updates and patches to the BAS as part of the software licensing agreement as the updates and patches are released. If any security vulnerabilities are discovered by the provider, the provider shall notify the client within five business days.
- C. Ownership of Proprietary Material: Project-specific software and documentation shall become Owner's property upon project completion. This includes, but is not limited to the following:
 - 1. Graphics.
 - 2. Record drawings.
 - 3. Database.
 - 4. Application programming code.
 - 5. Documentation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Corporate Edition Products: The following manufacturers and product lines shall be manufacturer's most current vintage and of open protocol design. Corporate editions shall be based on manufacturer developed software.
 - 1. Automated Logic, WebCtrl.
 - 2. Delta Controls, enteliBUS.
 - 3. Johnson Controls, Metasys.
 - 4. Schneider Electric, EcoStruxure Building Expert.
 - 5. Siemens, Apogee – Desigo CC.
 - 6. Trane, Tracer SC.
- B. The above list of manufacturers applies to operator workstation software, controller software, the custom application programming language, building controllers, custom application controllers, and application specific controllers. All other products specified under Division 23 Section "Instrumentation and Control Devices for HVAC" need not be manufactured by the above manufacturers.

2.2 SYSTEM DESCRIPTION

- A. General:
 - 1. The BAS shall consist of all necessary hardware and software to perform the control sequences of operation as called for in the Specifications and Drawings. Contractor shall install and commission all necessary devices to ensure a reliable and stable network.

2. System design is based on a distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
3. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
4. The BAS shall be capable of integrating multiple devices, sensors, and functions from multiple control vendors into a common front end, including equipment supervision and control, alarm management, energy management, and trend data collection.
5. The BAS shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, ASC's, and operator devices.
6. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

B. Local Area Network:

1. The BAS shall be set up as a physically separate network within the building.

C. Network Architecture: The BAS network architecture shall be based upon the OSI basic reference model in accordance with ISO 7498.

1. Application/Network Layer:

- a. BACnet protocol complying with ASHRAE Standard 135.

2. Physical/Data Link Layer:

- a. Hard-wired type:

- 1) Ethernet according to ISO 8802-2 protocol.
- 2) EIA-485 Twisted Cable Pair according to Master Slave/Token-Passing (MS/TP) protocol.

3. Communication between operator workstation(s) and building controller(s):

- a. Ethernet.
- b. MS/TP.

4. Communication between building controller(s) and application specific and custom application controllers:

- a. MS/TP.
- b. PTP.

D. Web Services Enabled Network:

1. The network shall be capable of being accessed remotely over the internet via a virtual link according to Internet Protocol.
2. System software shall be based on a client/server architecture, designed around the open standards of web technology. The BAS server shall be accessed using a web browser over the BAS network, Owner's LAN, and remotely over the Internet (through the Owner's LAN).
3. No special software other than a web browser shall be required to access graphics, point displays, and trends, configure trends, configure points and controllers, or to edit programming. Connection shall be browser agnostic.
4. Software applications shall be designed and optimized for hand-held device interface (e.g., tablets, smart phones, etc.). Interface shall grant visibility and control access, at a minimum, to the following data: Summary, Alarm, Setpoints, Status, Schedule, and Trending.

E. Network Integration:

1. The BAS network shall be integrated with other automation networks controlled by the Owner. Coordinate with the Owner's information technology (IT) department for networks that shall be integrated.
2. Provide gateways or other integration devices across networks with different communication protocol to provide a single network visibility and interoperability at the operator workstation. Coordinate communication protocol with each automation system specified.
3. Interoperable networks shall be capable of sharing all point and point information across networks to a single BAS front end.
4. Interoperable networks shall be capable of automatically downloading application program changes.
5. For integrated networks that cannot automatically download application program changes, provide a link to the Controller Manual Download Schedule, as defined in the submittals section of Part 1 on the BAS front end summary page

F. Network Interoperability:

1. Provide communication between control units over local area network (LAN).
2. Communication services over the LAN shall result in operator interface and value passing that is transparent to the network architecture as follows:
 - a. Connection of an operator interface device to any one controller on the network shall allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the network.

- b. All database values (e.g., objects, software variables, custom program variables) of any one controller shall be readable by any other controller on the network. This value passing shall be automatically performed by a controller when a reference to an object name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communication services to perform network value passing.

2.3 OPERATOR INTERFACE

A. General:

1. The Operator Interface shall provide overall BAS supervision and system software interface. Communications from the workstation shall be executed directly to and between the integration level building controllers and field level controllers.
2. The operator interface shall be capable of command entry, information and alarm management, database management, access of all system data, and be independent of hardware technology.

B. Hardware:

1. Laptop:

- a. Laptop(s) to be provided by BAS controls manufacturer.
- b. Laptop shall be general purpose and commercially available, with sufficient memory and processing capability to meet the requirements of the BAS.
- c. Quantity: 1.
- d. Minimum RAM: 4.0 Gigabytes.
- e. Minimum Processing Speed: Intel i3 Dual Core Microprocessor or better running at no less than 3.0 gigahertz.
- f. Minimum Hard Drive Memory: 500 Gigabyte.
- g. Drives: External 32X CD/8X DVD drive with USB connection.
- h. Ports: Minimum of 2 USB 2.0 or faster.
- i. Display: Minimum 15 inch.
- j. Network Connection:
 - 1) Suitable for network technology provided.
 - 2) Ethernet interface card with minimum speed: 10/100/1000.
 - 3) Wireless interface card, dual band.

2. Hand Held Operator Terminal for Mobile Devices:
 - a. Device shall be provided by BAS controls manufacturer.
 - b. Quantity: 1.
 - c. Operating System: Android or iOS.
 - d. Performance: Device shall meet the minimum performance requirements to run applications developed for hand held devices by the BAS controls manufacturer.
 - e. Accessories:
 - 1) Provide dongle adapter with one end suitable for connecting into hand-held device and the other end with an Ethernet cable port.
 - 2) Provide dongle adapter with one end suitable for connecting into hand-held device and the other end suitable for building controller or application specific controller service communication port.
 - f. Provide secure remote system access via PDA, iPad, or Smart Phone with browser agnostic connectivity, including controller point monitor and control access to the following data:
 - 1) Alarm.
 - 2) Summary.
 - 3) Setpoints.
 - 4) Status.
 - 5) Schedule.
 - 6) Trend.
 - g. Provide the capability to view in text list based format.
3. System Printer:
 - a. Printer(s) to be provided by BAS controls manufacturer.
 - b. Quantity: 1.
 - c. Type: Business/office quality inkjet or laser jet equivalent printer.
 - d. Resolution: Up to 600 x 1200 dots per inch (dpi) black and up to 4800 x 1200 dpi color.
 - e. Minimum Print Speed: Minimum 18 ppm black and 10 ppm color.

- f. Locations(s): As directed by the Owner.
- 4. Database Save/Restore/Back-Up:
 - a. Back-up copies of all Building Controller and ASC data as well as mass storage for trend logs shall be stored in the mass storage device designated by the Owner.

2.4 CONTROLLERS

A. Building Controllers

- 1. General:
 - a. Input Power Requirements: 24Vac.
 - b. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
 - c. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - d. Share data between networked controllers.
 - e. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
 - f. Utilize real-time clock for scheduling.
 - g. Continuously check processor status and memory circuits for abnormal operation.
 - h. Monitor and assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - i. Communication with other network devices to be based on assigned protocol.
 - j. Monitor the status of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited.
- 2. Communication:
 - a. Perform routing when connected to a network of custom application and application specific controllers.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 - 1) Port shall be USB type.
- 3. Anticipated Environmental Ambient Conditions:

- a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within NEMA 4X waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F and 95 percent RH, non-condensing.
- b. Conditioned Space:
 - 1) Mount within NEMA 1 dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
- 4. Local Keypad and Display for each Controller:
 - a. Use for interrogating and editing data.
 - b. System security password prevents unauthorized use.
 - c. If the manufacturer does not normally provide a keypad and display for the controller, provide software and interface cabling needed to use a portable operator terminal for the system.
- 5. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
- 6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
- 7. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Upon restoration of normal power, the controller shall automatically resume full operation without manual intervention.
 - d. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
- 8. Surge and Transient Protection:
 - a. Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard C62.41.2.

- b. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

B. Custom Application Controllers

1. General:

- a. Input Power Requirements: 24Vac.
- b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
- c. Share data between networked, microprocessor based controllers.
- d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
- e. Utilize real-time clock for scheduling.
- f. Continuously check processor status and memory circuits for abnormal operation.
- g. Monitor and assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
- h. Communication with other network devices to be based on assigned protocol.
- i. Monitor the status of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited.

2. Communication:

- a. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.

3. Anticipated Environmental Ambient Conditions:

- a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within NEMA 4X waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F and 95 percent RH, non-condensing.
- b. Conditioned Space:
 - 1) Mount within NEMA 1 dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.

4. Provisions for Serviceability:

- a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 - 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 - 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Upon restoration of normal power, the Digital Panel shall automatically resume full operation without manual intervention.
 - d. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
 - 7. Surge and Transient Protection:
 - a. Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard C62.41.2.
 - b. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.
- C. Application Specific Controllers
- 1. General:
 - a. Input Power Requirements: 24Vac.
 - b. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
 - c. Customized for operation within the confines of equipment served.
 - d. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - e. Communication with other network devices to be based on assigned protocol.
 - 1) Each ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.
 - f. Monitor and assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.

2. Communication:
 - a. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within NEMA 4X waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within NEMA 1 dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F and 95 percent RH, non-condensing.
4. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
5. Memory. In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Upon restoration of normal power, the controller shall automatically resume full operation without manual intervention.
 - d. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
7. Surge and Transient Protection:
 - a. Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard C62.41.2.
 - b. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

D. Input/Output Interface

1. Hardwired inputs and outputs shall tie into the BAS through building, custom application, or application specific controllers.
2. All Input/Output Points:
 - a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
 - b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
 - c. Universal-type inputs or outputs configurable between binary and analog are acceptable.
3. Binary Inputs:
 - a. Allow monitoring of On/Off signals from remote devices.
 - b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
 - c. Sense dry contact closure with power provided only by the controller.
4. Pulse Accumulation Input Objects: Conform to all requirements of binary input objects and accept up to 10 pulses per second.
5. Analog Inputs:
 - a. Allow for monitoring of low voltage 0 to 10 Vdc, 4 to 20 mA current, or resistance signals (thermistor, RTD).
 - b. Compatible with and field configurable to commonly available sensing devices.
6. Binary Outputs:
 - a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
 - b. Outputs provided with three position (On/Off/Auto) override switches.
 - c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
7. Analog Outputs:
 - a. Monitoring signal provides a 0 to 10 Vdc or a 4 to 20 mA output signal for end device control.

- b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
 - c. Drift to not exceed 0.4 percent of range per year.
- 8. Tri State Outputs:
 - a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
 - b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
 - 1) VAV terminal units.
 - 2) Duct mounted heating coils.
 - 3) Zone dampers.
 - 4) Radiant devices.
 - c. Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

2.5 ELECTRICAL CONTROL POWER AND LOW VOLTAGE WIRING

- A. Power Wiring: Copper wiring, plenum cable, and raceways shall be as specified in the applicable section of Division 26.
- B. Power and Communication Wiring Transient Protection:
 - 1. Comply with IEEE C62.41.2.
 - 2. Communications trunk wiring shall be protected with a transient surge protection device providing the minimal protection required.
 - 3. Communication circuitry, input/output circuitry, and communication unit shall provide protection against a 1000 volt, 3 amp transient signal, directly applied to the communication or input/output terminations.
 - a. For systems not complying with this requirement, provide equivalent protection external to the automatic temperature control system controller. Protection shall be provided for the individual communications and input/output terminations for each automatic temperature control system controller.
 - b. Submittal documentation shall clearly define how this requirement will be met and how the external protection will not affect the performance of the controllers.
- C. Power Supplies:

1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
2. Limit connected loads to 80 percent of rated capacity.
3. Match DC power supply to current output and voltage requirements.
4. Supplies shall be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
7. Operational Ambient Conditions: 32 to 120 degrees F.
8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD 810 for shock and vibration.
9. Line voltage units UL recognized and CSA approved.

D. Power Line Filtering:

1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
2. Minimum surge protection attributes:
 - a. Dielectric strength of 1000 volts minimum.
 - b. Response time of 10 nanoseconds or less.
 - c. Transverse mode noise attenuation of 65 dB or greater.
 - d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

E. Input/Output Control Wiring

1. Control wiring shall be sized to accommodate the voltage drop associated with the distance between the control device and the controller. Minimum size shall be as specified herein.
2. In all communication conduits, provide one spare twisted pair to be installed, tagged and labeled at each end.
3. Control wiring not installed in conduit shall be UL rated for plenum installation.
4. Ethernet control wiring shall be fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.

5. RTD wiring shall be three-wire or four-wire twisted, shielded, minimum number 22 gauge.
 6. Other analog inputs shall be a minimum of number 22 gauge, twisted, shielded.
 7. Binary control function wiring shall be a minimum of number 18 gauge.
 8. Analog output control functions shall be a minimum of number 22 gauge, twisted, shielded.
 9. Binary input wiring shall be a minimum of number 22 gauge, twisted, shielded.
 10. Thermistors shall be equipped with the manufacturer's calibrated lead wiring.
 11. 120V control wiring shall be #14 THHN in 3/4 inch conduit. Provide 20% fill extra wire in each conduit.
- F. Splices: Splices in shielded cables shall consist of terminations and the use of shielded cable couplers that maintain the integrity of the shielding.
- G. Conduit and Fittings
1. Conduit for Control Wiring, Control Cable and Transmission Cable: EMT with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.
 2. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.
 3. Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.
 4. Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.
- H. Relays
1. Relays other than those associated with digital output cards shall be general purpose, enclosed plug-in type with 8-pin octal plug and protected by a heat and shock resistant duct cover. Number of contacts and operational function shall be as required.
 2. Solid State Relays (SSR):
 - a. Input/output isolation: Greater than 10^9 ohms with a breakdown voltage of 1500V root mean square or greater at 60 Hz.
 - b. Contact Life: 10×10^6 operations or greater.
 - c. Ambient Temperature Range: Minus 20 to +140 degrees F.
 - d. Input impedance: Not be less than 500 ohms.

- e. Relays shall be rated for the application. Operating and release time shall be for 100 milliseconds or less. Transient suppression shall be provided as an integral part of the relay.
- 3. Contactors:
 - a. Type: Single coil, electrically operated, mechanically held, double-break, silver-to-silver type protected by arcing contacts.
 - b. Positive locking shall be obtained without the use of hooks, latches, or semi permanent magnets.
 - c. The number of contacts and rating shall be selected for the application. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices.

2.6 SYSTEM SOFTWARE

A. General:

- 1. Provide all necessary system software to form a complete operating system for all operator interface devices.
- 2. System software shall integrate with all controller software and allow management of software applications at the operator workstation.
- 3. System software display language: English.

B. Device Profile: BACnet devices shall Conform to the following device profiles as specified in ASHRAE/ANSI 135 BACnet Annex L:

- 1. Operator workstation: BACnet Operator Workstation (B-OWS).
- 2. Building Controller: BACnet Building Controller (B-C).
- 3. Advanced Application Controller: BACnet Advanced Application Controller (B-AAC).
- 4. Application Specific Controller: BACnet Application Specific Controller (B-ASC).

C. Software Programming:

- 1. Provide programming for the system and adhere to the sequences of operation provided. Provide actions for all possible situations. All other system programming necessary for the operation of the system shall be provided by the Contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Provide text-based, graphic-based, and parameter-based programming where appropriate.

D. Operating System:

- 1. Concurrent, multi-tasking capability.

2. Common Software Applications Supported:
 - a. Microsoft Windows and Microsoft Office Suite.
 - b. Open platform compatible database: Microsoft Access, Oracle Database, IBM Analytics, or other SQL database software. Proprietary databases shall not be acceptable.
3. Acceptable Operating Systems: Most recent version of operating system.

E. System Graphics:

1. Color type, saved in an industry-standard format such as BMP, JPEG, PNG, or GIF.
2. Allow simultaneous display for comparison and monitoring of system status.
3. Web based graphics shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X, Java Virtual Machine, and Adobe Flash).
4. Animate displayed objects by shifting image files of objects based on object status.
5. Functionality: Provide method for operator with password to perform the following:
 - a. Move between, change size, and change location of graphic displays.
 - b. Modify on-line.
 - c. View a summary of the most important data for each controlled zone or piece of equipment.
 - d. View a summary of the most important global data for the project, including but not limited to date, day of week, time, outdoor dry bulb temperature, and humidity.
 - e. Use point-and-click navigation between graphic screens.
 - f. Edit setpoints and other specified parameters.
 - g. Edit equipment names and numbers.
 - h. Edit room names and numbers.
 - i. Indicate areas or equipment in an alarm condition using color or other visual indicator.
 - j. Add, delete, or change dynamic objects consisting of:
 - 1) Analog and binary values.
 - 2) Dynamic text.

- 3) Static text.
 - 4) Animation files.
 - k. Display graphic file, text, and dynamic object data together on a single graphic. Display all measured and commanded data, setpoints, calculated values, and input and output control points with appropriate engineering units associated with each system schematic.
 - l. Dynamic Data Displays: Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention.
 - m. Dynamic Data Displays shall be capable of including point data from multiple ASC's.
6. Include at least one graphic for each of the following:
- a. Each piece of equipment.
 - b. Occupied zone.
 - c. Hydronic system (chilled water, condenser water, hot water, steam, heat pump, etc.)
 - d. Floor plan displays of the building. Indicate summary conditions for each floor.
 - e. Indicate thermal comfort on floor plan using dynamic colors to represent zone temperature relative to zone setpoint.
7. Graphic Tree Structure:
- a. Structure graphic system tree to allow access to individual graphic screens from a macro to a micro level.
 - b. Allow each level of graphic direct access to the graphic screen above and below the graphic screen in the system tree.
 - c. Allow direct access to the main summary graphic screen/map from any individual graphic screen.
8. Sequence of Operation Graphics:
- a. Display the complete Sequence of Operation or include a link to a separate text file that contains the sequence of operation, as submitted by the Contractor and approved by the Engineer with each system schematic view. The Sequence of Operation text shall be in a separate frame above, below, or to the side of the graphic as appropriate for the graphic size and content.
9. Custom Graphics Generation Package:

- a. Allow operator to create, delete, modify, and save custom graphic files and displays. File format of graphics shall be compatible with BAS software.
 - b. Web-based Graphics: HTML graphics to support web browser compatible formats.
 - c. The BAS Contractor shall provide libraries of pre-engineered screens and symbols depicting standard components with which custom graphics may be built. Standard components include but are not limited to
 - 1) Air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.).
 - 2) Complete mechanical systems (e.g., constant volume-terminal reheat, VAV, etc.).
 - 3) Electrical symbols.
 - d. The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following
 - 1) Define symbols.
 - 2) Position and size symbols.
 - 3) Define background screens.
 - 4) Define connecting lines and curves.
 - 5) Locate, orient and size descriptive text.
 - 6) Define and display colors for all elements.
 - 7) Establish correlation between symbols or text and associated system points or other displays.
 - 8) Capture or convert graphics from AutoCAD.
 - e. Graphical displays shall be capable of representing a group of objects. Groups shall be capable of representing any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, or any other logical grouping of points which aids the operator in the analysis of the building.
10. Standard HVAC Graphics Library: Furnish a complete library of standard HVAC equipment graphics and standard symbols for ancillary equipment in a file format compatible with the graphics generation package program. Graphics shall include, but not be limited to, the following:
- a. HVAC Equipment:
 - 1) Air Handlers.
 - 2) Fan Coil Units.

b. Ancillary Equipment:

- 1) Fans.
- 2) Coils.
- 3) Valves.
- 4) Piping.
- 5) Dampers.
- 6) Ductwork.

F. Workstation System Applications:

1. General Application Functions:

- a. All applications shall be capable of being executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization.
- b. Allow BAS configuration and future changes or additions by operators with password protection.
- c. Execute configured processes defined by the user to automatically perform calculations and control routines.
- d. Process Inputs and Variables: It shall be possible to use any of the following in a configured process:
 - 1) Any system-measured point data or status
 - 2) Any calculated data
 - 3) Any results from other processes
 - 4) Boolean logic operators (and, or)
- e. Process Triggers: Configured processes may be triggered based on any combination of the following:
 - 1) Time of day
 - 2) Calendar Date
 - 3) Other processes
 - 4) Events (e.g., point alarms)

- f. Data Access: A single process shall be able to incorporate measured or calculated data from any and all other ASC's. In addition, a single process shall be able to issue commands to points in any and all other ASC's on the local network.
- 2. Network Configuration:
 - a. Allow for configuration of the BAS network.
 - b. Provide alarm when a break in communication between devices is detected.
 - c. Enable the operator to add, delete, or modify the following:
 - 1) Building controllers and ASC's.
 - 2) Points of any type, point parameters, and tuning constants.
 - d. Provide automatic reconfiguration if any station is added or lost.
- 3. Save and Restore:
 - a. Automatic System Database Save and Restore Functions:
 - 1) Store current database copy of each Building Controller on hard disk or server.
 - 2) Backup database on a user adjustable frequency basis. Default frequency shall be monthly.
 - 3) Automatically update upon change in any system panel.
 - 4) In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.
 - b. Manual System Database Save and Restore Functions by Operator with Password Clearance:
 - 1) Save database from any system panel.
 - 2) Clear a panel database.
 - 3) Initiate a download of a specified database to any system panel.
- 4. On-line Help:
 - a. Include context-sensitive system to assist operator in operation and editing.
 - b. Include topics available for all applications.
 - c. Include relevant screen data provided for particular screen display.

- d. Include additional help via hypertext.
- 5. Security:
 - a. Require user name and password for Operator log-on to view, edit, add, or delete data.
 - b. Include selectable system security for each operator. Support a minimum of five levels of access:
 - 1) Level 1 = Read-only data access and display.
 - 2) Level 2 = Level 1 + scheduling.
 - 3) Level 3 = Level 2 + operator overrides and commands.
 - 4) Level 4 = Level 3 + database generation and modification.
 - 5) Level 5 = Level 4 + Audit trail management.
 - 6) Operators shall be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device shall be limited to only the items defined as accessible for the user.
 - 7) Support a minimum of 4 passwords at each Building Controller.
 - c. Allow system supervisor to set passwords and security levels for all other operators.
 - d. Allow operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
 - e. Include automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
 - f. Store all system security data in encrypted format.
 - g. Log all user actions and store data for audit with permission access by system administrator only.
 - 1) Include the modified system.
 - 2) Include the value modified.
 - 3) Include the time of modification.
- 6. System Diagnostics:
 - a. Operations Automatically Monitored:
 - 1) Workstations.

- 2) Printers.
 - 3) Network connections.
 - 4) Building management panels.
 - 5) Controllers.
 - b. Device failure is annunciated to the operator.
7. Alarm Management:
- a. Allow alarm prioritizing to minimize nuisance reporting and to speed operator response to critical alarms.
 - 1) Provide a minimum of three, user definable priority levels.
 - 2) Enable users to manually inhibit alarm reporting for each point.
 - 3) Enable users to manually inhibit nuisance alarm reporting for maintenance or repair work that is scheduled to be performed.
 - 4) Enable user to define conditions under which point changes need to be acknowledged by an operator, and/or logged for analysis at a later date.
 - 5) Allow alarm prioritization to lock out or circumvent other alarms that may be generated as a result of primary alarm.
 - b. Prohibit interference with the ability of the system software to report alarms by either operator activity at the local I/O device, or communications with other system controllers on the network.
 - c. Allow all system objects that are configurable to "alarm in" and "alarm out" of normal state.
 - d. Configurable Objects:
 - 1) Alarm limits.
 - 2) Alarm limit differentials.
 - 3) States.
 - 4) Reactions for each object.
 - 5) Alarm delay.
 - e. Alarm Messages:
 - 1) Descriptor: English language. Acronyms or mnemonics for objects in alarm are not acceptable.

- 2) Recognizable Features:
 - a) Source.
 - b) Location.
 - c) Nature.
 - d) Time and Date.
 - e) Alarm message box to more fully describe the alarm condition or direct operator response.
 - f) Each Alarm messages shall be assignable to any point in the BAS. Alarm messages shall be assignable to multiple points.
 - g) Notification of an alarm override.
- f. Configurable Alarm Reactions by Workstation and Time of Day:
 - 1) Logging.
 - 2) Printing.
 - 3) Starting programs.
 - 4) Displaying messages.
 - 5) Phone text message.
 - 6) Email.
 - 7) Providing audible annunciation.
 - 8) Displaying specific system graphics.
- 8. Custom Trend Logs:
 - a. Maintain trend information for minimum 365 days.
 - b. Definable for any data object in the system including interval, start time, and stop time.
 - 1) Resolution: Interval periods shall be adjustable down to one minute.
 - 2) Multiple Interval Period: Each trended point shall have the ability to be trended at a different trend interval.
 - c. Trend Data:
 - 1) Sampled and stored on the building controller panel.

- 2) Auto-Delete Period: Software shall be capable of automatically deleting stored trend data after a user-adjustable period of time. Each trended point shall have the ability to have a different auto-delete interval period.
 - 3) Archivable on hard disk or server.
 - 4) Retrievable for use in reports, spreadsheets and standard database programs.
 - 5) Protected and encrypted format to prevent manipulation or editing of historical data and event logs.
- d. Trend Graph Display:
- 1) Group Trend Time Series Plots:
 - a) Provide user-selectable Y-axis points.
 - b) Provide user editable titles, point names, and Y-axis titles.
 - c) Individual trended points shall be able to be grouped into groups of up to four points per plot with up to four plots per page.
 - 2) X-Y Trend Plots:
 - a) User selectable X and Y trend inputs.
 - b) User editable titles, point names, and X and Y-axis titles.
 - c) User selectable time period options:
 - i) 1-day 24-hour period.
 - ii) 1-week 7-day period.
 - iii) 1-month period with appropriate days for the month selected.
 - iv) 1-year period.
 - v) User shall be able to select the beginning and ending period for each X-Y chart, within the time domain of the database being used.
 - vi) User selectable display up to 6 plots per screen in 2 columns.
 - 3) Automatic Scaling: System shall automatically scale the axis on which trends are displayed when multiple points with different trend interval periods are selected for graphical display.
 - 4) Dynamic Update: Trends shall be able to dynamically update at operator-defined intervals.

- 5) Zoom: Software shall allow zoom-in function for detailed examination of trends.
 - e. Numeric Value Display: Software shall display value of any sample on a trend when picked.
- 9. Alarm and Event Log:
 - a. View all system alarms and change of states from any system location.
 - b. List events chronologically.
 - c. List alarm priority.
 - d. Allow operator with proper security to acknowledge and clear alarms. Log operator and time when alarm is acknowledged.
 - e. Archive alarms not cleared by operator to the workstation.
- 10. Object, Property Status, and Control:
 - a. Provide a method to view, edit if applicable, the status of any object and property in the system.
 - b. Status Available by the Following Methods:
 - 1) Menu.
 - 2) Graphics.
 - 3) Custom Programs.
- 11. Clock Synchronization:
 - a. The real-time clocks in all building control panels and workstations shall be able to automatically synchronize daily from any operator-designated device in the system.
 - b. The system shall automatically adjust for daylight savings and standard time, if applicable.
- 12. Reports and Logs:
 - a. Reporting Package:
 - 1) Allow operator to select, modify, or create reports.
 - 2) Definable as to data content, format, interval, and date.
 - 3) Under no conditions shall the operator need to specify the address of hardware controller to obtain system information.

- 4) Provide ability to obtain real-time logs of all objects available by type or status such as alarm, lockout, normal, etc.
 - 5) Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
 - 6) Allow printing on operator command or specific time(s).
- b. Standard Report Format Options:
- 1) Objects with current values.
 - 2) Global modification values.
 - 3) Current alarms not locked out.
 - 4) Disabled and overridden objects, points and variables.
 - 5) Objects in manual or automatic alarm lockout.
 - 6) Objects in alarm lockout currently in alarm.
 - 7) Objects currently in override status.
 - 8) Objects in Schedules
 - a) Daily.
 - b) Weekly.
 - c) Holiday.
 - 9) Logs:
 - a) Alarm History.
 - b) System messages.
 - c) System events.
 - d) Trends.
- c. Custom Report Format Options:
- 1) Daily.
 - 2) Weekly.
 - 3) Monthly.
 - 4) Annual.

- 5) Time and date stamped.
- 6) Title.
- 7) Facility name.
- 8) Point Groups.
 - a) User-selectable.
 - b) Group may be comprised of specific points, group of equipment objects, group of groups, or for the entire facility without restriction due to the hardware configuration of the BAS.
- d. Electrical, Fuel, and Weather:
 - 1) Electrical Meter(s):
 - a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
 - b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.
 - 2) Fuel Meter(s):
 - a) Monthly showing daily fuel consumption for each meter.
 - b) Annual summary showing monthly consumption for each meter.
 - 3) Weather:
 - a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.
- 13. Global Modify:
 - a. Allow global modification of all editable data. Similar data shall be grouped into logical objects based on building function, mechanical system, building layout, or any other logical grouping of points.
 - b. Allow each common type of equipment to be excluded or included within the global editing process.
 - c. Display status information on all similar points in one global report.
 - d. Allow modification of the following:
 - 1) Individual data point edited.
 - 2) List of all points within the category.

- 3) Global change field.
- 4) Copy feature to assist in downloading the new changes.
- 5) Verification that all changes were completed.
- e. Include a change-all feature to change all selections.
- f. Prevent acceptance of changes until an accept icon is acknowledged.

G. Workstation Applications Editors:

- 1. Provide editing software for each system application at the PC workstation.
- 2. Edited applications shall be automatically downloaded and executed at the controller panel.
- 3. Programming Description: Definition of operator device characteristics, ASC's, individual points, applications and control sequences shall be performed through fill-in-the-blank templates.
- 4. System Definition/Control Sequence Documentation: All portions of system definition shall be self-documenting to provide hard copy printouts of all configuration and application data.
- 5. System definition and modification procedures shall not interfere with normal system operation and control.
- 6. Provide consistent text-based displays of all system point and system applications.
- 7. Point identification, engineering units, status indication, and application naming conventions shall be the same at all operator devices.
- 8. Full screen editor for each application shall allow operator to view and change:
 - a. Configuration.
 - b. Name.
 - c. Control parameters.
 - d. Set-points.
 - e. Schedules.
- 9. Scheduling:
 - a. Allow scheduling down to the zone or room level.
 - b. Monthly calendar indicates schedules, holidays, and exceptions.

- c. Allows several related objects to be grouped, scheduled, and copied to other objects or dates.
 - d. Start and stop times adjustable from master schedule.
 - e. Schedule expiration.
 - f. Temporary overrides of systems with user adjustable time-out.
 - g. Provide minimum three tiers of priorities for scheduling.
 - 1) Priority 1: Event, temporary, or override.
 - 2) Priority 2: Calendar.
 - 3) Priority 3: Default.
 - h. Higher priority schedules shall overlay with lower priority schedules without interrupting or deleting them. Upon expiration of a higher priority schedule, schedule shall revert to next lower priority.
 - i. Expired priority 1 and priority 2 schedules shall be automatically deleted after execution.
10. Custom Application Programming:
- a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
 - b. Programming Features:
 - 1) English oriented programming language, allowing for free form programming.
 - 2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
 - 3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
 - 4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
 - 5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.
 - 6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

- 7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.
- 8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values can be used in IF/THEN comparisons, calculations, programming statement logic, etc.
- 9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.7 CONTROLLER SOFTWARE

- A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.
- B. System Security:
 1. User access secured via user passwords and user names.
 2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
 3. User Log On/Log Off attempts are recorded.
 4. Automatic Log Off occurs following the last keystroke after a user defined delay time.
- C. Object or Object Group Scheduling:
 1. Weekly Schedules Based on Separate, Daily Schedules:
 - a. Include start, stop, optimal stop, and night economizer.
 - b. 10 events maximum per schedule.
 - c. Start/stop times adjustable for each group object.
 2. Exception Schedules:
 - a. Based on any day of the year.
 - b. Defined up to one year in advance.
 - c. Automatically discarded and replaced with standard schedule for that day of the week upon execution.
 3. Holiday or Special Schedules:
 - a. Capability to define up to 99 schedules.

- b. Repeated annually.
 - c. Length of each period is operator defined.
- D. System Coordination: Provide a standard application for equipment coordination. The application shall provide the operator with a method of grouping together equipment based on function and location. Groups shall be capable of being used for scheduling and other applications.
- E. Alarms:
 - 1. Binary object is set to alarm based on the operator specified state.
 - 2. Analog object to have high/low alarm limits.
 - 3. All alarming is capable of being automatically or manually disabled.
 - 4. Alarm Reporting:
 - a. Operator determines action to be taken for alarm event.
 - b. Alarms to be routed to appropriate workstation.
 - 5. Reporting Action Options:
 - a. Start Programs.
 - b. Print.
 - c. Logged.
 - d. Custom messaging.
 - e. Graphical displays.
 - f. Dial out to workstation receivers via system protocol.
- F. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.
- G. Sequencing: Application software based upon specified sequences of operation on the control drawings.
- H. PID Control Characteristics:
 - 1. Provide proportional-integral algorithms.
 - 2. Direct or reverse action.
 - 3. Anti-windup.

4. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
 5. User selectable controlled variable, set-point, and PI gains.
- I. Staggered Start Application:
1. Prevents all controlled equipment from simultaneously restarting after power outage.
 2. Order of equipment startup is user selectable.
 - 3.
- J. Trending: Building controllers shall allow collection and delivery of (time, value) pairs.
- K. Totalization:
1. Run-Time Totalization:
 - a. Totalize run-times for all binary input objects.
 - b. Provides operator with capability to assign high run-time alarm.
 - c. Generates unique, user-specified messages when the limit is reached.
 - d. Resolution: Adjustable down to one minute.
 2. Pulse Totalization:
 - a. Totalize consumption for user-selected analog and binary pulse input-type objects.
 - b. Configurable for a daily, weekly, or monthly basis.
 - c. Provide calculation and storage accumulations of up to 9,999,999 units (e.g. KWH, gallons, KBTU, tons, etc.).
 - d. Resolution: Adjustable down to one minute.
 - e. Warning Limit: User definable. Generate unique, user-specified messages when the limit is reached.
 - f. The information available from the Pulse Totalization shall include, but not be limited to, the following:
 - 1) Peak Demand, with date and time stamp
 - 2) 24-hour Demand Log
 - 3) Accumulated KWH for day
 - 4) Sunday through Saturday KWH usage

- 5) Sunday through Saturday Demand kW
 - 6) Demand kW annual history for past 12 periods
 - 7) KWH annual history for past 12 periods
3. Event Totalization:
- a. Count user-selected events, such as the number of times a pump or fan system is cycled on and off.
 - b. Provide storage accumulations of up to 9,999,999 events before reset.
 - c. Warning Limit: User definable. Generate unique, user-specified messages when the limit is reached.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that systems are ready to receive work.
- C. Beginning of installation means installer accepts existing conditions.
- D. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices and wiring are installed prior to installation proceeding.
- E. Verify the integrity of control wiring, raceways, control panels, sensors, and control devices prior to reusing for the new work.
- F. Verify wiring insulation is defect free and test wiring for continuity and ground faults.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Coordination:
 1. Cooperate with other contractors performing work on this project as necessary to achieve a complete and coordinated installation. Each Contractor shall consult the Drawings and Specifications for all trades to determine the nature and extent of others work.
 2. Coordinate with the Owner to display additional virtual points on individual schematic graphic screens that are not directly associated with that system. Examples may include outdoor air temperature or global alarm conditions.
- C. Web Services Enabled Network:

1. Provide an IP network data drop for connection of BAS into Owner's IP network. Coordinate final location of IP network data drop with the Owners' IT staff.
2. If the Owner has no preference or not indicated on the drawings, locate data drop within the main BAS control panel.
3. Coordinate with the Owner's IT department to implement proper security measures, including secure access to the network data drop and firewalls at all virtual access points to the internet to protect access to the BAS.

D. General Workmanship:

1. Install equipment, piping, and wiring/raceway parallel to building lines wherever possible.
2. Install all equipment in readily accessible locations.
3. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
4. All installations shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
5. Control wiring routed in wall cavities shall be installed in conduit.
6. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
7. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation.

E. Controllers:

1. Install controllers in a locked control panel. Provide common keying for all controller covers.
2. Provide a separate controller for each piece of controlled equipment, such as an AHU, FCU, VAV box, etc. A controller may control more than one piece of equipment provided that all points associated with the equipment are assigned to the same BAS controller. Global points used for control loop reset are exempt from this requirement.
3. Select building controllers and custom application controllers to provide the required I/O point capacity required to monitor all of the hardware points listed on the control drawings.
4. Application specific controllers may be used where factory programming is capable of executing all control functions specified in the sequences of operation. Contractor shall add supplemental controllers, devices, and programming as required to execute the specified control function if the ASC cannot.

F. Wiring:

1. All control and interlock wiring shall comply with national and local electrical codes.

2. Properly ground all controllers.
3. Wire all safety devices through both hand and auto positions of motor starting device to ensure 100 percent safety shut-off.
4. Provide interlock wiring between devices as indicated on the control drawings.
5. Provide electrical wiring for relays (including power feed) for temperature and pressure indication.
6. All NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway according to NEC and Division 26 requirements.
7. All low-voltage wiring shall meet NEC Class 2 requirements. Low-voltage power circuits shall be sub-fused when required to meet Class 2 current limit.
8. Conceal all low voltage wiring in finished rooms.
9. Conceal all low voltage wiring in unfinished rooms below the elevation of the lights. Low voltage wiring above the elevation of the lights may be exposed.
10. Routing of low voltage wiring above working heights in equipment rooms and above accessible ceilings is acceptable subject to following criteria:
 - a. Wiring shall be plenum rated.
 - b. Do not lay wiring on ceiling tiles.
11. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for the intended applications.
12. All wiring in mechanical, electrical, service rooms, or where subject to mechanical damage, shall be installed in raceway at levels below 10 feet.
13. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two wires (e.g., relays and transformers).
14. Where Class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it and neatly tied at 10 foot intervals.
15. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.
16. All wire-to-device and wire-to-wire connections shall be made at a terminal block or terminal strip.
17. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

18. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, coordinate with Division 26 to provide step-down transformers.
19. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
20. Install plenum wiring in sleeves where it passes through floors and walls. Maintain fire rating at all penetrations.
21. Size of raceway and size and type of wire shall be the responsibility of the Contractor, in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.
22. Include one pull string in each raceway 1 inch and larger.
23. Use coded conductors throughout with conductors of different colors.
24. Control and status relays shall be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
25. Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 6 inches from high-temperature equipment (e.g., steam pipes or flues).
26. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
27. Install insulated bushing on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.
28. Terminate all control and/or interlock wiring and maintain updated (as-built) wiring diagrams with terminations identified at the job site.
29. Terminate BAS sensor input wiring cable shield by taping back at the field device and connect shield to the grounded control panel chassis or sub-panel.
30. Terminate BAS comm bus cable shield between controllers per manufacturer recommendations.
31. Terminate management level/enterprise level network wiring cable shield by wrapping the drain wire around the foil shield and connecting the ground strip to the drain wire.
32. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3 feet in length and shall be supported at each end. Flexible metal raceway less than 1/2 inch electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.
33. Raceway shall be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings

(according to code). Terminations shall be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

G. Communication Wiring:

1. Adhere to the items listed in the "Wiring" article in Part 3 of this specification in addition to the requirements listed below.
2. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication wiring.
3. Do not exceed 328 feet in Ethernet wiring length between switches or repeaters.
4. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.
5. Do not install power wiring, in excess of 30 Vac RMS, in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, use separate twisted shielded pairs with the shields grounded in accordance with the manufacturer's wiring practice.
6. Communication conduits shall not be installed closer than six feet from high power transformers or run parallel within six feet of electrical high power cables. Care shall be taken to route the cable as far from interference generating devices as possible.
7. Do not exceed maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer during installation.
8. Verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.
9. When a cable enters or exits a building, install a lightning arrestor between the lines and ground. Install the lightning arrestor according to the manufacturer's instructions.
10. Ground (earth ground) all shields at one point only, to eliminate ground loops.
11. All runs of communications wiring shall be unspliced length when that length is commercially available.
12. Terminate shielded cable splices in accessible locations. Harness cables with cable ties.
13. Make all wire-to-device and wire-to-wire connections at a terminal block or terminal strip.
14. Label all communications wiring to indicate origination and destination data.
15. Ground coaxial cable in accordance with NEC regulations.
16. Install BACnet MS/TP communications wiring in accordance with ASHRAE/ANSI Standard 135

- a. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 17 pF per foot at 76,800 Baud.
- b. The maximum length of an MS/TP segment shall be 3000 ft with AWG 22 or 24 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.
- c. The maximum number of nodes per segment shall be 50. Additional nodes may be accommodated by the use of repeaters.
- d. An MS/TP EIA-485 network shall have no T connections.

H. Identification of Hardware and Wiring:

1. Label all wiring and cabling, including that within factory-fabricated panels, at each end within 2 inch of termination with the BAS address or termination number.
2. Permanently label or code each point of field terminal strips to show the instrument or item served.
3. Identify control panels with minimum 1/2 inch letters on laminated plastic nameplates.
4. Identify all other control components with permanent labels. Label all plug-in components such that removal of the component does not remove the label.
5. Identify room sensors related to terminal box or valves with nameplates.
6. Maintain manufacturers' nameplates and UL or CSA labels visible and legible after equipment is installed.
7. Identifiers shall match record documents.

3.3 STARTUP AND DEMONSTRATION

- A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing the BAS in permanent operation.
- B. Contractor shall provide an on-site controls technician or programmer familiar with the project BAS installation and system programming to assist the Commissioning Agent as directed during all phases of system functional testing.
- C. Coordinate with Owner the setup of logins, passwords, and security level access for individuals requiring access to the BAS.
- D. BAS graphics shall be updated with final equipment names, equipment numbers, room names and room numbers to match the final construction documents and any Owner changes made prior to occupancy.

- E. BAS shall be set up and checked by factory trained technicians skilled in the setting and adjustment of the BAS equipment used in this project. Technicians shall be experienced in the type of HVAC systems associated with this project.
- F. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
- G. Test each control device to ensure that it is operating properly and is calibrated to the appropriate operating requirements. Run each control device through its range of operation and sequence. Verify all normal positions are correct. Adjust and tune PID control constants to achieve proper system operation.
 - 1. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
 - 2. Demand limiting. The Contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.
 - 3. Optimum start/stop. The Contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
 - 4. Any tests that fail to demonstrate the operation of the BAS shall be repeated at a later date. The Contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.
- H. Test and verify control interfaces to other building systems integrated into the network.
- I. Verify all alarms and interlocks.
 - 1. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
 - 2. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 - 3. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.
 - 4. Verify fire/smoke and smoke damper functionality. Verify that they respond to the proper fire alarm system general, zone, and/or detector trips.
- J. Document on system equipment schedules the final setting of controller PID constant settings, setpoints, manual reset values, maximum and minimum controller output, and ratio and bias settings in units and terminology specific to the controller. Store documentation with operator workstation.

K. Demonstrate complete and operating system to Owner.

1. Prior to acceptance, the BAS shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
2. The tests described in this section are to be performed in addition to the tests that the Contractor performs as a necessary part of the installation, start-up, and debugging process.
3. The Contractor shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. Any test equipment required to provide the proper operation shall be provided by and operated by the Contractor.
4. Demonstrate compliance with sequences of operation through all modes of operation.
5. Demonstrate complete operation of operator interface.

L. Acceptance:

1. All tests described in this specification shall have been performed to the satisfaction of the Owner prior to the acceptance of the BAS as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the completion requirements if stated as such in writing by the Contractor and submitted for approval by the Owner. Such tests shall then be performed as part of the warranty.
2. The BAS shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved.

3.4 MAINTENANCE SERVICE

- A. Provide service and maintenance of energy management and control systems for one year from Date of Substantial Completion.

3.5 TRAINING

- A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of eight hours on the operation and maintenance of the equipment provided under this section.
- B. Organize the training into sessions or modules for different levels of operators. Owner designated personnel shall be trained based on the level of operator training described below.
- C. Day-to-day Operator Training:
1. Overview of the system and/or equipment as it relates to the facility as a whole.
 2. Proficiently operate the BAS.
 3. Understand BAS architecture and configuration.

4. Understand BAS components.
 5. Understand system operation, including BAS control and optimizing routines (algorithms).
 6. Operate the workstation and peripherals.
 7. Log on and off the system.
 8. Access graphics, point reports, and logs.
 9. Adjust and change system set points, time schedules, and holiday schedules.
 10. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals.
 11. Understand BAS drawings and Operation and Maintenance manual.
 12. Understand the job layout and location of control components.
 13. Access data from BAS controllers and ASCs.
 14. Operate portable operator's terminals.
 15. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.
- D. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
- E. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.
- F. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF DOCUMENT 230923

DOCUMENT 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping.
- B. Refrigerant.
- C. Moisture and liquid indicators.
- D. Valves.
- E. Strainers.
- F. Check Valves.
- G. Pressure regulators.
- H. Pressure relief valves.
- I. Filter-driers.
- J. Solenoid valves.
- K. Expansion valves.
- L. Receivers.
- M. Flexible connections.

1.2 SUBMITTALS

- A. Product Data: Provide general assembly of valves and specialties, including manufacturer's catalog information. Provide manufacturer's catalog data including load capacity.
- B. Shop Drawings showing layout of refrigerant piping, specialties, and fittings including, but not necessarily limited to, pipe and tube sizes, valve arrangements and locations, slopes of horizontal runs, wall and floor penetrations, and equipment connection details. Show interface and spatial relationship between piping and proximate to equipment.
- C. Test reports specified in Part 3 below.
- D. Manufacturer's Installation Instructions: Indicate support requirements, connection requirements and isolation requirements for servicing.
- E. Brazers' Certificates signed by Contractor certifying that brazers comply with requirements specified under "Quality Assurance" below.

- F. Maintenance Data: Include maintenance instructions for refrigerant valves and piping specialties, for inclusion in Operation and Maintenance manual.

1.3 QUALITY ASSURANCE

- A. Comply with Division 23 Section, "Basic Piping Materials and Methods."
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver and store piping and specialties in shipping containers with labeling in place.
- B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
- C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, and maintain sealed until connected into system.

PART 2 - PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Comply with ASME/ANSI B31.5: ASME Code for Pressure Piping - Refrigerant Piping.
- B. Comply with ANSI/ASHRAE Standard 15: Safety Code for Mechanical Refrigeration.
- C. Comply with applicable Mechanical Code.
- D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

2.2 PIPING

- A. Copper Tubing:
 - 1. ASTM B280, Type ACR, seamless, hard-drawn straight lengths and soft-annealed coils. Tubing shall be factory cleaned, ready for installation, and have ends capped to protect cleanliness of pipe interiors prior to shipping.
 - 2. ASTM B88, Type L, seamless, hard-drawn straight lengths and soft-annealed coils.
 - 3. ASTM B88, Type K, seamless, hard-drawn straight lengths and soft-annealed coils.
- B. Refrigerant Line Kits:
 - 1. Type ACR seamless copper roll of refrigerant tubing with pipe diameters as recommended by the manufacturer and of length as required for the installation.
 - 2. Factory or field installed flexible unicellular insulation:

- a. Minimum thickness as required per Division 23 section "HVAC Insulation".

3. Quick-connect flare tubing compression fittings or solder connections as required to match the connections of the condensing unit and evaporator coil.

2.3 FITTINGS

- A. Wrought-Copper Fittings for Solder-joint: ANSI B16.22, streamlined pattern.
- B. Mechanical Flared Fittings: ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tube.

2.4 JOINING MATERIALS

- A. Refer to Division 23 Section "Basic Piping Materials and Methods" for joining materials.

2.5 PIPE SUPPORTS

- A. Hanger, supports, and anchors are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing. Provide plastic galvanic isolators for copper tubing where indicated.

2.6 REFRIGERANT

- A. Refrigerant: R-410A, as defined in ASHRAE Standard 34.

2.7 MOISTURE AND LIQUID INDICATORS

- A. Manufacturers
 1. Emerson Electric.
 2. Henry Technologies.
 3. Parker Hannifin/Refrigeration and air Conditioning.
 4. Sporlan, Division of Parker Hannifin.
- B. Moisture/liquid Indicators: Single port type, UL listed, with forged brass body, solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; rated for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.8 SHUT OFF VALVES

- A. Manufacturers:
 1. Danfoss.
 2. Emerson Electric.
 3. Henry Technologies.

4. Parker Hannifin/Refrigeration and air Conditioning.
 5. Sporlan, Division of Parker Hannifin.
- B. General: Complete valve assembly shall be UL-listed and designed to conform to AHRI 760. Where insulation is indicated or specified, provide extended stems arranged to receive insulation.
- C. Diaphragm Packless Valves: Globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F
- D. Ball: Two piece bolted forged brass body with Teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seal; maximum working pressure 500 psig and maximum temperature of 275 F.
- E. Globe: Cast bronze body, with cast bronze or forged brass wing cap and bolted bonnet; replaceable resilient seat disc; plated steel stem. Valve shall be capable of being repacked under pressure. Valve shall be straight through or angle pattern, with solder-end connections; for maximum working pressure of 500 psig and maximum operating temperature of 275 deg. F.

2.9 STRAINERS

- A. Manufacturers:
1. Danfoss.
 2. Parker Hannifin/Refrigeration and air Conditioning.
 3. Sporlan, Division of Parker Hannifin.
- B. Strainers: 500 psig maximum working pressure; forged brass body with Monel 80-mesh screen, and screwed cleanout plug; Y-pattern, with solder end connections.

2.10 CHECK VALVES

- A. Manufacturers:
1. Danfoss.
 2. Parker Hannifin/Refrigeration and air Conditioning.
 3. Sporlan, Division of Parker Hannifin.
- B. Check Valves - Smaller Than 7/8 inch: 500 psig maximum operating pressure, 300 deg. F maximum operating temperature; cast bronze or forged brass body, with removable piston, Teflon seat, and stainless steel spring; straight through globe design. Valve shall be straight through pattern, with solder-end connections.
- C. Check Valves - 7/8 inch and Larger: 450 psig maximum operating pressure, 300 deg. F maximum operating temperature; cast bronze body, with cast bronze or forged brass bolted bonnet; floating

piston with mechanically retained Teflon seat disc. Valve shall be straight through or angle pattern, with solder-end connections.

2.11 PRESSURE REGULATING VALVES

A. Manufacturers:

1. Danfoss.
2. Emerson Electric.
3. Parker Hannifin/Refrigeration and air Conditioning.
4. Sporlan, Division of Parker Hannifin.

- B. Evaporator Pressure Regulating Valves: Pilot-operated, forged brass or cast bronze; complete with pilot operator, stainless steel bottom spring, pressure gage tapings, 24 volts DC, 50/60 Hz, standard coil; and wrought copper fittings for solder end connections.

2.12 PRESSURE RELIEF VALVES

A. Manufacturers:

1. Danfoss.
2. Parker Hannifin/Refrigeration and air Conditioning.
3. Sporlan, Division of Parker Hannifin.

- B. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB, selected to ASHRAE Std 15, with standard setting of 235 psi.

2.13 FILTER DRIERS

A. Manufacturers:

1. Danfoss.
2. Emerson Electric
3. Parker Hannifin/Refrigeration and air Conditioning.
4. Sporlan, Division of Parker Hannifin.

- B. Filter-driers: 500 psig maximum operation pressure; steel shell, flange ring, and spring, ductile iron cover plate with steel cap screws, and wrought copper fittings for solder end connections. Furnish complete with replaceable filter-drier core kit, including gaskets, as follows: Standard capacity desiccant sieves to provide micronic filtration.

- C. Suction Line Filter-Drier: 350 psig maximum operation pressure, 225 deg. F maximum operating temperature; steel shell, and wrought copper fittings for solder end connections. Permanent filter

element shall be molded felt core surrounded by a desiccant for removal of acids and moisture for refrigerant vapor.

- D. Suction Line Filters: 500 psig maximum operation pressure; steel shell, flange ring, and spring, ductile iron cover plate with steel cap screws, and wrought copper fittings for solder end connections. Furnish complete with replaceable filter core kit, including gaskets.

2.14 SOLENOID VALVES

- A. Manufacturers:
 - 1. Danfoss.
 - 2. Emerson Electric.
 - 3. Parker Hannifin/Refrigeration and air Conditioning.
 - 4. Sporlan, Division of Parker Hannifin.
- B. Valves: 250 deg. F temperature rating, 500 psig working pressure; forged brass body, with Teflon valve seat, two-way straight through pattern, and solder end connections. Provide manual operator to open valve.
- C. Furnish complete with NEMA 1 solenoid enclosure with 1/2 inch conduit adapter, and 24 volt, 60 Hz. normally closed holding coil.

2.15 THERMOSTATIC EXPANSION VALVES

- A. Manufacturers:
 - 1. Danfoss.
 - 2. Emerson Electric.
 - 3. Parker Hannifin/Refrigeration and air Conditioning.
 - 4. Sporlan, Division of Parker Hannifin.
- B. Thermal Expansion Valves: thermostatic adjustable, modulating type; size as required for specific evaporator requirements, and factory set for proper evaporator superheat requirements. Valves shall have copper fittings for solder end connections; complete with sensing bulb, and an external equalizer line.
- C. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select valve to avoid being undersized at full load and excessively oversized at part load.

PART 3 - EXECUTION

3.1 PIPE APPLICATION SCHEDULE

- A. Above Grade:

18225R21006
232300 - 6

REFRIGERANT PIPING

1. Type L or Type ACR tubing.
 - B. If other than Type ACR tubing is used, clean and protect inside of tubing as specified in Article "CLEANING" below.
 - C. At contractor's option, use refrigerant line kits for refrigerant systems of 5 tons and smaller capacity.
- 3.2 INSTALLATION, GENERAL
- A. Install products in accordance with manufacturer's instructions.
 - B. Install piping to ASME B31.9 requirements.
 - C. Reference Division 23 Section "Basic Piping Materials and Methods" for general piping installation requirements.
 - D. Do not install PVC or non-plenum rated HDPE piping in return air plenums.
- 3.3 PIPING INSTALLATIONS
- A. General: Install refrigerant piping in accordance with ASHRAE Standard 15 - "The Safety Code for Mechanical Refrigeration" and the equipment manufacturer's installation requirements.
 - B. Install piping in as short and direct arrangement as possible to minimize pressure drop.
 - C. Install piping for minimum number of joints using as few elbows and other fittings as possible.
 - D. Arrange piping to allow normal inspection and servicing of compressor and other equipment. Install valves and specialties in accessible locations to allow for servicing and inspection.
 - E. Provide adequate clearance between pipe and adjacent walls and hanger, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full thickness insulation.
 - F. Insulate piping per Division 23 Section "HVAC Insulation."
 1. Do not install insulation until system testing has been completed and all leaks have been eliminated.
 - G. Install branch tie-in lines to parallel compressors equal length, and pipe identically and symmetrically.
 - H. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.
 - I. Slope refrigerant piping as follows:
 1. Install horizontal hot gas discharge piping with 1/2 inch per 10 feet downward slope away from the compressor.

2. Install horizontal suction lines with 1/2 inch per 10 feet downward slope to the compressor, with no long traps or dead ends which may cause oil to separate from the suction gas and return to the compressor in damaging slugs.
 3. Install traps and double risers where indicated, and where required to entrain oil in vertical runs.
 4. Liquid lines may be installed level.
- J. For bendable copper tubing system, bend tubing in accordance with manufacturer's instructions using tools that are acceptable to the manufacturer.
- K. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.
- L. Install unions to allow removal of solenoid valves, pressure regulating valves, expansion valves, and at connections to compressors and evaporators.
- 3.4 HANGERS AND SUPPORTS
- A. Comply with the requirements of Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
1. Provide insulation saddles and protection shields as specified in Section "Hangers & Supports for HVAC Piping & Equipment". Provide insulation inserts as specified in Section "HVAC Insulation".
- C. Install hangers with the following minimum rod sizes and maximum spacing:
- | <u>NOM. PIPE SIZE</u> | <u>MAX. SPAN-FT</u> | <u>MIN. ROD SIZE – INCHES</u> |
|-----------------------|---------------------|-------------------------------|
| Up to 3/4 | 5 | 3/8 |
| 1 | 6 | 3/8 |
| 1-1/4 | 7 | 3/8 |
| 1-1/2 | 8 | 3/8 |
| 2 | 8 | 3/8 |
| 2-1/2 | 9 | 1/2 |
| 3 | 10 | 1/2 |
| 4 | 12 | 1/2 |
| 6 | 14 | 5/8 |
- D. Support vertical runs at each floor. Support riser piping independently of connected horizontal piping.
- E. Install a support within one foot of each change of direction.
- F. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

3.5 PIPE JOINT CONSTRUCTION

- A. Reference Division 23 Section, "Basic Piping Materials and Methods" for basic pipe joint construction.
- B. Press-Fit Joints: Installers of the press-fit joints shall be trained using manufacturers training tools prior to installing any press-fit joints.
 - 1. Prepare the copper tube in accordance with manufacturers instructions.
 - 2. Install fittings to minimum depth required by the fitting manufacturer.
 - 3. Crimp the fitting only using the crimping tools allowed by the manufacturer using the jaw size appropriate for the tube diameter.
 - 4. Verify the joint is properly installed using crimp gauges or manufacturer's approved verification methods.

3.6 VALVE AND PIPING SPECIALTIES INSTALLATIONS

- A. General: Install refrigerant valves where indicated, and in accordance with manufacturer's instructions.
- B. Install globe valves on each side of strainers and driers, in liquid and suction lines at evaporators, and elsewhere as indicated.
- C. Install a full sized, 3-valve bypass around each drier.
- D. Install solenoid valves ahead of each expansion valve . Install solenoid valves in horizontal lines with coil at the top.
 - 1. Electrical wiring for solenoid valves is specified in Division 26. Coordinate electrical requirements and connections.
- E. Thermostatic expansion valves may be mounted in any position, as close as possible to the evaporator.
 - 1. Where refrigerant distributors are used, mount the distributor directly on the expansion valve outlet.
 - 2. Install the valve in such a location so that the diaphragm case is warmer than the bulb.
 - 3. Secure the bulb to a clean, straight, horizontal section of the suction line using two bulb straps. Do not mount bulb in a trap or at the bottom of the line.
 - 4. Where external equalizer lines are required make the connection where it will clearly reflect the pressure existing in the suction line at the bulb location.
- F. Install pressure regulating and relieving valves as required by ASHRAE Standard 15.

- G. Install strainers immediately ahead of each expansion valve, solenoid valve, hot gas bypass valve, compressor suction valve, and as required to protect refrigerant piping system components.
- H. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
 - 1. Install moisture/liquid indicators in lines larger than 2-1/8 inch OD, using a bypass line.
- I. Install flexible connectors at the inlet and discharge connection of compressors.

3.7 EQUIPMENT CONNECTIONS

- A. The Drawings indicate the general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow servicing and maintenance.

3.8 FIELD QUALITY CONTROL

- A. Inspect, test, and perform corrective action of refrigerant piping in accordance with ASME Code B31.5, Chapter VI. Provide test report summarizing the test procedures and results of the tests.
- B. Repair leaking joints using new materials, and retest for leaks.
- C. Field Test: Every refrigerant-containing part of every system that is erected on the premises, except safety devices, pressure gauges, control mechanisms, compressors, evaporators, and systems that are factory-tested, shall be tested and proved tight after complete installation and before operation. The high side and low side of each system shall be tested and proved tight at not less than the lower of the design pressure or the setting of the pressure-relief device protecting the high side and low side of the system, respectively.
- D. Testing Procedure: Tests shall be performed with dry nitrogen. The means used to build up the test pressure shall have either a pressure-limiting device or a pressure-reducing device and a gage on the outlet side. The pressure-relief device shall be set above the test pressure but low enough to prevent permanent deformation of the system's components.

3.9 CLEANING

- A. Before installation of copper tubing other than Type ACR tubing, clean the tubing and fitting using following cleaning procedure:
 - 1. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through the tubing by means of a wire or an electrician's tape.
 - 2. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
 - 3. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
 - 4. Finally, draw a clean, dry, lintless cloth through the tube or pipe.

3.10 ADJUSTING AND CLEANING

- A. Verify actual evaporator applications and operating conditions, and adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.
- B. Clean and inspect refrigerant piping systems in accordance with requirements of Division 23 Basic Mechanical Materials and Methods section "Pipes and Pipe Fittings".
- C. Adjust controls and safeties. Replace damaged or malfunctioning controls and equipment with new materials and products.

3.11 STARTUP

- A. Charge system using the following procedure:
 - 1. Install core in filter dryer after leak test but before evacuation.
 - 2. Evacuate refrigerant system with vacuum pump; until temperature of 35 deg F is indicated on vacuum dehydration indicator.
 - 3. During evacuation, apply heat to pockets, elbows, and low spots in piping.
 - 4. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
 - 5. Break vacuum with refrigerant gas, allow pressure to build up to 2 psi.
 - 6. Complete charging of system, using new filter dryer core in charging line. Provide full operating charge.
- B. Train Owner's maintenance personnel on procedures and schedules related to start-up and shut-down, troubleshooting, servicing, and preventative maintenance of refrigerant piping valves and refrigerant piping specialties.
- C. Review data in Operating and Maintenance Manuals. Refer to Division 01 section "Closeout Procedures."
- D. Schedule training with Owner through the Architect, with at least 7 days advance notice.

END OF DOCUMENT 232300

DOCUMENT 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Metal ductwork.
- B. Duct liner.
- C. Duct sealants.
- D. Duct hangers and supports.
- E. Wire rope hanging system.

1.2 REFERENCE STANDARDS

- A. - ASHRAE Handbook - Fundamentals.
- B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- C. ASTM A90 - Standard Specification for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
- D. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- F. ASTM A700 - Standard Guide for Packaging, Marking, and Loading Methods for Steel Products for Shipment.
- G. ASTM A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- H. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
- I. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- J. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

- K. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
- L. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- M. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- N. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- O. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
- P. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems, 2013
- Q. AWS D1.1 - Structural Welding Code - Steel
- R. AWS D9.1 - Sheet Metal Welding Code
- S. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements.
- T. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements.
- U. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.
- V. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
- W. NADCA ACR-2002 - Assessment, Cleaning & Restoration of HVAC Systems; National Air Duct Cleaners Association
- X. NAIMA - Duct Cleaning Guide; North American Insulation Manufacturers Association
- Y. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- Z. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- AA. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
- BB. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.
- CC. TIMA AHC-101; Thermal Insulation Manufacturers Association
- DD. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; current edition, including all revisions.

- EE. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.3 DEFINITIONS

- A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:
 - 1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
 - 2. Joints: Joints include girth joints; branch and subbranch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

- A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

1.5 SUBMITTALS

- A. Product data including details of construction relative to materials, dimensions of individual components, profiles, and finishes for the following items:
 - 1. Duct Liner.
 - 2. Sealing Materials.
- B. Shop drawings from duct fabrication shop, drawn to a scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as the Contract Drawings, detailing:
 - 1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
 - 2. Duct layout, indicating pressure classifications, duct gauge and sizes in plan view. For exhaust ducts systems, indicate the classification of the materials handled as defined in this Section.
 - 3. Fittings.
 - 4. Reinforcing details and spacing.
 - 5. Seam and joint construction details.

6. Penetrations through fire-rated and other partitions.
 7. Terminal heating and cooling unit, coil installations.
 8. .
 9. Location of manual balancing dampers.
 10. Duct smoke detector locations. Refer to electrical drawings for general locations and coordinate locations with the electrical contractor.
 11. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
- C. Coordination drawings for ductwork installation in accordance with Division 23 Section "General Mechanical Requirements." In addition to the requirements specified in "General Mechanical Requirements" show the following:
1. Coordination with ceiling suspension members.
 2. Spatial coordination with other systems installed in the same space with the duct systems.
 3. Coordination of ceiling- and wall-mounted access doors and panels required to provide access to dampers and other operating devices.
 4. Coordination with ceiling-mounted lighting fixtures and air outlets and inlets.
- D. Record drawings including duct systems routing, fittings details, reinforcing, support, and installed accessories and devices, in accordance with Division 23 Section "General Mechanical Requirements" and Division 1.
- E. Welding certificates including welding procedures specifications, welding procedures qualifications test records, and welders' qualifications test records complying with requirements specified in "Quality Assurance" below.
- 1.6 QUALITY ASSURANCE
- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.
- C. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel" for hangers and supports and AWS D9.1 "Sheet Metal Welding Code."

- D. Qualify each welder in accordance with AWS qualification tests for welding processes involved. Certify that their qualification is current.
- E. NFPA Compliance: Comply with the following NFPA Standards:
 - 1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise.
 - 2. NFPA 90B, "Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
- F. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Provide ductwork systems in conformance with "HVAC Duct Construction Standards – Metal and Flexible," latest edition.
- G. Underwriter's Laboratories (UL): Comply with the UL standards listed within this section. Provide mastic and tapes that are listed and labeled in accordance with UL 181A and marked according to type.
- H. National Air Duct Cleaners Association, Inc. (NADCA): Clean ductwork systems in accordance with the standard Assessment, Cleaning and Restoration of HVAC Systems (ACR 2002).

1.7 PROTECTION AND REPLACEMENT

- A. Protect ductwork during shipping and storage from dirt, debris and moisture damage. Provide plastic covers over ends of ductwork during shipping, storage and installation.
- B. Replace duct liner that is damaged and cannot be repaired satisfactorily, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installing new duct liner.

1.8 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 - PRODUCTS

2.1 DUCT ASSEMBLIES

- A. Ducts: Galvanized steel, unless otherwise indicated. Provide sheet metal in thickness indicated (minimum 26 gauge), packaged and marked as specified in ASTM A700.
- B. Supply Air Ducts (constant volume or single zone VAV systems): 3 inches w.g pressure class, galvanized steel.

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- C. Return and Relief: 2 inch w.g. pressure class, galvanized steel.
- D. General Exhaust: 2 inch w.g. pressure class, galvanized steel.
- E. Outside Air Intake: 2 inch w.g. pressure class, galvanized steel.
- F. Combustion Air: 2inch w.g. pressure class, galvanized steel, aluminum or stainless steel.
- G. Transfer Air and Sound Boots: 1/2 inch wg pressure class, galvanized steel.
- H. Exterior Ductwork: Ductwork installed exterior to the building shall be minimum #18 gauge with longitudinal and transverse joints welded or sealed airtight as specified under Paragraph "Seam and Joint Sealing".
- I. Duct Liner Application: Provide duct liner on the following interior air ducts and where specified on the drawings.
 - 1. Supply Ductwork:
 - a. Exposed rectangular ductwork.
 - b. Exposed round ductwork.
 - c. First 15 feet of ductwork downstream of equipment outlets.
 - 2. Return Ductwork.
 - a. Exposed rectangular ductwork.
 - b. Exposed round ductwork.
 - c. First 15 feet of ductwork upstream of equipment outlets.

2.2 MATERIALS

- A. Sheet Metal, General: Provide sheet metal in thickness indicated (minimum 26 gauge), packaged and marked as specified in ASTM A 700.
- B. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, lock-forming quality with G90/Z275 coating.. Provide mill phosphatized or galvanized finish for surfaces of ducts exposed to view that is to be field painted. Provide bright galvanized finish for ductwork that is exposed to view and not field painted.
- C. Carbon Steel for Ducts: ASTM A1008/A1008M, Designation CS (commercial steel), cold-rolled, with oiled, exposed matte finish.

- D. Aluminum for Ducts: ASTM B209 (ASTM B209M); aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength, with standard, one-side bright finish where ducts are exposed to view, and mill finish for concealed ducts.
- E. Stainless Steel for Ducts: ASTM A 480, Type 316, with No. 4 finish on exposed surface for ducts exposed to view; Type 304, sheet form, with No. 1 finish for concealed ducts.
- F. PVC-Coated Galvanized Steel: UL-181 Class 1 Listing. Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, lock-forming quality with G90/Z275 coating. Provide with factory-applied, 4-mil, PVC coating on exterior of ducts and fittings for underground applications, and the interior of ducts and fittings for fume-handing applications and 2-mil PVC coating on the reverse side of the ducts and fittings.
- G. Duct Liner

1. General:

- a. Comply with NFPA Standard 90A and North American Insulation Manufacturers Association (NAIMA) Standard AHC-101.
- b. Liner shall have a flame spread rating of not more than 25 without evidence of continued progressive combustion and a smoke developed rating of no higher than 50, when tested in accordance with ASTM E84 or UL 723.
- c. Duct sizes on mechanical plans indicate clear inside airflow dimensions. Sheet metal sizes for ductwork with duct liner shall be increased accordingly to account for liner thickness.

2. Fiberglass: ASTM C1071, Type I or II, glass fibers firmly bonded together with a thermosetting resin with surface exposed to airstream coated to prevent erosion of glass fibers. Liner surface shall serve as a barrier against infiltration of dust and dirt, shall meet ASTM C 1338 for fungi resistance and shall be cleanable using duct cleaning methods and equipment outlined by NAIMA Duct Cleaning Guide. Duct liner shall be rated for air velocity of 6,000 fpm.

- a. Rectangular fiberglass duct liner shall be Certainteed ToughGard T, JohnsManville Linacoustic RC, Knauf Atmosphere, Owens Corning QuietR or approved equal.

1) Thickness and Density:

- a) 2 inch, 1-1/2 pounds per cubic foot.

- b. Round fiberglass duct liner shall be Certainteed ToughGard UltraRound, JohnsManville Spiracoustic Plus, Owens Corning QuietZone Spiral, or approved equal.

1) Thickness and Density:

- a) 2 inch, 4 pound per cubic foot.
- c. Thermal Performance: Meet minimum "K-Factor" equal to 0.28 (Btu·in/h·sq ft·F) or better, at a mean temperature of 75°F and rated in installed condition in accordance with ASTM C518 and/or ASTM C177.
- d. Liner Adhesive: Comply with NFPA Standard 90A /UL 181 classified with flame spread/smoke development less than 25/50 and ASTM C 916. Adhesive shall be a minimum 50% solid content, water-based, non-oxidizing and have a service temperature of -20 to 200 F. Water-based adhesive shall be one of the following:
 - 1) Armacell LLC Armaflex 520 BLV low VOC.
 - 2) Design Polymerics DP 2502.
 - 3) Duro Dyne WIT.
 - 4) Foster 85-60.
 - 5) Childers CP-127.
 - 6) Johns Manville SuperSeal HV.
 - 7) Hardcast 951.
 - 8) United McGill Uni-Tack.
- e. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct.
 - 1) Fastener Pin Length: As required for thickness of insulation, and without projecting more than 1/8 inch into the airstream.
 - 2) Adhesive For Attachment of Mechanical Fasteners: Comply with the "Fire Hazard Classification" of duct liner system.
- 3. Flexible Elastomeric Duct Liner: Insulation material shall be a flexible, closed cell, elastomeric insulation in sheet form that complies with ASTM C534. Material shall have a maximum thermal conductivity of 0.27 Btu-in/h·sf·F and a minimum water vapor transmission of 0.08 perm-inches. Liner shall be 1 inch thick or greater to meet local code requirements.
 - a. Manufacturers:
 - 1) Aeroflex USA, Inc Aerocel Sheet.

- 2) Armacell LLC, AP Armaflex SA or Amaflex Ultra.
- 3) K-Flex USA Liner Gray.
4. Flexible Elastomeric Acoustical and Conformable Duct Liner: Compliance with ASTM C 534 Grade 1, Type II or ASTM C 1534, NFPA 90A or NFPA 90B, Thickness: 1/2 inch and 1 inch, Thermal Conductivity: 0.25 BTU-in/hr sq ft F at 75 F mean temp, ASTM C 518, Noise Reduction Coefficient: 0.6, ASTM C 423, Sound Transmission Class (STC) 25, ASTM E 90, EPA registered anti-microbial additive to inhibit mold and mildew, ASTM G21.
 - a. Manufacturers:
 - 1) Aeroflex USA, Inc PLUS Acoustical Duct Liner.
 - 2) Armacell LLC, AP Coilflex.
 - 3) Approved equal.
5. Flexible Elastomeric Round or Spiral Duct Liner: Compliance with ASTM C 534 Grade 1, Type II or ASTM C 1534, NFPA 90A or NFPA 90 B, Thickness: 1 inch, Thermal Conductivity: 0.28 Btu-in/hr sq ft F at 75 F mean temp, ASTM C 518 Noise Reduction Coefficient: 0.4, ASTM C 423 Sound Transmission Class (STC) 31, ASTM E90, EPA registered anti-microbial additive to inhibit mold and mildew, ASTM G21.
 - a. Manufacturers:
 - 1) Armacell LLC, AP Spiraflex.
 - 2) Approved equal.
6. Polyester Duct Liner: Duct liner shall be an engineered nonwoven, thermally bonded polyester with a smooth and durable FSK facing. Liner shall have a noise reduction coefficient of at least 0.65 per ASTM C423 and have thermal values greater or equal to an R-5 at 1 inch, R-6 at 1-1/2 inch and R-8 at 2 inch, respectively. Polyester liner must be able to withstand a constant internal temperature up to 250 F, must be compliant with Greenguard Environmental Institute, and contain zero VOCs per ASTM D5116. Liner must comply with NFPA 90A, NFPA 90 B and UL 181. Liner must meet ASTM C518 for thermal conductance properties and ASTM G-21 for fungal resistance properties. Liner must consist of at least 25 percent recycled content.
 - a. Manufacturers:
 - 1) Ductmate Industries "PolyArmor."
 - 2) Approved equal.

H. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.

1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
2. Surface Burning Characteristics: Sealants shall be ASTM E84 or UL 723 listed with a flame spread index not more than 25 and a smoke-developed index not more than 50.
3. For Use with Flexible Ducts: UL labeled.
4. The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics. Duct tape shall not be used as a sealant on any ducts.
5. Joint and Seam Tape: 2 inches wide, glass-fiber-reinforced fabric.
6. Tape Sealing System: Woven-fiber tape impregnated with a gypsum mineral compound and a modified acrylic/silicone activator to react exothermically with the tape to form a hard, durable, airtight seal.
7. Solvent-Based Joint and Seam Sealant: One-part, non-sag, solvent-release-curing, polymerized butyl sealant complying with FS TT-S-001657, Type I; formulated with a minimum of 70 percent solids. Approved products: Childers CP-140, Duro Dyne SGD, Fosters 32-14, or approved equal.
8. Water-Based Joint and Seam Sealant: Non-Fibrated: UL 181 listed. Sealant shall be rated to ± 15 inches w.g. Sealant shall have a service temperature of -25 to 200 F and be freeze/thaw stable through 5 cycles. Approved products: Childers CP-146, Design Polymeric DP 1010, Ductmate Proseal/Fiberseal, Duro Dyne Duroseal, Fosters 32-1, United Duct Sealer (Water Based), and Hardcast 601.
9. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
10. Flanged Gasket Tapes: Butyl gasket shall be UL 181 classified. Gasket size shall be minimum $5/8$ inch x $3/16$ inch and have nominal 100 percent solid content. It shall be non-oxidizing, non-skinning and have a service temperature of -25 to 180 F. Approved Products: Design Polymeric DP 1040, Ductmate 440, and Hardcast 1104.

I. Hangers and Supports

1. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
2. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:

- a. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 - b. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
 - c. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
 - d. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
 - e. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
3. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4 inches thick.
 4. Hangers: Galvanized sheet steel, or round, uncoated steel, threaded rod.
 - a. Hangers Installed In Corrosive Atmospheres: Electro-galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.
 - b. Straps and Rod Sizes: Conform with SMACNA HVAC Duct Construction Standards, 2005 Edition, for sheet steel width and gauge and steel rod diameters.
 5. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
 6. Trapeze and Riser Supports: Steel shapes conforming to ASTM A 36.
 - a. Where galvanized steel ducts are installed, provide hot-dipped-galvanized steel shapes and plates.
 - b. For stainless steel ducts, provide stainless steel support materials.
 - c. For aluminum ducts, provide aluminum support materials, except where materials are electrolytically separated from ductwork.
 7. Wire Rope Hanging Systems:
 - a. General: Wire rope hanger system shall have a minimum 5 to 1 safety factor based upon the applied working load being supported.
 - b. Source Limitations: Furnish associated fittings, accessories, and hardware produced by a single manufacturer.
 - c. Wire Rope: Zinc coated or galvanized steel, with wire thread type as required to support the applied working load being supported. Provide same size wire for all applications based on worst case loading.

- d. Cable Lock: Cast zinc housing with steel spring with wedge grip, selected to meet the vertical load applied to the hanging system and wire thread. Do not exceed the working load limit.
 - e. Accessories: Hanger attachments and structural attachments shall be compatible with wire rope hanger system and shall be by the same manufacturer as the wire rope hanger system.
 - f. Manufacturers:
 - 1) ASC Engineered Solutions.
 - 2) Ductmate Industries, Inc; Clutcher Cable Hanging System.
 - 3) Duro Dyne.
 - 4) Gripple.
 - J. Reinforcement Shapes and Plates: Unless otherwise indicated, provide galvanized steel reinforcing where installed on galvanized sheet metal ducts. For aluminum and stainless steel ducts provide reinforcing of compatible materials.
 - K. Tie Rods: Same material as the duct, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.
- 2.3 DUCTWORK FABRICATION
- A. Fabricate and support duct in accordance with latest edition of SMACNA (DCS).
 - B. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
 - 1. Fabricate rectangular ductwork of minimum 26 gauge sheet metal.
 - 2. Fabricate ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
 - C. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.
 - D. Field Painted Ductwork: Provide mill phosphatized finish on exposed surfaces of rectangular ductwork and duct fittings to be field painted.
 - E. Exterior Ductwork: Ductwork installed exterior to the building without weather-proof jacket or cladding shall be minimum #18 gauge with longitudinal and transverse joints welded or sealed airtight as specified under Paragraph "Seam and Joint Sealing".

- F. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20 gauge or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 2-9, unless they are lined or are externally insulated.
- G. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," 2005 Edition, Figures 4-1 through 4-8. Unless otherwise noted on drawings, provide prefabricated 45 degree, high efficiency, rectangular/round branch duct takeoff fittings with manual balancing damper, 3/8 inch square shaft, U-bolt, nylon bushings, locking quadrant, and 2 inch insulation build-out for branch duct connections and take-offs to individual diffusers, registers and grilles. 45 degree, high efficiency, rectangular/round branch duct takeoff fittings shall be Flexmaster STO with model BO3 damper or equal.
- H. Provide radius elbows, turns, and offsets with a minimum centerline radius of 1-1/2 times the duct width. Where space does not permit full radius elbows, provide short radius elbows with a minimum of two continuous splitter vanes. Vanes shall be the entire length of the bend. The use of square throat, radius heel elbows is prohibited. Remove and replace all installed elbows of this type with an approved elbow at no additional cost to the owner.
- I. Provide mitered elbows where space does not permit radius elbows, where shown on the drawings, or at the option of the contractor with the engineer's approval. The contractor shall obtain approval to substitute mitered elbows in lieu of radius elbows prior to fitting fabrication. Mitered elbows less than 45 degrees shall not require turning vanes. Mitered elbows 45-degrees and greater shall have single thickness turning vanes of same material and gauge as ductwork, rigidly fastened with guide strips in ductwork. Vanes for mitered elbows shall be provided in all supply and exhaust ductwork and in return and outside air ductwork that has an air velocity exceeding 1000 fpm. Do not install vanes in grease ductwork. Refer to Section "Ductwork Accessories" for turning vane construction and mounting.
- J. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- K. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.
- L. Round and Flat Oval Duct Fabrication
 - 1. General: "Basic Round Diameter" as used in this article is the diameter of the size of round duct that has a circumference equal to the perimeter of a given sized of flat oval duct. Except where interrupted by fittings, provide round and flat oval ducts in lengths not less than 12 feet.
 - a. Fabricate round and flat oval ductwork of minimum 26 gauge sheet metal.
- M. Round Ducts: Fabricate round supply ducts using seam types identified in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 3-2, RL-1, RL-4, or RL-5 except where

diameters exceed 72 inches. Seam Types RL-2 or RL-3 may be used for ducts smaller than 72 inches in diameter if spot-welded on 1-inch intervals. Fabricate ducts having diameters greater than 72 inches with longitudinal butt-welded seams. Comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Table 3-5 through 3-13 for galvanized steel gauges. For round duct with static pressure classification of 2 inches water gauge or lower, round supply ducts may be fabricated using snaplock seam types identified in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 3-2, RL-6A, RL-6B, RL-7 or RL-8.

N. Round and Flat Oval Fittings Fabrication

1. 90-Degree Tees and Laterals and Conical Tees: Fabricate to conform to SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figures 3-5, 3-6 and 3-7 and with metal thickness specified for longitudinal seam straight duct.
2. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.
3. Elbows: Unless elbow construction type is indicated, provide elbows meeting the following requirements:
 - a. Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate the bend radius of die-formed, gored, and pleated elbows 1.5 times the elbow diameter.
 - 1) Elbows in Round Duct: Provide full radius elbows.
 - 2) Elbows in Flat Oval Duct: Provide full radius elbows. Where space limits the installation of full radius elbows, short radius elbows with a minimum of two continuous splitter vanes shall be installed. Vane length shall be the entire length of the bend or 36 inches whichever is greater.
 - 3) The use of square throat, radius heel elbows is prohibited. Remove and replace all installed elbows of this type with an approved elbow at no additional cost to the owner.
 - 4) Provide full radius elbows for ductwork installed in noise critical spaces or where shown on the drawings. Refer to Section "Basic Mechanical Materials and Methods" for noise critical spaces.
 - b. Mitered Elbows: Fabricate mitered elbows with welded construction in gauges specified below.
 - 1) Mitered Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Table 3-1.
 - 2) Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from minus 2 inches to plus 2 inches:

- a) 3 to 26 inches: 24 gauge.
 - b) 27 to 36 inches: 22 gauge.
 - c) 37 to 50 inches: 20 gauge.
 - d) 52 to 60 inches: 18 gauge.
 - e) 62 to 84 inches: 16 gauge.
- 3) Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from 2 inches to 10 inches:
- a) 3 to 14 inches: 24 gauge.
 - b) 15 to 26 inches: 22 gauge.
 - c) 27 to 50 inches: 20 gauge.
 - d) 52 to 60 inches: 18 gauge.
 - e) 62 to 84 inches: 16 gauge.
- 4) 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems, or exhaust systems for material handling classes A and B; and only where space restrictions do not permit the use of 1.5 bend radius elbows. Fabricate with a single-thickness turning vane.
- c. Round Elbows - 8 Inches and Smaller: Die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 3-1/2- and 4-1/2-inch) elbows with gored construction.
 - d. Round Elbows - 9 Through 14 Inches: Gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 9-1/2- and 10-1/2-inch) elbows with gored construction.
 - e. Round Elbows - Larger Than 14 Inches and All Flat Oval Elbows: Gored elbows, except where space restrictions require a mitered elbow.
 - f. Die-Formed Elbows for Sizes Through 8 Inches and All Pressures: 20 gauge with 2-piece welded construction.
 - g. Round Gored Elbows Gauges: Same as for non-elbow fittings specified above.

- h. Pleated Elbows Sizes Through 14 Inches and Pressures Through 10 Inches: 26 gauge.
 - 1)
- 4. PVC-Coated Elbows and Fittings: Fabricate elbows and fittings as follows:
 - a. Round Elbows 4 to 8 Inches: 2-piece, die stamped, with longitudinal seams spot welded, bonded, and painted with a PVC aerosol spray.
 - b. Round Elbows 9 to 26 Inches: Standing seam construction.
 - c. Round Elbows 28 to 60 Inches: Standard gore construction, riveted and bonded.
 - d. Other Fittings: Riveted and bonded joints.
 - e. Couplings: Slip-joint construction with a minimum of a 2-inch insertion length.
- O. Shop Application of Liner in Rectangular Ducts
 - 1. Adhere a single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness is prohibited.
 - 2. Apply a coat of adhesive to liner facing in direction of airflow not receiving metal nosing.
 - 3. Butt transverse joints without gaps and coat joint with adhesive.
 - 4. Fold and compress liner in corners of rectangular ducts or cut and fit to assure butted edge overlapping.
 - 5. Longitudinal joints in rectangular ducts shall not occur except at corners of ducts, unless the size of the duct and standard liner product dimensions make longitudinal joints necessary.
 - a. Apply an adhesive coating on longitudinal seams in ducts exceeding 2,500 FPM air velocity.
 - 6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely around perimeter; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
 - 7. Secure transversely oriented liner edges facing the airstream with metal nosings that are either channel or "Z" profile or are integrally formed from the duct wall at the following locations:

- a. Fan discharge.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where duct velocity is greater than 2,500 FPM.
8. Terminate liner with duct buildouts installed in ducts to attach dampers, turning vane assemblies, and other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to the duct wall with bolts, screws, rivets, or welds. Terminate liner at fire dampers at connection to fire damper sleeve through fire separation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Install products in accordance with manufacturer's instructions.
- C. Install ducts with the fewest possible joints.
- D. Seal duct joints with the appropriate sealing material.
- E. Use fabricated fittings for all changes in directions, changes in size and shape, and connections.
- F. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.
- G. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.
- H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- I. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.
- J. Install insulated ducts with 1-inch clearance outside of insulation.
- K. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.

- L. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.
- M. Exposed Ductwork: Exposed ductwork shall be free of defects, dents or blemished surfaces to provide a smooth, finished appearance. Any damaged material shall be replaced with new material. Ductwork that is to be field painted shall have surfaces wiped clean of lubricant, dirt, or fil prior to priming and painting. Apply primer and paint of type as recommended by paint manufacturer for duct material and finish.
- N. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- O. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on 4 sides by at least 1-1/2 inches.
- P. Cover ducts openings during construction with duct caps or three-mil plastic to protect inside of (installed and delivered) ductwork from exposure to dust, dirt, paint and moisture. Do not use duct tape on ducts that will be exposed or painted.
- Q. Duct Liner Installation
 - 1. Fiberglass Duct Liner:
 - a. Attach fiberglass duct liner using fasteners that do not damage the liner when applied as recommended by the manufacturer, that do not cause leakage in the duct, and will indefinitely sustain a 50-pound tensile dead load test perpendicular to the duct wall.
 - 2. Flexible Elastomeric Duct Liner:
 - a. Install liner in accordance with the manufacturer's installation instructions or ASTM C 1710.
 - b. Attach flexible elastomeric duct liner to clean, oil-free sheet metal surfaces with adhesive as recommended by the liner manufacturer.
 - c. Seal all longitudinal seams and end joints with manufacturer's recommended adhesive and install compression joints in accordance with manufacturer's instructions to eliminate any openings in insulation that would allow passage of air to duct surface being insulated.
 - 3. Polyester Duct Liner:
 - a. Install polyester duct liner per SMACNA Manual, "HVAC Duct Construction Standards, Metal and Flexible," unless otherwise specified.
 - b. Attach polyester duct liner using a nonflammable, low VOC water based adhesive.

- c. Apply a nonflammable, low VOC water based lagging adhesive to the exposed leading edge of the insulation.
- d. Install fasteners per SMACNA HVAC Duct Liner installation instructions.

R. PVC-Coated Metal Ductwork

- 1. Install PVC-coated duct and fittings in accordance with the manufacturer's instructions.
- 2. Seal all joints and seams. Apply sealer to male end connectors before insertion, and afterwards to cover the entire joint and sheet metal screws.
- 3. Secure couplings with sheet metal screws. Install screws at an interval of 12 inches, with a minimum of 3 screws in each coupling.
- 4. Repair damage to PVC coating with manufacturer's recommended materials.

S. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

T. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

U. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.

V. Seam and Joint Sealing

- 1. General: Seal duct seams and joints as follows:
 - a. All transverse joints, longitudinal seams, and duct wall penetrations shall be sealed to meet SMACNA Seal Class A.
 - b. Seal class shall apply to all supply, return, outdoor air, and exhaust ductwork, regardless if the duct is positively or negatively pressurized. Transfer air ducts and sound boots do not need to be sealed.
- 2. Seal externally insulated ducts prior to insulation installation.
- 3. Ductwork installed exterior to the building shall have longitudinal and transverse joints welded or sealed airtight with weatherproof heavy liquid sealant applied according to manufacturer's instructions.

W. HANGING AND SUPPORTING

1. Install rigid round, rectangular, and flat oval metal duct with support systems per SMACNA standards.
2. The use of wire rope hanging systems is an acceptable alternate hanging method when installed in strict accordance with manufacturer's instructions. Wire rope hanger spacing shall not exceed 8 feet. Supported load shall not exceed manufacturer's recommended load rating.
 - a. Where approved by local code authority, the loop system may be swaged directly on to a seismic approved bracket or appropriate end fixing.
3. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.
4. Support vertical ducts at a maximum interval of 16 feet and at each floor.
5. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated. Hangers and supports shall be fastened to building joists or beams. Do not attach hangers and supports to the above floor slab or roof with sheet metal screws.
6. Install concrete insert prior to placing concrete.
7. Install powder actuated concrete fasteners after concrete is placed and completely cured.
8. Provide double nuts and lock washers on threaded rod supports.
9. 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.

X. Penetrations

1. Exterior Wall Penetrations: Seal duct penetrations through exterior wall constructions with sleeves, packing, and sealant. Refer to Division 23 Section "Basic Piping Materials and Methods" for additional information.
2. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of No-Fire Rated Walls and Concrete Slab on Grade Penetrations: Seal ducts that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 23 Section "Basic Piping Materials and Methods" for special sealers and materials.

Y. CONNECTIONS

1. Equipment Connections: Connect equipment with flexible connectors in accordance with Division 23 Section "Air Duct Accessories."

2. Branch Connections: Comply with SMACNA "HVAC Duct Construction Standards".
3. Outlet and Inlet Connections: Comply with SMACNA "HVAC Duct Construction Standards". Where a 90-degree elbow is required at the connection to air devices, provide a rigid duct elbow or, at Contractor's option, a flexible elbow assembly as specified in Division 23 Section "Air Duct Accessories."
4. Fan Connections: Comply with SMACNA "HVAC Duct Construction Standards".

3.2 FIELD QUALITY CONTROL

- A. The Owner will contract with an independent testing agency to perform, record, and report leakage tests.
- B. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.
- C. General Duct Systems: Perform leakage tests in accordance with ASHRAE and SMACNA standards.
 1. Disassemble, reassemble, and seal segments of the systems as required to accommodate leakage testing, and as required for compliance with test requirements.
 2. Conduct tests, in the presence of the Architect, at static pressures equal to the maximum design pressure of the system or the section being tested. If pressure classifications are not indicated, test entire system at the maximum system design pressure. Do not pressurize systems above the maximum design operating pressure. Give 7 days' advanced notice for testing. Submit a letter report to the Owner and Engineer summarizing the test procedures followed, systems tested and the results of the leakage tests.
 3. Determine leakage from entire system or section of the system by relating leakage to the surface area of the test section.
 4. Maximum Allowable Leakage: As described in ASHRAE 2005 Handbook, "Fundamentals" Volume, Chapter 35, Table 9 and Figure 13. Comply with requirements for leakage classification 3 for round and flat oval ducts, leakage classification 12 for rectangular ducts in pressure classifications less than and equal to 2 inches water gauge (both positive and negative pressures), and leakage classification 6 for pressure classifications greater than 2 inches water gauge and less than and equal to 10 inches water gauge.
 5. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.
 6. Leakage Test: Perform volumetric measurements and adjust air systems as described in ASHRAE 2003 "HVAC Applications" Volume, Chapter 37 and ASHRAE 2005 "Fundamentals" Volume, Chapter 14, and Division 23 Section "TESTING, ADJUSTING, AND BALANCING FOR HVAC."

- D. Ductwork with Pressure Rating > 3" W.C.: Ducts and plenums shall be leak tested in accordance with SMACNA HVAC Air Duct Leakage Test Manual to prove they meet leakage classification less than or equal to 6. Submit test reports to the Engineer of Record demonstrating that at least 25 percent of the installed duct area has been tested and pass this test.

3.3 ADJUSTING, STARTUP

- A. Adjust volume control devices as required by the testing and balancing procedures to achieve required air flow. Refer to Division 23 Section "TESTING, ADJUSTING, AND BALANCING FOR HVAC" for requirements and procedures for adjusting and balancing air systems.
- B. Remove temporary protection devices over ductwork prior to starting equipment and turning the system over to the owner.
- C. If permanent HVAC equipment is used during the construction period, provide temporary filters at all openings in the ductwork and at inside equipment to protect the system from dust, dirt, paint, and moisture. Replace and maintain filters when needed, but not less than every month. On the day of substantial completion, clean the duct system and provide a new set of filters in the HVAC unit.
 - 1. Refer to Division 23 Section 234100 Particulate Air Filtration for filter requirements.

END OF SECTION 233113

DOCUMENT 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Turning vanes.
- B. Backdraft dampers.
- C. Duct access doors.
- D. Duct hardware.
- E. Flexible duct connectors.
- F. Volume control dampers.
- G. Duct opening closure film.
- H. Cable operated damper systems.
- I. Flexible ductwork.
- J. Flexible elbow assembly.

1.2 REFERENCE STANDARDS

- A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating.
- B. ASTM A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- D. ASTM E477 - Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
- E. ASTM E814 - Standard Test Methods of Fire Resistance of Through-Penetration Fire Stops.
- F. ISO 6944 - Fire Containment — Elements of Building Construction.
- G. - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- H. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- I. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
- J. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.

- K. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.
- L. UL 181 - Factory-Made Air Ducts and Connections.
- M. UL 263 - Standard for Fire Tests of Building Construction and Materials; Current Edition, Including All Revisions.

1.3 SUBMITTALS

- A. Product Data: Provide for each type of ductwork accessory the following:
 - 1. Electrical characteristics.
 - 2. Connection requirements.
 - 3. Dimensions.
 - 4. Capacities.
 - 5. Pressure drops,
 - 6. Leakage rates.
 - 7. Materials of construction.
- B. Shop Drawings: Indicate for shop fabricated assemblies the following:
 - 1. Interfacing requirements with ductwork.
 - 2. Method of fastening or support.
 - 3. Methods of assembly of components.
- C. Performance Data: Submit performance data for duct silencers including insertion loss performance in octave bands from 63 Hz to 8,000 Hz and pressure drop at specified airflow.
- D. Project Record Drawings: Record actual locations of access doors and test holes.
- E. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. SMACNA Compliance: Comply with applicable portions of SMACNA (DCS).
- C. UL Compliance:

1. Flexible Ductwork: Construct flexible ductwork in compliance with UL Standard 181.
 2. Duct Tape: Label in accordance with UL Standard 181B and marked 181B-FX.
 3. Duct Clamps: Label in accordance with UL Standard 181B and marked 181B-C.
- D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated
- E. NFPA Compliance:
1. Comply with applicable provisions of NFPA 90A and NFPA 90B pertaining to installation of ductwork accessories.
 2. Comply with NFPA 96 for fire-rated grease exhaust ducts.
- F. ASTM Compliance: Products shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 "Surface Burning Characteristics" (NFPA 255) method.
- 1.5 DELIVERY, STORAGE, AND HANDLING
- A. Protect ductwork accessories during shipping and storage from dirt, debris and moisture damage.
 - B. Protect dampers from damage to operating linkages and blades.
- 1.6 SPARE PARTS
- A. Extra Fusible Links: One link for every 10 installed of each type, size and temperature range. Obtain receipt.

PART 2 - PRODUCTS

2.1 TURNING VANES

- A. Manufacturer:
1. Aero Dyne Co.
 2. Anemostat Products Div.; Dynamics Corp. of America.
 3. Ductmate Industries.
 4. Duro Dyne Corp.
 5. Elgen Manufacturing Co., Inc.
 6. Hart & Cooley Mfg. Co.
 7. Register & Grille Mfg. Co., Inc

8. Sheet Metal Connectors, Inc.

- B. Manufactured Turning Vanes: Provide turning vanes and runners fabricated from galvanized sheet metal, lock-forming quality, ASTM A 653, minimum Coating Designation G 60, of the same gauge thickness or greater as the ductwork in which they are installed.

1. Vanes shall be rigidly fastened with guide strips to minimize noise and vibration.
2. Vanes in ductwork over 30" deep shall be installed in multiple sections with vanes not over 30" long and shall be rigidly fastened.
3. Turning vanes shall be constructed per SMACNA Duct Construction Standards Metal and Flexible – 2005 Edition, Figure 4-3 and set into side strips suitable for mounting in ductwork.

2.2 BACKDRAFT DAMPERS

- A. Manufacturers:

1. Air Balance, Inc.
2. Arrow United Industries.
3. Cesco
4. Greenheck
5. Louvers & Dampers, Inc.
6. Nailor Industries, Inc.
7. Pottorff
8. Ruskin Mfg. Co.
9. TAMCO
10. Vent Products

- B. Backdraft Dampers: Provide dampers with parallel blades, counterbalanced and factory-set to open at indicated static pressure. Provide adjustment device to permit setting for varying differential static pressure

1. Construct frames of minimum 16 gauge galvanized steel or 10 gauge aluminum.
2. Construct blades of minimum 16 gauge aluminum.
3. Provide minimum 1/2" diameter, corrosion-resistant bearings and 1/2" diameter, galvanized or stainless steel axles.

4. Mechanically lock blade edge seals into blade edge. Provide neoprene seals for round dampers and silicone or vinyl seals for rectangular dampers.

2.3 DUCT ACCESS DOORS

A. Manufacturers:

1. Air Balance Inc.
2. Ductmate Industries.
3. Duro Dyne Corp.
4. Greenheck.
5. Register & Grille Mfg. Co., Inc.
6. Ruskin Mfg. Co.
7. Ventifabrics, Inc.
8. Vent Products.
9. Zurn Industries, Inc.; Air Systems Div.

B. Provide, where indicated on the drawings or where specified in Part 3 of this section, duct access doors of size allowable by duct dimensions with, unless otherwise noted on the drawings, minimum size of 10" by 10" and maximum size of 24" by 24". Fabricate in accordance with SMACNA (DCS) and as indicated. Label access doors for fire and smoke dampers as specified in Part 3.

C. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. Construct of same or greater gauge as ductwork served. For insulated ductwork, install minimum 1 inch thick insulation with sheet metal cover. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct.

1. 12 inches square or less: Provide one size hinged, other side with one handle-type latch for doors 12" high and smaller, 2 handle-type latches for larger doors. Provide removable section of duct where duct size is too small for a 10" by 10" access door.
2. Larger than 12 inches square: Provide two hinges and two handle-type latches.

2.4 DUCT HARDWARE

A. Manufacturers:

1. Ductmate Industries.
2. Elgen Manufacturing Co., Inc.
3. Ventfabrics, Inc.

4. Young Regulator Co.

B. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated.

1. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
2. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

C. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

2.5 FLEXIBLE DUCT CONNECTORS

A. Manufacturers:

1. Carlisle HVAC Products.
2. Ductmate Industries.
3. Duro Dyne Corp.
4. Elgen Manufacturing Co., Inc.
5. Ventfabrics, Inc.

B. Fabricate in accordance with SMACNA (DCS) and as indicated. Flexible connectors shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

C. Flexible Duct Connections: Fabric crimped into metal edging strip. Provide metal compatible with connected ducts. Factory fabricated. Flame-retardant or noncombustible fabrics compliant with NFPA 701.

1. Indoor Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric compliant with NFPA 90A.
 - a. Minimum Weight: 26 oz./sq. yd.
 - b. Minimum Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - c. Service Temperature: Minus 40 to plus 200 deg F.
2. Metal: Factory fabricated with a fabric strip minimum 3-1/2 inches wide attached to two strips of minimum 24 gauge galvanized sheet steel or 0.032-inch- thick aluminum.

D. Maximum Installed Length: 14 inch.

E. Coatings and Adhesives: Comply with UL 181, Class 1.

2.6 VOLUME CONTROL DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. Arrow United Industries
3. Cesco
4. Greenheck
5. Louvers & Dampers, Inc.
6. Nailor Industries, Inc.
7. Pottorff
8. Rossi Air Flow
9. Ruskin Mfg. Co.
10. TAMCO
11. Vent Products

B. Fabricate dampers in accordance with SMACNA (DCS) and as indicated. Construct using galvanized steel for standard air systems, aluminum for wet or natatorium environments and stainless steel for corrosive environments.

C. Single Blade Dampers:

1. Fabricate for duct sizes up to 12 x 36 inch.
2. Blade: 20 gauge, 0.04 inch, minimum.

D. Multi-Blade Damper: Fabricate of parallel or opposed blade pattern with maximum blade sizes 8 by 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

1. Blade: 18 gauge, 0.0478 inch, minimum.

E. Bearings: Corrosion resistant, molded synthetic.

F. Axles: Positively lock into the damper blade.

G. Blade Seals: Where used for shutoff duty, provide Neoprene seals for round dampers and silicone for rectangular dampers.

H. Quadrants:.

1. Provide locking, indicating quadrant regulators.
2. On insulated ducts, provide extended shafts and mount regulator on standoff bracket, base or adapter.
3. Where rod lengths exceed 48 inches, provide regulator at both ends.

2.7 DUCT OPENING CLOSURE FILM

- A. Mold-resistant, self-adhesive film to keep debris out of ducts during construction.
- B. Thickness: 2 mils.
- C. High tack water-based adhesive.
- D. UV stable.
- E. Elongation Before Break: 325 percent, minimum.

2.8 CABLE OPERATED DAMPER SYSTEMS

- A. Manufacturer:
 1. DuroDyne, DuroZone.
 2. Metropolitan Air Technology, Inc. (Reference model number for round damper is RT-250 and for rectangular damper is RT-200).
 3. Young Regulator Co. (Reference model number is 270).
- B. General: Where access to dampers through a hard ceiling is required, provide a concealed, remote cable-operated, butterfly-type volume damper assembly with external worm gear operator.
- C. Damper assembly shall include duct casing with rolled bead stiffeners, reinforced blade, self-lubricating bearing, and remote operator mounting plate.
- D. Adjustable through the diffuser frame with standard 1/4 inch nut-driver or flat screwdriver.
- E. Cable assembly shall attach to damper as a single piece with no linkage adjustment required.
- F. Positive, direct, two-way damper control with no sleeves, springs or screw adjustments to come loose after installation.
- G. Cable length as required to span the distance from the damper to the remote operator location.
- H. Where approved by Architect, a ceiling cup with cover plate can be used for access to cable operator.

2.9 FLEXIBLE DUCTWORK

- A. Manufacturers:

1. ATCO Rubber Products.
 2. Flexmaster.
 3. JPL (J.P. Lamborn Co)
 4. Thermaflex.
- B. Construction: Provide flexible ductwork conforming to UL 181-Class I, NFPA 90A and NFPA 90B and as follows. Duct types of manufacturers are indicated for reference in regard to required quality of construction and materials.
- C. Insulated Flexible Ductwork: Provide duct fabric of ply-vinyl film, polyethylene film or multiple layers of aluminum laminate supported by helically wound spring steel wire. Wrap fabric with fiberglass insulation and provide fire retardant polyethylene or reinforced metalized protective vapor barrier as specified herein.
1. Duct pressure class up to and including 6" w.g.
 - a. Fire retardant polyethylene vapor barrier
 - 1) ATCO 80 Series
 - 2) Flexmaster Type 5B
 - 3) JPL Type PR Series
 - 4) Thermaflex Type G-KM
 - b. Reinforced metalized vapor barrier
 - 1) ATCO 30 Series
 - 2) Flexmaster Type 5M
 - 3) JPL Type MHP Series
 - 4) Thermaflex Type M-KE
 2. Flexible ductwork shall have CPE liner with steel wire helix mechanically locked or permanently bonded to the liner.
 3. Provide acoustical, fiberglass insulated duct with minimum R-value of R-8.0.
- 2.10 FLEXIBLE ELBOW ASSEMBLY
- A. Manufacturers:
1. Build Right Products, FlexRight Elbow.
 2. Flexible Technologies, Inc., FlexFlow Elbow.

3. Titus, FlexRight.

- B. General: At Contractors option, in lieu of rigid sheet metal elbows at connections to air inlets and outlets in concealed spaces, provide flexible elbow assembly to air devices requiring a 90 degree elbow connection.
- C. Flexible elbow assembly shall be constructed of durable composite material and UL listed for use in return air plenums with a turning radius of not less than 3 inches.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF DUCTWORK ACCESSORIES

- A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Provide turning vanes, of same gauge as ductwork, rigidly fastened with guide strips in ductwork having an offset of 45 degrees or more. Provide vanes in all supply and exhaust ductwork and in return and outside air ductwork that has an air velocity exceeding 1000 fpm. Do not install vanes in grease or dryer exhaust ductwork.
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Provide duct access doors to maintain and/or clean components internal to ductwork including, but not limited to, coils, airflow stations, motorized and backdraft dampers, humidifiers, etc, Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.
 - 1. Provide duct access door(s) as scheduled below, at each fire and smoke damper within 12 inches of the device to allow for testing and maintenance. Label each door (with minimum 1" lettering) indicating which damper type is served. Door shall be capable of being fully opened or provide removable door.

DUCT ACCESS DOOR SCHEDULE

Duct Width/Depth	Door Size	Quantity
10" TO 12"	10 X 10	1
14" TO 18"	12 X 12	1
20" TO 36"	14 X 14	1
38" TO 54"	18 X 18	1
56" TO 72"	18 X 18	2 (1 EACH END)
74" TO 96"	20 X 20	2 (1 EACH END)

2. Provide duct access doors for cleaning kitchen exhaust ducts in accordance with NFPA 96. Review locations prior to fabrication.
- E. Provide flexible duct connections wherever ductwork connects to vibrating equipment and when transitioning between two different metallic duct materials (e.g., aluminum to galvanized steel). Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibration of connected equipment.
1. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
 2. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.
- F. Provide volume control dampers at branch takeoffs from main ducts. Unless otherwise noted on drawings, provide prefabricated 45 degree, high efficiency, rectangular/round branch duct takeoff fittings with manual volume control damper and locking quadrant for branch duct connections and take-offs to individual diffusers, registers and grilles.
- G. Provide cable operated volume dampers with remote operators where access to dampers through a hard ceiling is required.
1. Support cable assembly to avoid bends and kinks in cable.
- H. Install flexible ductwork in accordance with manufacturer's instructions. At a minimum, install two wraps of duct tape around the inner core connection and a metallic or non-metallic clamp over the tape and two wraps of duct tape or a clamp over the outer jacket.
1. Flexible ductwork runs shall not exceed 5 feet in length. Utilize the minimum length of duct to make the connections.
 2. Install flexible ductwork straight as possible avoiding tight turns with a maximum of one 90 degree bend in any length. Install flexible ductwork fully extended minimizing compression.
 3. Provide continuous length with no intermediate joints.
 4. Support flexible ductwork from structure and not from ceiling tile, light fixtures or air terminals. Support for maximum sag of 1/2-inch per foot.
 5. Avoid incidental contact with metal fixtures, water lines, pipes, or conduit.

6. Support straps/saddles shall be minimum 1-1/4" wide. Use of wire hanging systems shall utilize strap and connect wire to strap.
 - a. Factory installed suspension systems are acceptable
7. Do not crimp flexible ductwork against joist or truss members, pipes, conduits, etc.
8. Install flexible ductwork with bend radius at the center line equal to or greater than one duct diameter.
 - a. Support bends approximately one duct diameter on both sides of bends.
9. Connect flexible ductwork to sheet metal ductwork and air devices with at least 1" overlap.
- I. Provide rigid duct elbow or flexible elbow assembly where a 90 degree elbow is required at connection to air devices.
- J. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.3 FIELD QUALITY CONTROL

- A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.
- B. After start-up, final corrections and balancing of systems, test duct silencers by taking octave band sound measurements over full audio frequency range in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and other critical locations, as directed. Refer to Division 23 Section "Testing, Adjusting and Balancing of HVAC" for additional requirements.
 1. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements.
 2. Submit complete report of test results including sound curves.

3.4 ADJUSTING AND CLEANING

- A. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.
- B. Label access doors in accordance with Division-23 section "Identification for HVAC Piping and Equipment".
- C. Final positioning of manual dampers is specified in Division-23 section "Testing, Adjusting, and Balancing for HVAC".
- D. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF DOCUMENT 233300

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AIR DUCT ACCESSORIES

DOCUMENT 233413 - AXIAL HVAC FANS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. High Volume Low Speed (HVLS) fans.

1.2 REFERENCE STANDARDS

- A. AMCA 99 – Standards Handbook.
- B. AMCA 204 – Balance Quality and Vibration Levels for Fans.
- C. AMCA 210 – Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
- D. AMCA 230 – Laboratory Methods of Testing Air Circulation Fans for Rating and Certification.
- E. AMCA 300 – Reverberant Room method for Sound Testing of Fans.
- F. AMCA 301 – Certified Ratings Program Product Rating manual for Fan Sound Performance.
- G. AMCA 311 – Certified Ratings Program Product Rating Manual for Fan Sound Performance.

1.3 SUBMITTALS

- A. General: Submit data in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements. Include the following:
 - 1. For fans with factory-furnished starters or variable frequency drives, include short circuit current ratings.
 - 2. Materials gages and finishes, including color charts.
 - 3. Dampers, including housings, linkages, and operators.
- C. Shop Drawings: Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.
- D. Wiring Diagrams: Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field-installed wiring.
- E. Maintenance Data: Include instructions for lubrication, motor and drive replacement and spare parts list.

1.4 QUALITY ASSURANCE

A. AMCA Compliance:

1. Provide HVLS fans that are tested and labeled in accordance with AMCA 230.

B. UL Compliance: Fans and components shall be UL listed and labeled.

1. Fans used in grease exhaust applications shall be certified in accordance with UL 762.

C. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Fans and components shall be NRTL listed and labeled. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

D. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

E. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect motors, shafts, and bearings from weather and construction dust.

1.6 FIELD CONDITIONS

A. Permanent fans may be used for ventilation during construction only after ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

PART 2 - PRODUCTS

2.1 FANS, GENERAL

A. General: Provide fans that are factory fabricated and assembled, factory tested, and factory finished with indicated capacities and characteristics.

B. Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.

1. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fan's class.

C. Motors: Refer to Section "Common Motor Requirements for HVAC Equipment" for requirements.

2.2 HVLS FANS

A. Manufacturers:

1. Altra Air
2. Big Ass Fans.

3. Epic.
 4. Greenheck.
 5. Kelley Company
 6. Macro Air Technology
 7. Rite Hite
 8. SkyBlade
- B. General Description: Propeller-type fans 6 feet in diameter and larger consisting of fan blades, hub, mounting system, drive, motor, and fan controller.
- C. Fan Blades: Aluminum alloy, airfoil design.
- D. Hub: Cast aluminum alloy incorporating 1/4" or greater steel safety clips to restrain the hub/airfoil assembly in case of shaft failure.
- E. Fan Drive:
1. Bevel Gear Reducer: High efficiency, helical gear reducer with a cast iron housing, designed for low noise and long service life with a backlash of less than 20 arc-minutes. Output shaft shall be stainless steel. Gear reducer shall be permanently lubricated and be assembled with double lip seals to prevent contamination or oil leakage.
 2. Gearless, direct drive.
- F. Motor and Frame: 1750 RPM, 208-230/460 VAC, 60 Hz, 3 phase, inverter rated with class F insulation, 40 degrees C Ambient-Continuous. Provide HP as scheduled or as applicable. Motor frame and mount shall be constructed of minimum 3/16" powder-coated steel.
- G. Mounting System: Designed for secure mounting of fan from overhead support structure with extension rod. Mount shall be constructed of minimum 3/16" powder-coated steel. Provide minimum 1/4" 7x19 steel safety cable to secure fan assembly to structure.
- H. Fan Controller:
1. Auxiliary contacts to shutdown fan upon notification from fire alarm system.
 2. Industrial Control Panel constructed per UL 508A and NEC.
 3. Factory programmed Variable Frequency Drive (VFD) for soft start and infinite speed control.
 4. Size VFD for motor full load amp rating.
 5. Provide overload relay for each motor when VFD controls multiple fans.

6. Provide fan on/off/auto switch, speed control potentiometer, safety disconnect and properly sized fuse block.
7. Provide NEMA Type 1 controls enclosure.

PART 3 - EXECUTION

3.1 SEQUENCING AND SCHEDULING

- A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad.
- B. Coordinate the size and location of structural steel support members.

3.2 INSTALLATION

- A. Install fans level and plumb, in accordance with manufacturer's written instructions.
- B. Support units using the vibration control devices indicated and specified in Division 23 Section "Vibration Isolation for HVAC Piping and Equipment."
- C. Arrange installation to provide access space around fans for service and maintenance.
- D. Provide safety screen where inlet or outlet is exposed.
- E. Install extension rod to maintain minimum 3 feet vertical clearance between HVLS fan blades and sprinkler deflectors according to NFPA 13.

3.3 ADJUSTING, CLEANING, AND PROTECTING

- A. Adjust damper linkages for proper damper operation.
- B. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

3.4 STARTUP

- A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:
 1. Remove shipping blocking and bracing.
 2. Verify fan assembly is secure on mountings and supporting devices and that connections for ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
 3. Perform cleaning and adjusting specified in this Section.
 4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
 5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.

6. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.
7. Disable automatic temperature control operators.

B. Starting procedures for fans:

1. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
 - a. Replace fan and motor pulleys as required to achieve design conditions.
 - b. Measure and record motor electrical values for voltage and amperage.
 - c. Shut unit down and reconnect automatic temperature control operators.
 - d. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for air-handling-system testing, adjusting, and balancing.

3.5 DEMONSTRATION

A. Demonstration Services: Train Owner's maintenance personnel on the following:

1. Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 1 Section "Closeout Procedures" and Division 23 Section "General Mechanical Requirements."

B. Schedule training with at least 7 days' advance notice.

END OF DOCUMENT 233413

DOCUMENT 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Inline centrifugal fans.

1.2 REFERENCE STANDARDS

- A. AMCA 99 – Standards Handbook.
- B. AMCA 204 – Balance Quality and Vibration Levels for Fans.
- C. AMCA 210 – Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
- D. AMCA 300 – Reverberant Room method for Sound Testing of Fans.
- E. AMCA 301 – Certified Ratings Program Product Rating manual for Fan Sound Performance.
- F. AMCA 311 – Certified Ratings Program Product Rating Manual for Fan Sound Performance.
- G. NFPA 96 – Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- H. UL 705 – Power Ventilators; Current Edition Including all Revisions.
- I. UL 762 – Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances; Current Edition Including all Revisions.

1.3 SUBMITTALS

- A. General: Submit data in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements. Include the following:
 - 1. For fans with factory-furnished starters or variable frequency drives, include short circuit current ratings.
 - 2. Materials gages and finishes, including color charts.
 - 3. Dampers, including housings, linkages, and operators.

- C. Shop Drawings: Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.
- D. Wiring Diagrams: Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field-installed wiring.
- E. Maintenance Data: Include instructions for lubrication, motor and drive replacement and spare parts list.

1.4 QUALITY ASSURANCE

- A. AMCA Compliance: Provide products that meet AMCA certified performance and sound ratings and are licensed to use the AMCA Seal.
- B. UL Compliance: Fans and fan motors shall be designed, manufactured, and tested in accordance with UL 705 "Power Ventilators."
- C. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Fans and components shall be NRTL listed and labeled. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.
- D. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- E. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors, shafts, and bearings from weather and construction dust.

1.6 FIELD CONDITIONS

- A. Permanent fans may be used for ventilation during construction only after ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

PART 2 - PRODUCTS

2.1 POWER VENTILATORS - GENERAL

- A. General: Provide fans that are factory fabricated and assembled, factory tested, and factory finished; with indicated capacities and characteristics.
- B. Statically and Dynamically Balanced: Fans and shafts shall be statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.
 - 1. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fan's class.

- C. Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA Standard 210.
- D. Sound Ratings: Comply with AMCA 301. Test fans in accordance with AMCA Standard 300.
- E. Fabrication: Comply with AMCA 99.
- F. Motors: Refer to Section "Common Motor Requirements for HVAC Equipment" for requirements.
- G. Motor and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15 HP; fixed pitch for use with motors larger than 15 HP. Select pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions.
 - 1. Belt Guards: Provide steel belt guards for motors mounted on the outside of the fan cabinet.
- H. Hazardous Duty: Provide fans with spark resistant construction and explosion proof motor where specified in the schedule.
- I. Factory Finish: The following finishes are required:
 - 1. Sheet Metal Parts: Prime coating prior to final assembly.
 - 2. Exterior Surfaces: Baked-enamel finish coat after assembly.

2.2 INLINE CENTRIFUGAL FANS

- A. Manufacturers:
 - 1. Acme Engrg. & Mfg. Corp.
 - 2. CaptiveAire
 - 3. Carnes Company, Inc.
 - 4. Cook (Loren) Co.
 - 5. Greenheck Fan Corp.
 - 6. PennBarry.
 - 7. Twin City Fan Company
- B. Fan Unit: Inline, belt or direct driven, centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, drive assembly, motor and disconnect switch, mounting brackets, and accessories.

- C. Housing: Galvanized steel or split, spun-aluminum housing, with straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- D. Wheel: Aluminum, forward curved, backward inclined or airfoil blades welded to aluminum hub.
- E. Direct-Drive Units: Motor encased in housing out of air stream, factory-wired to disconnect located on outside of fan housing.
- F. Accessories: Provide the following accessories as indicated:
 - 1. Volume Control Damper: Manual operated with quadrant lock, located in fan outlet.
 - 2. Companion Flanges: For inlet and outlet duct connections.
 - 3. Speed Control: Variable speed switch with on-off control and speed control for 100 to 50 percent of fan air delivery.

PART 3 - EXECUTION

3.1 SEQUENCING AND SCHEDULING

- A. Coordinate the size and location of structural steel support members.

3.2 INSTALLATION

- A. Install fans level and plumb, in accordance with manufacturer's written instructions.
- B. Install vibration isolation for equipment as specified in Division 23 Section "Vibration Isolation for HVAC Piping and Equipment."
- C. Arrange installation to provide access space around fans for service and maintenance.

3.3 ADJUSTING, CLEANING, AND PROTECTING

- A. Adjust damper linkages for proper damper operation.
- B. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

3.4 STARTUP

- A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:
 - 1. Remove shipping blocking and bracing.

2. Verify fan assembly is secure on mountings and supporting devices and that connections for ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
3. Perform cleaning and adjusting specified in this Section.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
6. Verify manual and automatic volume control and that fire and smoke dampers in connected ductwork systems are in the full-open position.
7. Disable automatic temperature control operators.

B. Starting procedures for fans:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
 - a. Replace fan and motor pulleys as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Shut unit down and reconnect automatic temperature control operators.
4. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for air-handling-system testing, adjusting, and balancing.

3.5 DEMONSTRATION

A. Demonstration Services: Train Owner's maintenance personnel on the following:

1. Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 1 Section "Closeout Procedures" and Division 23 Section "General Mechanical Requirements."

B. Schedule training with at least 7 days' advance notice.

END OF DOCUMENT 233423

DOCUMENT 233713 - DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Ceiling air diffusers.
- B. Registers and grilles.
- C. Linear slot diffusers.
- D. Louvers.

1.2 REFERENCE STANDARDS

- A. ADC 1062 – Certification, Rating and Test Manual.
- B. AHRI 880 – Performance Rating of Air Terminals.
- C. AHRI 885 – Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets (with Addendum 1)
- D. AMCA 500 – Test Method for Louvers, Dampers and Shutters.
- E. AMCA Standard 540 – Test Method for Louvers Impacted by Windborne Debris.
- F. AMCA Standard 550 – Test Method for High Velocity Wind Driven Rain Resistant Louvers.
- G. ASHRAE 70 – Method of Testing the Performance of Air Outlets and Inlets.
- H. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
- I. Test.
- J. NFPA 90A – Standard for the Installation of Air Conditioning and Ventilating Systems.
- K. – Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- L. UL 723 – Standard for Test for Surface Burning Characteristics of Building Materials.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:
 - 1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.
 - 2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details. Indicate selections on product data.

3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses; throw and drop; and noise criteria ratings at specified airflows.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.
- C. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.
- D. Coordination Drawings: Reflected ceiling plans and wall elevations drawn to scale to show locations and coordination of diffusers, registers, and grilles with other items installed in ceilings and walls.
- E. Color Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for diffusers, registers, and grilles with factory-applied color finishes.

1.4 QUALITY ASSURANCE

- A. Test and rate air outlets and inlets in accordance with ASHRAE 70.
- B. Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062.
- C. Provide air outlets and inlets bearing ADC Certified Rating Seal.
- D. Test and rate sound data for air outlets and inlets in accordance with AHRI 885.
- E. Install air outlets and inlets in accordance with NFPA 90A.
- F. Test and rate louvers in accordance with AMCA 500.

1.5 SPARE PARTS

- A. Furnish to Owner, with receipt, 3 operating keys for each type of air outlet and inlet that require them.

PART 2 - PRODUCTS

2.1 CEILING AIR DIFFUSERS

- A. Manufacturers
 1. Carnes Co.
 2. Greenheck.
 3. Krueger Mfg. Co.
 4. Metalaire; Metal Industries, Inc.
 5. Nailor Industries, Inc.

6. Price Industries, Inc.
 7. Titus HVAC
 8. Tuttle & Bailey; Div. of Air Systems Components, Inc.
- B. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.
- C. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- D. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.
- E. Types: Provide ceiling air diffusers of type, capacity, and with accessories and finishes as scheduled on the drawings.

2.2 REGISTERS AND GRILLES

- A. Manufacturers
1. Carnes Co.
 2. Greenheck.
 3. Krueger Mfg. Co.
 4. Metalaire; Metal Industries, Inc.
 5. Nailor Industries, Inc.
 6. Price Industries, Inc.
 7. Titus HVAC
 8. Tuttle & Bailey; Div. of Air Systems Components, Inc.
- B. General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.
- C. Performance: Provide registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.

- D. Ceiling Compatibility: Provide registers and grilles with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of register and grille.
- E. Wall Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.
- F. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as scheduled on the drawings.

2.3 LINEAR SLOT DIFFUSERS

- A. Manufacturers
 - 1. Carnes Co.
 - 2. Greenheck.
 - 3. Krueger Mfg. Co.
 - 4. Metalaire; Metal Industries, Inc.
 - 5. Nailor Industries, Inc.
 - 6. Price Industries, Inc.
 - 7. Titus HVAC
 - 8. Tuttle & Bailey; Div. of Air Systems Components, Inc.
- B. General: Except as otherwise indicated, provide manufacturer's standard linear slot diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.
- C. Performance: Provide linear slot diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- D. Compatibility: Provide linear slot diffusers with border styles that are compatible with adjacent ceiling or wall systems, and that are specifically manufactured to fit into ceiling or wall with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling and wall systems which will contain each type of linear slot diffuser.
- E. Linear Slot Diffusers: Slot diffusers shall be standard one-piece lengths up to 6-feet and shall be furnished in multiple sections greater than 6-feet.
 - 1. Provide straight and curved sections as required to accommodate layout shown on the drawings.

2. Multiple sections shall be joined together end-to-end with alignment pins to form a continuous slot appearance. All alignment components shall be provided by the manufacturer.
3. Where specified on the drawings, plenums shall be manufactured by the slot diffuser manufacturer. Plenums shall be internally insulated, by the manufacturer, with minimum 1/4" thick, closed-cell insulation. Insulation shall not be made of fibrous material.

- F. Types: Provide linear slot diffusers of type, capacity, and with accessories and finishes as scheduled on the drawings.

2.4 LOUVERS

- A. Manufacturers: Subject to compliance with requirements, provide louvers of one of the following:

1. American Warming & Ventilating Inc.
2. Arrow United Industries, Inc.
3. Carnes Co.; Div. of Wehr Corp.
4. Cesco
5. Greenheck
6. Industrial Louvers, Inc.
7. Louvers & Dampers, Inc.
8. Nailor Industries, Inc.
9. Pottorff
10. Ruskin Mfg. Co.
11. Tampco.

- B. General: Except as otherwise indicated, provide manufacturer's standard louvers as scheduled or indicated on the drawings; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.

- C. Performance: Provide louvers that have minimum free area, and maximum pressure drop of each type as listed in manufacturer's current data, complying with louver schedule.

1. Structural Performance: Louvers shall withstand the effects of gravity loads and wind and/or seismic loads as defined in the applicable building code for the installed location without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

2. Windborne-Debris Impact Resistance: Louvers located within 30 feet of grade shall comply with AMCA 540.
 3. Wind Driven Rain Performance: Louvers shall comply with ANSI/AMCA 500L for wind driven rain performance. Louvers shall have not less than 99 percent effectiveness when subjected to wind velocities of 29 and 50 mph with rainfall rates of 3 in/hr and 8 in/hr respectively and a core intake velocity not less than what is scheduled on the plans.
- D. Substrate Compatibility: Provide louvers with frame and sill styles that are compatible with adjacent substrate, and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to general construction drawings and specifications for types of substrate which will contain each type of louver.
 - E. Materials: Construct of aluminum extrusions, ASTM B 221, Alloy 6063-T52. Weld units or use stainless steel fasteners.
 - F. Louver Screens: On inside face of exterior louvers, provide 1/2" square mesh anodized aluminum wire bird screens mounted in removable extruded aluminum frames.
 - G. Louver Supports: Louver design shall limit span between visible mullions to 10' and shall incorporate structural supports required to withstand a wind load of 20 lbs. per sq. ft.
 - H. Intermediate Blade Supports: Where needed blade supports shall be provided by louver manufacturer on the rear of blade only.
 - I. Louver Blank-Off Panels: Blank off any unused portions of louver with lined galvanized sheet metal panels and seal airtight. Back of panels shall be insulated with 1" thick, 3 lb. density duct liner.
 - J. Special Considerations:
 1. Louvers installed on buildings in Hurricane-Prone and Wind-Borne Debris Regions must comply with AMCA 540 and AMCA 550.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which air outlets and inlets are to be installed for compliance with installation tolerances and conditions that would affect the performance of the equipment. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install air outlets and inlets in accordance with manufacturer's written instructions, design drawings, referenced standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Coordinate with other work, including ductwork and duct accessories, to interface installation of air outlets and inlets with other work.

- C. Where a 90-degree elbow is required at the connection to air devices, provide a rigid duct elbow or, at Contractor's option, a flexible elbow assembly as specified in Division 23 section "Air Duct Accessories".
- D. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling module.
- E. Linear Slot Diffuser Installation:
 - 1. For installations in a hard ceiling, install diffuser prior to installation of drywall. Use manufacturer's hard ceiling clips for mounting to ceiling framing. Screws through face of diffuser are not acceptable.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before beginning air balance.

3.4 CLEANING

- A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove dirt and smudges. Replace any air device that has damaged finishes.

END OF DOCUMENT 233713

DOCUMENT 238126 - SPLIT SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.
- B. Indoor evaporator fan coil units.
- C. Outdoor condenser units.

1.2 REFERENCE STANDARDS

- A. AHRI 210/240 - Standard for Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; most current edition.
- B. AHRI 270 – Sound Performance Rating of Outdoor Unitary Equipment, most current edition.
- C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; most current edition.
- D. NFPA 70 – National Electric Code.
- E. UL 1995 Testing and Certification.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, type of refrigerant used, refrigerant pipe sizing, and electrical characteristics. Provide short circuit current rating of units with factory mounted starter or variable frequency drive.
- B. Shop Drawings: Provide drawings that indicate size, profile, dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.
- C. Design Data: Indicate refrigerant pipe sizing.
- D. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.
- E. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.
- F. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
- G. Operation and Maintenance Data: Include manufacturer's descriptive literature, start-up and operating instructions, maintenance and repair data, parts lists, controls, accessories, and trouble-shooting guide.

1. Include manufacturer's recommended maintenance schedule of units installed in a seacoast application, within 5 miles of the coast.

H. Warranties: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer including special warranties specified in this Section.

1.4 QUALITY ASSURANCE

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

B. Fabricate and label refrigeration system to comply with ASHRAE 15.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Units shall be designed to operate with HCFC-free refrigerants.

E. Units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 and bear the Listed Mark.

F. The system components shall be rated in accordance with AHRI Standard 210/240.

1.5 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: A written warranty, executed by the manufacturer and signed by the Contractor, agreeing to replace components that fail in materials or workmanship within the specified warranty period, provided manufacturer's written instructions for installation, operation, and maintenance have been followed.

1. Warranty Period, Compressors: Manufacturer's standard, but not less than 5 years after date of Substantial Completion.

1.6 SPARE PARTS

A. General: Furnish to Owner, with receipt, the following spare parts described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Fan Belts: One set for each belt-drive fan.
2. Gaskets: One set for each access door.
3. One set of spare filters of each type required for each unit.

4. If HVAC equipment is used during the construction period, Contractor shall provide one set of filters (if system is designed to include pre-filters and after-filters, provide only pre-filters) when the unit is started and replace filters when needed, but not less than every month. On the day of substantial completion, the Contractor shall clean the unit and provide a new set of filters at each location in the unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Comfort Star.
- B. Carrier.
- C. Daikin US Corporation.
- D. Fujitsu.
- E. Friedrich Air Conditioning Company.
- F. Hitachi Air Conditioning Company.
- G. Koldwave, Inc.
- H. Lennox Industries, Inc..
- I. LG.
- J. Mitsubishi Electric & Electronics USA, Inc.
- K. Panasonic.
- L. Samsung.
- M. Trane.
- N. York.

2.2 INDOOR UNITS

- A. General: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heating and cooling element(s), controls, and accessories; wired for single power connection with control transformer.
- B. Cabinet:
 1. Floor or Wall Mounted: Steel with baked enamel finish in color selected by Architect, easily removed and secured access doors with safety interlock switches.
- C. Discharge Grille: Steel with surface mounted frame.

- D. Insulation: Faced, glass-fiber duct liner.
- E. Supply Fan: Centrifugal type rubber mounted with direct or belt drive with adjustable variable pitch motor pulley.
- F. Fan Motor:
 - 1. Comply with NEMA designation temperature rating, service factor, enclosure type, and efficiency requirements specified in Section "Common Motor Requirements for HVAC Equipment."
 - 2. Multi-tapped, multi-speed with internal thermal protection and permanent lubrication.
- G. Air Filters: Washable type for wall-mount units, throwaway type for all other units, unless scheduled otherwise. Arrange for easy replacement. Refer to equipment schedules on the drawings for required thickness and MERV ratings.
- H. Condensate Drain Pan: Slope in all directions to drain to drain connection that is sized to prevent overflow. Material options include:
 - 1. Galvanized steel with top surface coating of asphaltic waterproof compound.
 - 2. Stainless steel.
 - 3. Polymer material.
- I. Refrigerant Coil: Copper tube aluminum fin assembly, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
- J. Gas Furnace:
 - 1. Heat Exchanger: Options include:
 - a. Aluminized steel welded construction.
 - b. Aluminized and stainless steel tubular type.
 - 2. Insulation: Foil-faced.
 - 3. Burner: Atmospheric type with adjustable combustion air supply.
 - a. Gas valve with 100 percent safety gas shut-off; pressure regulation, safety pilot, manual set (On-Off), pilot filtration, and automatic electric valve.
 - b. Electronic pilot ignition, with electric spark igniter.
 - 4. Burner Safety Controls:
 - a. Thermocouple Sensor: Prevents opening of gas valve until pilot flame is proven and stops gas flow on ignition failure.

- b. Flame Rollout Switch: Installed on burner box and prevents operation.
- c. Vent Safety Shutoff Sensor: Temperature sensor installed on draft hood and prevents operation, manual reset.
- d. Limit Control: Fixed stop at maximum permissible setting, de-energizes burner on excessive bonnet temperature, automatic reset.

K. Controls:

- 1. Unit-mounted panel with contactors.
- 2. Control transformer with circuit breaker.
- 3. Solid-state temperature- and humidity-control modules.
- 4. Time-delay relay.

- L. Where scheduled on the drawings, provide condensate lift pump with a built-in safety cutoff switch and integral check valve on discharge.

2.3 OUTDOOR UNITS

- A. General: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
- B. Compressor: Hermetic scroll-type with resilient suspension system, oil strainer, crankcase heater, start capacitor, time delay relay, contactor, and internal motor overload protection.
- C. Air-Cooled Condenser:
 - 1. General: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.
 - 2. Casing: Steel, baked enamel finish, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
 - 3. Accessories:
 - a. Liquid line filter drier.
 - b. High pressure switch (manual reset).
 - c. Low pressure switch (automatic reset).
 - d. Service valve with gauge ports.
 - e. Thermometer well in liquid line.
 - f. Low-ambient kit where scheduled.

- g. Compressor short-cycling controls.
- h. Reversing valve for heat pump units.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine area for compliance with requirements for installation tolerances and other conditions affecting performance of units. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Verify that flooring or ceiling system is ready to receive work and opening dimensions are as indicated on Shop Drawings.
- C. Verify that power supply is available and of the correct characteristics.

3.2 COORDINATION

- A. Coordinate layout and installation of units and suspension components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate installation of single rail equipment supports and roof penetrations with roof construction and actual equipment provided. Refer to "Hangers and Supports for HVAC Piping and Equipment" for equipment supports. Roof specialties are specified in Division 7 Sections. Concrete, reinforcement and formwork are specified in Division 3 Sections.

3.3 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install unit level and plumb.
- C. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- D. Install roof-mounted, compressor-condenser components on roof equipment supports with vibration isolation. Anchor units to supports with removable, cadmium-plated fasteners.
- E. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base or polyethylene mounting base with vibration isolators.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of piping and required valves and piping accessories. The following are specific connection requirements:
 - 1. Arrange piping installations adjacent to units to allow unit servicing and maintenance.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

- C. Connect condensate drain piping to the unit with appropriate trap. Verify that the piping material and installation is in accordance with Division 22 requirements.
- D. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect ductwork to units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories." Provide transitions to exactly match unit duct connection size.

3.5 ADJUSTING, CLEANING, AND PROTECTING

- A. Adjust fan for required airflow in accordance with Section "Testing, Adjusting and Balancing." Tighten belts as required for proper operation.
- B. Adjust damper linkages for proper damper operation.
- C. Set initial temperature and humidity set points.
- D. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, intake plenum cabinet, heat exchange surfaces, cooling/heating coil sections, filter sections, access sections, etc.

3.6 STARTUP

- A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:
 - 1. Remove shipping, blocking, and bracing.
 - 2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects. Verify vibration isolation and flexible connections are installed correctly.
 - 3. Perform cleaning and adjusting specified in this Section.
 - 4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
 - 5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
 - 6. Set outside-air and return-air mixing dampers to minimum outside-air setting.
 - 7. Comb coil fins for parallel orientation.
 - 8. Install new filters at completion of installation and prior to testing, adjusting, and balancing. Do not operate air handling unit without pre-filters installed.
 - 9. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.

10. Disable automatic temperature control operators.

B. Start-Up Services: Start-up units in accordance with manufacturer's written start-up instructions. Do not operate units without filters installed. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

1. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
 - a. Replace fan and motor pulleys as required to achieve design conditions.
 - b. Measure and record motor electrical values for voltage and amperage.
 - c. Shut unit down and reconnect automatic temperature control operators.
 - d. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for system testing, adjusting, and balancing.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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 motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

C. Prepare test and inspection reports.

3.8 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of two hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.
2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.
3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

- C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.
- D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF DOCUMENT 238126

DOCUMENT 260010 - GENERAL ELECTRICAL 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 and to all following sections within Division 26.

1.2 SECTION INCLUDES

- A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the Work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.
- B. Division 26 of these Specifications, and Drawings numbered with prefixes E, generally describe these systems, but the scope of the electrical work includes all such work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.
- C. Drawings are graphic representations of the Work upon which the Contract is based. They show the materials and their relationship to one another, including sizes, shapes, locations, and connections. They also convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, outlets and circuits without showing all of the exact details as to elevations, offsets, control lines, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.
- D. Specifications define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

1.3 DEFINITIONS

- A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:
 - 1. Furnish: "To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations."
 - 2. Install: "To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use."
 - 3. Provide: "To furnish and install complete, and ready for the intended use."

4. Furnished by Owner (or Owner-Furnished) or Furnished by Others: "An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division.
5. Engineer: Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division.
 - a. A Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".
6. Contract Administrator: Where referenced in this Division, "Contract Administrator" is the primary liaison between the Owner and the Contractor. Specifically, for this project this is the "Architect".
7. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
8. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTLs that are acceptable to the AHJ, and standards that meet the specified criteria.
9. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.
 - a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.
10. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.
11. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified

- a. When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.
 - b. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.
 - c. Manufacturers: The listing of specific manufacturers does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed are not relieved from meeting these specifications in their entirety.
12. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
13. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
14. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference, unless otherwise noted.

1.4 REFERENCE STANDARDS

- A. Execute all work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the particular class of work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes. Bring all conflicts observed between codes, ordinances, rules, regulations and these documents to the Contract Administrator's and Engineer's attention in sufficient time, prior to the opening of bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.
- B. If the conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Contract Administrator and Engineer, without additional compensation. Contractor will be held responsible for any violation of the law.
- C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.

- D. All material, manufacturing methods, handling, dimensions, methods of installation, and test procedures shall conform to industry standards, acts, and codes, including, but not limited to the following, except where these Drawings and Specifications exceed them:

IBC	International Building Code
ADA	Americans with Disabilities Act
AEIC	Association of Edison Illuminating Companies
ANSI	American National Standards Institute
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
ICEA	Insulated Conductors Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code, NFPA 70
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers' Association
NETA	InterNational Electrical Testing Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Act
UL	Underwriter's Laboratories

- E. Comply with rules and regulations of public utilities and municipal departments affected by connections of services.
- F. Perform all electrical work in compliance with applicable safety regulations, including OSHA regulations. All safety lights, guards, and warning signs required for the performance of the electrical work shall be provided by the Contractor.
- G. Obtain and pay for all permits, licenses and fees that are required by the governing authorities for the performance of the electrical work.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with other divisions for electrical work included in them but not listed in Division 26 or indicated on electrical Drawings.
- B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any work covered by this Division.
- C. Refer to Drawings and divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Make all offsets required to clear equipment, beams and other structural members, and to facilitate concealing conduit in the manner anticipated in the design.

- D. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
- E. Provide materials with trim that will fit properly the types of ceiling, wall, or floor finishes installed.
- F. Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
- G. Maintain an electrical foreman on the jobsite at all times to coordinate this work with other trades so that various components of the electrical systems is installed at the proper time, fits the available space, and allows proper service access to all equipment. Carry on the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.
- H. Work of this Division shall progress according to the "Construction Schedule" as described in Division 01 and as approved by the Contract Administrator. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of all schedule dates.

1.6 MEASUREMENTS AND LAYOUTS:

- A. The Drawings are schematic in nature but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. Correct, at no additional costs to the Owner, errors that could have been avoided by proper checking and inspection.

1.7 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.
 - 1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
 - 2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
 - 3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
 - 4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.

5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
 6. Indicate required installation sequence to minimize conflicts between entities.
 7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
 8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.
- B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of electrical equipment locations within electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.
1. Clearly identify all required working clearances and access provisions required for installation and maintenance.
 2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.
 3. Indicate path to allow for the future removal of each large piece of equipment (up to and including generators and unit sub-station transformers) without removal of non-related equipment or architectural elements.
 4. Include work provided by others routed through the equipment rooms.

1.8 SUBMITTALS

- A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.
- B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.
- C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow for the Engineer Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

- D. Engineer Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time, plus to/from mailing time via the Architect, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.
- E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.
- F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.
- H. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.
- I. Refer to individual Sections for additional submittal requirements.
- J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- K. Submittals shall contain the following information:
 - 1. The project name.
 - 2. The applicable specification section and paragraph.
 - 3. Equipment identification acronym as used on the drawings.
 - 4. The submittal date.
 - 5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
 - 6. Submittals not so identified will be returned to the Contractor without action.
- L. The checking and subsequent acceptance by the Engineer and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings

and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Architect prior to implementing any deviation.

- M. BIM Incorporation: Develop and incorporate Shop Drawing files into BIM established for Project.
- N. Video Recordings: Record all equipment training and demonstrations in .AVI format, unless noted otherwise in Division 01 specifications or where approved by the Owner.

1.9 SUBSTITUTIONS

- A. Refer to Division 01 and General Conditions for substitutions in addition to requirements specified herein.
- B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.
- D. Request for Substitution:
 - 1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
 - 2. The burden of proof of the merit of the proposed substitution is upon the proposer.
 - 3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, Construction Manager, and Owner the following:
 - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
 - b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
 - c. Proposed substitution has received necessary approvals of the Authorities Having Jurisdiction.
 - d. Same warranty will be furnished for proposed substitution as for specified Work.
 - e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
 - f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
2. Prior to receipt of Bids: No substitutions will be considered prior to receipt of bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of bids.
 - a. If the proposed substitution is approved prior to receipt of bids, such approval will be stated in an addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
3. After receipt of Bids: No substitutions will be considered after receipt of Bids and before award of the Contract.
4. After award of Contract: No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.10 ELECTRONIC DRAWING FILES

- A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet.
- B. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form.
- C. Contact the Contract Administrator for written authorization.
- D. The following must be received before electronic drawing files will be sent:
 1. Contract Administrator's written authorization
 2. Engineer's release agreement form
 3. Payment

1.11 QUALITY ASSURANCE

- A. Execute all work under this Division in a thorough and professional manner by competent and experienced workmen duly trained to perform the work specified.
- B. Install all work in strict conformance with all manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.
- C. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and

capacity. Provide all material and equipment of the same type from the same manufacturer whenever practicable.

- D. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.

1.12 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.
- B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.
- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Prior to Substantial Completion of the project, furnish the Operation and Maintenance Manuals to the Contract Administrator, for Engineer's review, and for the Owner's use.
 - 1. Refer to Division 01 for acceptance of electronic manuals for this project. If not specified in Division 1, provide manuals in the form of a multiple file composite electronic PDF file for each manual type required. Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size. 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.
 - a. Contractor shall notify the Contract Administrator and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives.
 - 2. If Division 01 requires paper manuals, provide four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings.
- E. Each manual shall contain equipment data, approved submittals, shop drawings, diagrams, capacities, spare part numbers, manufacturer service and maintenance data, warranties and guarantees. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

1.13 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections of this Division.

1.14 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.
- B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.
- C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Contract Administrator.

1.15 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.
- B. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Contract Administrator.
- D. Be responsible for the safe storage of tools, material and equipment.

1.16 WARRANTIES

- A. Refer to Division 01 and General Conditions for Warranties in addition to requirements specified herein.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- C. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific

items are noted to carry a longer warranty in these Construction Documents or manufacturer's standard warranty exceeds 12 months. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions and Division 01.

- D. Also warrant the following additional items:
 - 1. All raceways are free from obstructions, holes, crushing, or breaks of any nature.
 - 2. All raceway seals are effective.
 - 3. The entire electrical system is free from all short circuits and unwanted open circuits and grounds.
- E. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.
- F. Perform the remedial work promptly, upon written notice from the Contract Administrator or Owner.
- G. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.17 TEMPORARY FACILITIES

- A. Refer to Division 01 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.
- B. Temporary Utilities: The types of services required include, but are not limited to, electricity, telephone, and internet. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.
- C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.
 - 1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.
 - 2. Heating: Provide heat, as necessary, to protect work, materials and equipment from damage due to dampness and cold. In areas where building is occupied, maintain a temperature not less than 65 degrees F. Use steam, hot water, or gas from piped distribution system where available. Where steam, hot water or piped gas are not available, heat with self-contained LP gas or fuel oil heaters, bearing UL, FM or other approval labels appropriate for application. Use electric-resistance space heaters only where no other, more energy-efficient, type of heater is available and allowable.

- a. Vent and exhaust fuel-burning heaters per SMACNA Guidelines for Source Control and equip units with individual-space thermostatic controls.
- b. If permanent HVAC systems are used during construction, provide HVAC Protection and replace all filtration prior to occupancy in accordance with SMACNA Guidelines.

1.18 FIELD CONDITIONS

- A. Conditions Affecting Excavations: The following project conditions apply:
 - 1. Maintain and protect existing building services that transit the area affected by selective demolition.
 - 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
- B. Use of explosives is not permitted.
- C. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits specified by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Refer to Division 02 and General Conditions.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 PERMITS

- A. Secure and pay for all permits required in connection with the installation of the Electrical Work. Arrange with the various utility companies for the installation and connection of all required utilities for this facility and pay all charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.3 TEMPORARY ELECTRICAL SERVICE AND WIRING

- A. Provide 208Y/120 volt, three-phase, four-wire, temporary electrical service and temporary lighting system to facilitate construction.
- B. Pay all charges made by the Electric Utility, with respect to installation and energy charges for temporary services.
- C. Work for the temporary power shall consist of all labor and materials, including, but not limited to conduit, wiring, panelboards, fuse blocks, fused disconnecting switches, fuses, pigtails,

receptacles, wood panel switch supports, and other miscellaneous materials required to complete the power system.

- D. Install all temporary wiring in accordance with applicable codes, and maintain in an OSHA-approved manner.
- E. Provide an adequate number of GFCI type power distribution centers, rated 208Y/120V, four-wire, and not less than 60A, with sufficient fuse blocks or breakers for lighting and hand tool circuits, 60A four-wire feeders, all mounted within pre-fabricated enclosures UL listed for this application or on suitable wood panels bolted to columns or upright wood supports as required.
- F. Install circuits to points on each level of each building so that service outlets can be reached by a 50-foot extension cord for 120V power and a 100-foot extension cord for 208V power (or as required by OSHA or local authorities).
- G. Provide one lighting outlet per 30 linear feet of corridor and at least one light in each room and for every 800 square feet of floor area. Temporary lighting shall comply with OSHA requirements.
- H. If additional service is required for cranes, electrical welders or for electric motors over 1/2 HP per unit, such additional service shall become the responsibility of the trade involved.
- I. When the permanent wiring for lighting and power is installed, with approval of the Contract Administrator and Owner, the permanent system may be used, provided the Contractor assumes full responsibility for all electrical material, equipment, and devices contained in the systems and provided that roof drainage system and roofing are complete.
- J. When directed by the Contract Administrator, remove all temporary services, lighting, wiring and devices from the property.

3.4 ACCESS TO EQUIPMENT

- A. Locate all pull boxes, junction boxes and controls to provide easy access for operation, service inspection and maintenance. Provide an access door where equipment or devices are located above inaccessible ceilings. Refer to Division 26 Section "Common Work Results for Electrical".
- B. Maintain all code required clearances and clearances required by manufacturers.

3.5 PENETRATIONS

- A. Unless otherwise noted as being provided under other divisions, provide sleeves, box frames, or both, for openings in floors, walls, partitions, and ceilings for all electrical work that passes through construction. Refer to Division 26 Section "Common Work Results for Electrical".
- B. Provide sleeves, box frames, or both, for all conduit, cable, and busways that pass through masonry, concrete, or block walls.
- C. The cutting of new construction will not be permitted except by written approval of the Contract Administrator.

3.6 EXCAVATION AND BACKFILLING

- A. Refer to Division 01, Division 02 and General Conditions for Excavation and Backfilling in addition to the requirements specified herein.
- B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this division. Excavation shall be in conformance with applicable Divisions and sections of the Specifications.
- C. Restore roads, alleys, streets, and sidewalks damaged during this work to the satisfaction of Authorities Having Jurisdiction.
- D. Do not excavate trenches close to walks or columns without prior consultation with the Contract Administrator.
- E. Erect barricades around excavations, for safety, and place an adequate number of amber lights on or near the work and keep those burning from dusk to dawn. Be responsible for all damage that any parties may sustain in consequence of neglecting the necessary precautions in prosecuting the work.
- F. Slope sides of excavations to comply with local, state, and federal codes and ordinances. Shore and brace as required for stability of excavation.
- G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state, and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
 - 1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.
- H. Install sediment and erosion control measures in accordance with local codes and ordinances.
- I. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
 - 1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
 - 2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.
- J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.
 - 1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
 - 2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

- K. Excavation for Underground Tanks and Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.
1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of one inch in diameter and larger with emulsified asphalt tree paint.
 2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- L. Trenching: Excavate trenches for electrical installations as follows:
1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of six to nine inches clearance on both sides of raceway and cables.
 2. Excavate trenches to depth indicated or required for raceway and cables to establish slope, away from buildings and indicated elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.
 3. Limit the length of open trench to that in which raceway and cables can be installed, tested, and the trench backfilled within the same day.
 4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceway and cables. Provide a minimum of six inches of stone or gravel cushion between rock bearing surface and raceway and cables.
 5. Excavate trenches for raceway, cables, and equipment with bottoms of trench to accurate elevations for support of raceway and cables on undisturbed soil.
- M. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.
- N. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.
1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
 2. Under building slabs, use drainage fill materials.
 3. Under raceway and cables, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
 4. For raceway and cables less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support. After installation and testing of raceway and cables, provide a 4-inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.

5. Other areas use excavated or borrowed materials.
- O. Backfill excavations as promptly as work permits, but not until completion of the following:
1. Inspection, testing, approval, and locations of underground utilities have been recorded.
 2. Removal of concrete formwork.
 3. Removal of shoring and bracing, and backfilling of voids.
 4. Removal of trash and debris.
- P. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
1. For vertical and diagonal raceway installations, thoroughly support raceways from permanent structures or undisturbed earth at no less than 10-foot intervals, while placing backfill materials, so that raceways are not deflected, crushed, broken, or otherwise damaged by the backfill placement.
- Q. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- R. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.
- S. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below:
1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).
 - a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

- c. Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.
- 2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.
- T. Subsidence: Where subsidence occurs at mechanical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.7 CUTTING AND PATCHING

- A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.
- B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.
- C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.
- D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.
- E. Patch around openings to match adjacent construction, including fire ratings, if applicable.
- F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

3.8 PAINTING

- A. Refer to Division 09 Section "Painting" for painting requirements.
- B. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under individual sections and Division 09 of the Specifications; colors shall be as selected by the Contract Administrator.
- C. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.
- D. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.
- E. Where factory finishes are provided and no additional field painting is specified, touch up or refinish, as required by, and to the acceptance of, the Contract Administrator, marred or damaged

surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Contract Administrator, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.

3.9 CLEANING

- A. Remove dirt and refuse, resulting from the performance of the Work, from the premises as required to prevent accumulation. Cooperate in maintaining reasonably clean premises at all times.
- B. Immediately prior to the final inspection, the Electrical Contractor shall clean material and equipment installed under the Electrical Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment.
- C. Damaged finishes shall be touched-up and restored to their original condition

3.10 ADJUSTING, ALIGNING AND TESTING

- A. Adjust, align and test all electrical equipment furnished and/or installed under this Division.
- B. Check motors for alignment with drive and proper rotation, and adjust as required.
- C. Check and test protective devices for specified and required application, and adjust as required.
- D. Check, test and adjust adjustable parts of all light fixtures and electrical equipment as required to produce the intended performance.
- E. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.
- F. After completion, perform tests for continuity, unwanted grounds, and insulation resistance in accordance with the requirements of NFPA 70 and NETA.
- G. Be responsible for the operation, service and maintenance of all new electrical equipment during construction and prior to acceptance by the Owner of the complete project under this Contract. Maintain all electrical equipment in the best operating condition including proper lubrication.
- H. Notify the Contract Administrator immediately of all operational failures caused by defective material, labor or both.
- I. Maintain service and equipment for all testing of electrical equipment and systems until all work is approved and accepted by the Owner.
- J. Keep a calibrated voltmeter and ammeter (true RMS type) available at all times. Provide service for test readings when and as required.
- K. Refer to individual sections for additional and specific requirements.

3.11 START-UP OF SYSTEMS

- A. Prior to start-up of electrical systems, check all components and devices, lubricate items appropriately, and tighten all screwed and bolted connections to manufacturers' recommended torque values using appropriate torque tools.
- B. Each power, lighting and control circuit shall be energized, tested and proved free of breaks, short-circuits and unwanted grounds.
- C. Adjust taps on each transformer for rated secondary voltages.
- D. Balance all single phase loads at each panelboard, redistributing branch circuit connections until balance is achieved to plus or minus 10 percent.
- E. Replace all burned-out lamps. Replace the lamps of all light fixtures that use incandescent, halogen or quartz lamp sources that are installed as part of the finished building, but are used by the Contractor during construction, with new lamps of appropriate type and wattage prior to turning the facility over to the Owner.
- F. After all systems have been inspected and adjusted, confirm all operating features required by the Drawings and Specifications and make final adjustments as necessary.
- G. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.
- H. At the time of final review and tests of the power and lighting systems, all equipment and system components shall be in place and all connections at panelboards, switches, circuit breakers, and the like, shall be complete. All fuses shall be in place, and all circuits shall be continuous from point of service connections to all switches, receptacles, outlets, and the like.

3.12 TEST REPORTS

- A. Perform tests as required by these Specifications and submit the results to the Contract Administrator, for Engineer's review. Record the results, date and time of each test and the conditions under which the test was conducted. Include a copy of the finalized test results, with corrections made, in the operations and maintenance manuals. The tests shall establish the adequacy, quality, safety, and reliability for each electrical system installed. Notify the Contract Administrator and Engineer two working days prior to each test.
- B. For specific testing requirements of special systems, refer to the Specification section that describes that system. The Contractor shall provide the following to facilitate the testing of the electrical systems:
 - 1. Perform tests as described in the individual sections;
 - 2. Engage the services of a 3rd Party testing agency to perform tests as noted below, or;
 - a. Agent may be an employee of the contractor but shall be NETA certified to perform electrical testing.

- C. Upon completing each test, record the results, date and time of each test and the conditions under which the test was conducted. Submit to the Contract Administrator, for Engineer's review, in duplicate, the test results for the following electrical items:
1. Building service entrance voltage and amperes at each phase.
 2. Electrical service grounding conditions and grounding resistance.
 3. Proper phasing throughout the entire system.
 4. Voltages (phase-to-phase and phase-to-neutral) and amperes at each phase for each panelboard, switchboard, and the like.
 5. Phase voltages and amperes at each three-phase motor.
 6. Test all wiring devices for electrical continuity and proper polarity of connections.
- D. Promptly correct all failures or deficiencies revealed by these tests in accordance with the manufacturer's recommendations and as determined by the Engineer.

3.13 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:
1. Submit complete Operation and Maintenance Data.
 2. Submit complete Record Drawings.
 3. Perform all required training of Owner's personnel.
 4. Turn over video recordings of training sessions to the Owner.
 5. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.
 6. Perform start-up tests of all systems.
 7. Remove all temporary facilities from the site.
 8. Comply with all requirements for Substantial Completion in the Division 01 and General Conditions.
- B. Request in writing a review for Substantial Completion. Give the Contract Administrator at least seven (7) days notice prior to the review.
- C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Contract Administrator will either proceed with the review or advise the Contractor of unfilled requirements.

- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, he shall reimburse the Contract Administrator and Engineer for time and expenses incurred for the visit.
- F. Upon completion of the review, the Contract Administrator will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.
- G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.
- H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF DOCUMENT 260010

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER

Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

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

Reason for not providing specified item: _____

Similar Installation:

Project: _____ Architect: _____

Address: _____ Owner: _____

Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

- ▲ A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
- B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
- C. Proposed substitution does not affect dimensions and functional clearances.
- D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
- E. Same warranty will be furnished for proposed substitution as for specified Work.
- F. Same maintenance service and source of replacement parts, as applicable, is available.
- G. Proposed substitution will not adversely affect other trades or delay construction schedule.
- H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

_____ Submitting Contractor	_____ Date	_____ Company
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Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

_____ Manufacturer's Representative	_____ Date	_____ Company
--	---------------	------------------

Engineer Review and Recommendation Section

Recommend Acceptance	<input type="checkbox"/> Yes	<input type="checkbox"/> No	
Additional Comments:	<input type="checkbox"/> Attached	<input type="checkbox"/> None	

Acceptance Section:

_____ Contractor Acceptance Signature	_____ Date	_____ Company
_____ Owner Acceptance Signature	_____ Date	_____ Company
_____ Architect Acceptance Signature	_____ Date	_____ Company
_____ Engineer Acceptance Signature	_____ Date	_____ Company

DOCUMENT 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This Section includes limited scope general construction materials and methods, electrical equipment coordination, and common electrical installation requirements as follows:
1. Access doors in walls, ceilings, and floors for access to electrical materials and equipment.
 2. Sleeves and seals for electrical penetrations.
 3. Joint sealers for sealing around electrical materials and equipment, and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.
 4. Sealing penetrations through noise critical spaces.

1.2 DEFINITIONS

- A. The following abbreviations apply to this and other Sections of these Specifications:
1. AHJ: Authority(ies) having Jurisdiction
 2. ATS: Acceptance Testing Specifications
 3. EPDM: Ethylene-propylene-diene monomer rubber
 4. MC: Metal Clad
 5. N/A: Not Available or Not Applicable
 6. NBR: Acrylonitrile-butadiene rubber
 7. NRTL: Nationally Recognized Testing Laboratory
 8. PCF: Pounds per Cubic Foot
- B. The following definitions apply to this and other Sections of these Specifications:
1. Homerun: That portion of an electrical circuit originating at a junction box, termination box, receptacle or switch with termination at an electrical panelboard. Note: Where MC Cable is utilized for receptacle and/or lighting branch circuiting loads, the originating point of the homerun shall be at the first load in the circuit or at a junction box in an accessible ceiling space immediately above the first load.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate arrangement, mounting, and support of electrical equipment:
1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 3. To allow right of way for piping, ducts, and other systems installed at required slopes and/or elevations.
 4. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.
- D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":
1. Product data for the following products:
 - a. Sleeve seals.
 - b. Through and membrane penetration firestopping systems.
 - c. Joint sealers
 - d. Acoustical sealers
 - e. Endothermic rap
 2. Shop drawings for:
 - a. Detailed fabrication drawings of access panels and doors.
 3. Through and Membrane Penetration Firestopping Systems Product Schedule: Provide UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.
 - a. Where Project conditions require modification to qualified testing and inspecting agency's illustrations for a particular firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
 - b. Qualifications data for testing agency.

4. Endothermic Wrap drawings and system details: Provide UL listing, assembly rating and installation drawing for each case specific installation. Include installation instructions indicating layers of wrap required and securing method.
 - a. Where Project conditions require modifications to qualified testing and inspecting agency's installation requirements for a particular listed fire rated electrical circuit protective system, submit illustration with modifications marked and approved by Endothermic Wrap manufacturer's fire protection engineer as an engineering judgement or equivalent fire-resistive-rated assembly.
5. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26
 - a. Accurately record actual locations of firestopped penetrations and access panel/door locations. Indicate dimensions from fixed structural elements.

1.5 NOISE CRITICAL SPACES

- A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The table below designates the noise-critical spaces that will require application of sound attenuating measures and acoustical sealants.
 1. Sound/Lighting Control Rooms
 2. TV Production Studio
 3. Stage
 4. A/V Spaces

PART 2 - PRODUCTS

2.1 ACCESS TO EQUIPMENT

- A. Available Manufacturers:
 1. Bar-Co., Inc.
 2. Elmdor Stoneman.
 3. JL Industries
 4. Jay R. Smith Mfg. Co.
 5. Karp Associates, Inc.
 6. Milcor
 7. Nystrom Building Products
 8. Wade

9. Zurn

B. Access Doors:

1. Provide access doors for all concealed equipment, except where above lay-in ceilings. Refer to Section "Identification for Electrical Systems" for labeling of access doors.
2. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
3. Access doors must be of the proper construction for type of construction where installed.
4. The exact location of all access doors shall be verified with the Contract Administrator prior to installation.
5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
 - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.
 - b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.
 - c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.
7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
 - a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
8. Locking Devices:
 - a. Where indicated on the drawings or where access panels are installed in locations accessible to the public, provide 5-pin or 5-disc type cylinder locks, [individually keyed][all access panels keyed alike]; provide 2 keys per access panel.

2.2 SLEEVES

A. Steel sleeves for raceways and cables:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends and drip rings.

B. Cast iron wall pipe sleeves for raceways and cables:

1. Manufacturers
 - a. Josam Mfg. Co.
 - b. Smith (Jay R) Mfg. Co.
 - c. Tyler Pipe/Wade Div.; Subs of Tyler Corp.
 - d. Watts Industries, Inc.
 - e. Zurn Industries, Inc.; Hydromechanics Div.
2. Cast-iron sleeve with integral clamping flange with clamping ring, and nuts for membrane flashing.
 - a. Underdeck Clamp: Clamping ring with setscrews.
3. Sleeves for rectangular openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.
4. Coordinate sleeve selection and application with selection and application of firestopping to be used.

2.3 SEALANTS

A. SLEEVE SEALS

1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
2. Available Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. O-Z/Gedney
 - e. Pipeline Seal and Insulator, Inc.
3. Sealing Elements: Interlocking or solid sealing links shaped or pre-drilled to fit surface of cable or raceway. Include type and number required for material and size of raceway or cable.
 - a. EPDM
 - b. NBR

- c. Neoprene
- 4. Pressure Plates: Include two for each sealing element. For multi-phase circuits, use slotted pressure plates if metal.
 - a. Plastic
 - b. Carbon steel
 - c. Stainless steel
 - d. PVC-coated steel
- 5. Connecting Bolts and Nuts: Provide bolts of length required to secure pressure plates to sealing elements. Include one for each sealing element.
 - a. Carbon steel with corrosion-resistant coating
 - b. Stainless steel

B. JOINT SEALERS

- 1. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
- 2. Colors: As selected by the Contract Administrator from manufacturer's standard colors.
- 3. Elastomeric Joint Sealers: Provide the following types:
 - a. Silicone Joint Sealants, One-part nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer. Provide one of the following:
 - 1) Dow Corning, Dowsil 790
 - 2) Dow Corning, Dowsil 795
 - 3) GE, Silglaze II SCS 2350
 - 4) GE, Silpruf SCS 2000
 - 5) Owens Corning, Energy Complete
 - 6) Pecora, 864 NST
 - 7) Tremco, Spectrem 1
 - 8) Tremco, Spectrem 2

- b. Mildew Resistant Sealants, one-part mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, metal or porcelain plumbing fixtures and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide one of the following:
 - 1) Dow Corning, Dowsil 786
 - 2) GE, Momentum SCS 1700
 - 3) Pecora, 898 Silicone NST
- c. Hybrid Joint Sealants: One-part, nonsag, paintable complying with ASTM C 920, Type S, Grade NS, Class 50 recommended for exposed applications on interior and exterior locations involving joint movement of not more than plus or minus 50 percent. Subject to compliance with requirements, provide one of the following:
 - 1) BASF, MasterSeal NP 100
 - 2) Pecora, DyanTrol I-XL
 - 3) Tremco, Dymonic FC

C. FIRESTOPPING

- 1. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, by Underwriters' Laboratories, Inc., or other NRTL acceptable to AHJ. Subject to compliance with requirements, provide one of the following:
 - a. Available Manufacturers:
 - 1) 3M Corp., Fire Barrier Sealant
 - 2) Hilti, Inc.
 - 3) Tremco, Tremstop Fyre-Sil
 - 4) Pecora, AC-20 FTR
 - 5) RectorSeal
 - 6) Specified Technologies Inc. Firestop
 - 7) USG, SHEETROCK Firecode Compound
 - 8) Owens Corning Firestopping Insulation

D. ACOUSTICAL SEALANTS

1. General: Penetrations by conduit through surfaces that are around and between noise critical spaces shall be sleeved, packed and sealed airtight with foam rod, non-hardening sealant and/or packing material as described herein.
2. Foam Backer Rod: Closed cell polyethylene suitable for use as a backing for non-hardening sealant.
3. Non-Hardening Sealant: Sealant for penetrations shall be non-hardening, permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.
4. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 PCF (40 kg/m3).
5. Acoustical Joint Sealant: Manufacturer's standard non-sag, paintable, non-staining 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. Meeting ASTM E 84 for a smoke flame spread index of less than 25 / 50. Subject to compliance with requirements, provide one of the following:
 - 1) Pecora, AC-20 FTR
 - 2) Pecora, AIS-919
 - 3) USG, SHEETROCK Acoustical Sealant.

2.4 FIRE RATED PROTECTIVE WRAPS

A. Endothermic Wrap

1. General: Protective wrap, designed to provide fire protection of critical feeders and circuits in accordance with ASTM E1725. Subject to compliance with requirements, provide one of the following:
 - 1) 3M Corp., Interam Endothermic Mat
 - 2) Specified Technologies Inc., E-Wrap

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".
- C. Coordinate seals with wall, ceiling, roof or floor materials and rating of the surface (sound, fire, waterproofing, etc.)

- D. Comply with NECA 1.
- E. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items, unless indicated otherwise.
- F. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- G. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- H. Right of Way: Yield to raceways and piping systems installed at a required slope.

3.2 ACCESS DOORS

- A. Verify the exact location, sizes, and types of all access doors with the Contract Administrator prior to purchase.
- B. Provide access doors for all concealed electrical equipment, except where above lay-in ceilings.
- C. Coordinate with architectural finishes to set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- D. Adjust hardware and panels after installation for proper operation.
- E. Label all access doors with a nameplate as described in Division 26 Section "Identification for Electrical Systems".

3.3 SLEEVES AND SLEEVE SEALS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Provide sleeves for required openings in all concrete and masonry construction and fire, smoke, or both, partitions, for all electrical work that passes through such construction. Coordinate with all other trades and divisions to dimension and lay out all such openings.
- C. Only those openings specifically indicated on the Architectural or Structural Drawings will be provided under other divisions.
- D. New Construction:
 - 1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support raceway penetrations.
- E. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls. Do not cut or core drill new construction without written approval from the Contract Administrator and Structural Engineer.

- F. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- G. Rectangular Sleeve Minimum Metal Thickness:
 - 1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
 - 2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.
- H. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- I. Install pipe and rectangular sleeves in above-grade walls and slabs, where penetrations are not subject to hydrostatic water pressures. Ensure that drip ring is fully encased and sealed within the wall or slab.
- J. Sleeve Length:
 - 1. Sleeves through walls: Cut sleeves to length for mounting flush with both surfaces of walls.
- K. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or as required to meet seismic criteria; in which case, size sleeves as recommended by the seal manufacturer or per seismic criteria, or both.
- L. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- M. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint
- N. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.
- O. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- P. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (or larger, if required by the seal manufacturer) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- Q. Above Grade Concrete or Masonry Penetrations
 - 1. Provide sleeves for cables or raceways passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:
 - a. Install schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.

- b. Install galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 0.138 inches.
 - c. Install galvanized sheet metal for rectangular sleeves
 - d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.
- 2. Seal elevated floor, exterior wall and roof penetrations watertight and weather tight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of ½" of sealant.
- R. Underground, Exterior-Wall Penetrations: Install cast-iron wall pipes for sleeves. Size sleeves to allow for 1-inch (or larger, if required by the mechanical sleeve manufacturer) annular clear space between sleeve and cable or raceway. Provide mechanical sleeve seal.
 - 1. Use type and number of sealing elements recommended by manufacturer for pipe material and size. Position pipe in center of sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
 - 2. Inspect installed sleeve and sleeve-seal installation for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade to seal against hydrostatic pressure.
- S. Concrete Slab on Grade Penetrations:
 - 1. Provide ½" thick cellular foam insulation around perimeter of raceway passing through concrete foundation. Installation shall extend to 2" above and below the concrete slab.
- T. Elevated Floor Penetrations of waterproof membrane:
 - 1. Provide cast-iron wall pipes for sleeves. Size wall pipe for minimum ½" annular space between wall pipe and cable or raceway.
 - 2. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant.
 - 3. Secure waterproof membrane flashing between clamping flange and clamping ring.
 - 4. Extend bottom of wall pipe below floor slab as required and secure underdeck clamp to hold wall pipe rigidly in place.
- U. Interior Foundation Penetration: Provide sleeves for horizontal raceway passing through or under foundation. Sleeves shall be cast iron soil pipe two normal pipe sizes larger than the pipe served.
- V. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and cable or raceway, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of sealant.
- W. Exterior Wall Penetrations: Seal annular space between sleeve and raceway or duct, using joint sealant for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant.

X. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

Y. Sleeve-Seal Installation

1. Install sleeve seals for all underground raceway penetrations through walls at elevations below finished grade. Additionally, install seals inside raceways, after conductors or cables have been installed, in all raceway penetrations through walls at elevations below finished grade.

2. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Z. Inspect installed sleeve and sleeve-seal installations for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade and above grade where installed to seal against hydrostatic pressure.

AA. Sleeves shall be protected throughout the course of construction, and when damaged shall be replace and/or repaired to a satisfactory condition.

3.4 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire/smoke-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

B. joint sealers

C. Preparation for Joint Sealers

1. Clean surfaces of penetrations, sleeves, or both, immediately before applying joint sealers, to comply with recommendations of joint sealer manufacturer.

2. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

D. Application of Joint Sealers

1. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

a. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.

b. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

2. Tooling: Immediately after sealant application and prior to time shining or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.
- E. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around electrical raceways penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.5 ACOUSTICAL PENETRATIONS

- A. Do not allow direct contact of raceways with shaft walls, floor slabs and/or partitions. Sleeve, pack and seal airtight with foam rod, non-hardening sealant and/or packing material, as described herein, for all penetrations by raceway, through surfaces that encompass or are between noise critical spaces. Seal and pack with caulking for the full depth of the penetration all openings around raceways in the structure surrounding the electrical equipment and surrounding noise-critical spaces. This includes all slab penetrations and penetrations of noise critical walls.
- B. Where a raceway passes through a wall, ceiling or floor slab of a noise critical space, cast or grout a metal sleeve into the structure. The internal diameter or dimensions of the sleeve shall be 2 inches larger than the external diameter or dimensions of the raceway passing through it. After all of the raceways are installed in that area, check the clearances and correct, if necessary, to within 1/2-inch. Pack the voids full depth with packing material sealed at both ends, 1-inch deep, with non-hardening sealant backed by foam rod.

END OF DOCUMENT 260500

DOCUMENT 260502 - EQUIPMENT WIRING SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This Section includes limited scope for electrical connections to equipment specified under other sections or divisions, or furnished under separate contracts or by the Owner.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Unless otherwise noted, perform all electrical work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this contract.
- B. Coordinate with work described in Division 11 Sections for equipment requiring electrical connection.
- B. Coordinate with work described in Division 22 Section "Medical Gas Systems".
- C. Coordinate with work described in Division 23 Section "Common Work Results for HVAC".
- D. Coordinate with work described in Division 23 Section "Direct-Digital Control for HVAC".
- E. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.
- F. Determine connection locations and rough-in requirements based on shop drawings.
- G. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.
- H. Sequence electrical connections to coordinate with start-up schedule for equipment.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Product data for the following products for:
 - 1. Special connectors
 - 2. Special conductors or cable assemblies.
- C. Shop drawings for:
 - 1. Detailing electrical characteristics, wiring diagrams, fabrication and installation for wiring systems.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to Authorities Having Jurisdiction.
2. Marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CORDS AND CAPS

- A. Attachment Plugs: Conform to NEMA WD 1.
- B. Configuration: NEMA WD 6, matching receptacle configuration at outlet provided for equipment, or as required by the equipment manufacturer.
- C. Cord: See Paragraph "Flexible Cords" in Division 26 Section "Low-voltage Electrical Power Conductors and Cables".
- D. Provide cord size suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify conditions of equipment and installation prior to beginning work.
- B. Verify that equipment is ready for connecting, wiring, and energizing.

3.2 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's instructions.
- B. Provide fire-resistive protective assembly or an electrical circuit protective system for feeders and control circuit conductors and cables having a fire-resistance rating of not less than 2 hours where required by NFPA or local building codes. Types of systems requiring a fire-resistive protective assembly include, but are not limited to:
 1. Feeders for Emergency Power systems
 2. Smokeproof Enclosure Pressurization systems
 3. Smoke Removal systems
 4. Fire service and Occupant Evacuation Elevator systems

3.3 ELECTRICAL DEVICES

- A. Install disconnect switches, controllers, control stations, and control devices (other than temperature control devices) as indicated, specified in other divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.

3.4 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturers' instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquid tight flexible conduit with watertight connectors in damp or wet locations.
- C. Make wiring connections using conductors and cable with insulation suitable for temperatures encountered in heat producing equipment.
- D. Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated on the Drawings.
- E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- F. Provide interconnecting conduit and wiring between devices and equipment where indicated on the Drawings.

3.5 EQUIPMENT

- A. When equipment is delivered in separate parts and field assembled, internal wiring, indicated on Shop Drawings as field wiring, will be provided by the equipment supplier, unless otherwise noted.
- B. Provide power connection to all equipment as required and as indicated in the equipment supplier's installation drawings.
- C. Provide all control and interlock wiring for all equipment that is not included within the responsibility of Division 22 or 23.
- D. Motorized Damper: Provide lockable toggle, pilot lighted disconnect switch in an accessible location at each motor actuator, or group of motor actuators.

3.6 DOOR OPERATORS AND HARDWARE

- A. Provide electrical connections to automatic entry doors, automatic corridor doors, electrically held door latches, remote release doors, and all other required electrical connections for door systems included in other sections of these specifications.
- B. Provide power connection to all equipment as required and as indicated in the equipment supplier's installation drawings.
- C. Provide all control wiring and conduit for all equipment that is not included within the responsibility of the door hardware installer. Provide connection from junction boxes to the door operators or hardware and from door operators to actuation devices as required. Install key operated switches, push pad switches, and other electrically controlled door operation devices furnished by other divisions within this contract.
- D. Provide fire alarm devices and wiring as required for proper operation of door systems in accordance with the NFPA codes.

3.7 SIGNAGE

- A. Provide junction boxes, disconnect switches and grounding per manufacturer's installation drawings.

- B. Coordinate rough-in requirements with signage installation instructions.
- C. Coordinate box locations and conduit routing with parapets and roof elevations.
- D. Provide labelling on all junction boxes and disconnects in accordance with Division 26 section "Identification for Electrical Systems"

END OF DOCUMENT 260502

DOCUMENT 260504 - PROVISIONS FOR ELECTRIC UTILITY SERVICE

PART 1 - GENERAL

1.1 SUMMARY

- A. Provisions for Underground Secondary Electrical Service.

1.2 GENERAL REQUIREMENTS

- A. Utility service voltage:
 - 1. 208Y/120 volts, three-phase, four-wire, 60 Hz
- B. Utility service ampacity: As indicated on the Drawings.
- C. The extent of Work for the secondary electrical service includes providing the following:
 - 1. Raceways
 - 2. Provisions for Metering
 - 3. Grounding and Bonding
 - 4. Concrete pad for service transformer

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Product Data: For the following products:
 - a. Meter bases
 - b. Current transformer cabinets
- C. Shop Drawings: For the following:
 - a. Utility Company prepared installation drawings
 - b. Cast-in-place concrete pads
- D. Field quality-control test reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

4. Utility voltage adjustment request.
 - E. Where equipment or materials are specified to comply with utility standards and are listed above as required submittals, obtain approval from the serving utility before submitting to the Contract Administrator.
 - F. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":
 1. Accurately record actual routing of interior conduits two-inch and larger trade size and all exterior buried raceway, including coordination with other surrounding utilities and underground structures. Provide scaled plans and sections that Indicate dimensions from finished grade or other fixed structural elements.
- 1.4 QUALITY ASSURANCE
- A. Perform all work in accordance with Utility Company installation drawings and service standards.
 - B. Maintain one copy of Utility Company installation drawings and service standards at the site.
 - C. Prior to commencing work in this Section, meet with the Utility Company representative to review service entrance requirements and details.
 - D. Verify that field measurements are as indicated on Utility Company drawings.
 - E. Electrical Components, Devices, and Accessories:
 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that are acceptable to authorities having jurisdiction.
 2. Marked for intended use.
 - F. Comply with NFPA 70.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 SECONDARY SERVICE ENTRANCE UNDERGROUND

- A. Provide an underground secondary service lateral from the pad mounted transformer in accordance with NFPA 70 Article 230 and the Utility Company standards. Reference the Drawings for service lateral conductor and raceway quantities, sizes, and types.
- B. The Utility Company will provide the service transformer.
- C. Provide a concrete pad, complying with the Utility Company standards, for transformer mounting, and set coated GRS conduit elbows and riser(s), with grounding bushing(s), to receive primary and secondary raceways. Where direct burial primary is used, set coated GRS conduit elbow(s) and riser(s), with grounding bushing(s), to receive primary cables.

- D. Make connections to the secondary terminals of the transformer as required and in conformance with Utility Company requirements. Utility Company will provide primary conductors and terminal connections unless otherwise directed by the Utility Company.

3.2 SECONDARY SERVICE ENTRANCE OVERHEAD

- A. Provide overhead secondary service drop from the pole-mounted transformer in accordance with NFPA 70 Article 230 and the Utility Company standards. Reference the Drawings for service drop conductor quantities, sizes, and type.
- B. The Utility Company will provide the service transformer.
- C. Coordinate connection with Utility Company and make connections to service drop from transformers in accordance with Utility Company standards.

3.3 METERING

- A. Provide a 1-1/4-inch empty GRS conduit, with pull cord, from the current transformer compartment of service entrance equipment to the meter location indicated on the Drawings, or as directed by the Utility Company.
- B. Provide a 1-1/4-inch empty GRS conduit, with pull cord, from the secondary compartment of the pad-mounted service transformer to the meter location shown on the Drawings, or as directed by Utility Company.
- C. Install the meter base furnished by the Utility Company.
- D. Install the current transformer cabinet furnished by the Utility Company.
- E. The Utility Company will provide the meter and meter wiring.

3.4 UTILITY SERVICE CHARGES

- A. It shall be the responsibility of the Division 26 contractor to apply for the electrical service, including the preparation and completion of all forms. Submit the completed application along with all other required documentation for the new or modified service.
- B. Pay all Utility Company charges for providing electric service, including all charges for bringing primary service conductors to the site.

3.5 FIELD QUALITY CONTROL

- A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:
 - 1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each secondary unit substation. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.

2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
 - a. Rebalance loads.
 - b. Prepare written request for voltage adjustment by electric utility.
3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained. Submit results in writing.

END OF DOCUMENT 260504

DOCUMENT 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Conductors, cables, and cords rated 600V and less.
- B. Connectors and terminations rated 600V and less.

1.2 DEFINITIONS

- A. The following abbreviations apply to this and other Sections of these specifications:
 - 1. MC: Metal Clad
 - 2. NBR: Acrylonitrile-butadiene rubber
 - 3. NETA ATS: Acceptance Testing Specification.
- B. The following definitions apply to this and other Sections of these Specifications:
 - 1. HOMERUN: That portion of an electrical circuit beginning at a junction box, termination box, receptacle or switch with termination at an electrical panelboard.
 - a. Note: Where MC Cable is allowed to be utilized for receptacle and/or lighting branch circuiting loads, the originating point of the homerun shall be at the first load in the circuit or at a junction box in an accessible ceiling space immediately above the first (most upstream) load.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop and temperature deration.
 - 2. Coordinate routing of power, low-voltage, and control conduits requiring fire-resistive protective assembly or electrical circuit protective system. Fire-resistive protective assembly or electrical circuit protective system for power, low-voltage, and control circuit conductors and cables shall have a fire-resistance rating of not less than 2 hours and shall be provided where required by NFPA or local building codes. Types of systems requiring a fire-resistive protective assembly include, but are not limited to:
 - a. Feeders for Emergency Power systems
 - b. Smokeproof Enclosure Pressurization systems
 - c. Smoke Control systems
 - d. Smoke Removal systems

- e. Fire service and Occupant Evacuation Elevator systems
 - 3. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
 - 4. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.
 - B. Notify Contract Administrator of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
- 1.4 SUBMITTALS
- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Product data for the following products:
 - a. Conductors, cables, and cords rated 600V and less.
 - b. Metal Clad (MC) cable and fittings.
 - 2. Shop drawings for:
 - a. Fire-Resistive MC cables.
 - B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
 - C. Sustainable Design Documentation: Submit manufacturer's product data on conductor and cable showing compliance with specified lead content requirements.
 - D. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.
 - E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - F. Qualification Data: For testing agency.
 - G. Field quality-control test reports in accordance with NETA ATS:
 - 1. Submit all system and component test results.
 - H. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.
 - I. Operation and Maintenance Data: For cable and all accessories to include in operation and maintenance manuals.

- J. Follow-up service reports.

1.5 QUALITY ASSURANCE

- A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.
- B. Provide products listed and classified by Underwriters Laboratories, Inc (UL) as suitable for the purpose specified and indicated.
- C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- D. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Contract Administrator and obtain direction before proceeding with work.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner, or others, unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Contract Administrator and the Owner no fewer than 7 days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Contract Administrator and the Owner's written permission.
 - 3. Owner reserves the right to require Contractor to cease work in any area Owner requires access to on an emergency basis.
- C. Make every effort to schedule outages during non-business or off-peak business hours to minimize disruptions to business operations.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.8 SEISMIC REQUIREMENTS

- A. Seismic bracing, restraints, and controls for all electrical systems specified herein shall be designed and installed as required by Division 26 Section "Seismic Controls for Electrical Systems" and Division 20 Section "Seismic Controls for MEP/F/T Systems".

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES - GENERAL

- A. Available Manufacturers, unless noted otherwise:
 - 1. AFC Cable Systems, Inc.
 - 2. Alan Wire
 - 3. Cerrowire
 - 4. Colonial Wire & Cable
 - 5. Encore Wire Corporation
 - 6. General Cable
 - 7. Northern Cables Inc.
 - 8. Okonite Company
 - 9. Southwire Company
- B. Conductor Material: Annealed (soft) copper complying with ICEA S-95-658/NEMA WC70 and UL Standards 44 or 83, as applicable.
 - 1. Solid conductors for No. 10 AWG and smaller; concentric, compressed stranded for No. 8 AWG and larger
 - 2. Stranded conductors
 - 3. Stranded for all flexible cords, cables, and control wiring.
 - 4. As noted otherwise below.
- C. Conductor Material: Compact stranded, aluminum alloy (AA-8000 Series), complying with ICEA S-95-658/NEMA WC70; No. 3/0 AWG or larger only

- D. Conductor Insulation: Type THHN/THWN-2, THW, or XHHW-2 complying with ICEA S-95-658/NEMA WC70.
- E. Sizes of conductors and cables indicated or specified are American Wire Gage (Brown and Sharpe).
- F. Unless indicated otherwise, special purpose conductors and cables, such as low voltage control and shielded instrument wiring, shall be as recommended by the system equipment manufacturer.
- G. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

2.2 SINGLE CONDUCTORS

- A. 600V, insulated conductors as noted above shall be color-coded as follows, unless noted otherwise:

PHASE	208Y/120V
A	Black
B	Red
C	Blue
Neutral	White
Equipment Ground	Green
Isolated Ground	Green/Yellow Stripe

**Except as provided in NFPA 70.

- B. Conductors shall not be smaller than No. 12 AWG, with the exception of wiring for signal and pilot control circuits; and pre-manufactured whips for light fixtures which may be No. 14 AWG.
- C. Conductors installed for site electrical work shall be no smaller than No. 10 AWG CU. All site electrical branch circuit wiring shall be sized such that the maximum branch circuit voltage drop is less than 3 percent.

2.3 METAL CLAD CABLE; TYPE MC

- A. General:
 - 1. Shall not be used on this project.

2.4 MANUFACTURED WIRING SYSTEMS

- A. Manufacturers:
 - 1. Acuity – ReLoc
 - 2. Cooper Industries
- B. Description: Manufactured wiring assemblies complying with NFPA 70, and listed and labeled as complying with UL 183.

- C. Provide components necessary to transition between manufactured wiring system and other wiring methods.
 - D. Branch Circuit Cables:
 - 1. Conductor Stranding (Size 10 AWG and Smaller): Solid.
 - 2. Insulation Voltage Rating: 600 V.
 - 3. Insulation: Type THHN.
 - 4. Provide dedicated neutral conductor for each phase conductor.
 - 5. Grounding: Full-size integral equipment grounding conductor.
 - a. Provide additional isolated/insulated grounding conductor where indicated or required.
 - b. Provide redundant grounding, suitable for general purpose, non-essential electrical systems in non-hazardous patient care areas of health care facilities where indicated or required.
 - 6. Armor: Steel, interlocked tape.
 - E. Connectors: Keyed and color-coded to prevent interconnection of different voltages.
 - F. Fixture Leads: Type TFN insulation.
- 2.5 FLEXIBLE CORDS
- A. 600V, multi-conductor (2, 3, or 4 as indicated on the Drawings), oil-resistant jacket, extra-hard-usage; Type SEO, SO, or STO for indoor dry and damp locations; SEOW, SOW, or STOW for damp, wet, and outdoor locations; or as required by the manufacturer of the equipment to which the cords are connected.
 - B. 300V, multi-conductor (2, 3, or 4 as indicated on the Drawings), oil-resistant jacket, hard-usage; Type SJEO, SJO, or SJTO for indoor dry locations; SJEOW, SJOW, or SJTOW for damp, wet, and outdoor locations; or as required by the manufacturer of the equipment to which the cords are connected.
- 2.6 CONTROL WIRING
- A. Refer to Division 23 Section "Direct-Digital Control for HVAC"
 - B. Refer to Division 27 Section "Direct-Digital Control for HVAC"
 - C. Unless otherwise noted, all control wiring will be the responsibility of the Section or Division in which the control system is specified.
- 2.7 CONNECTORS
- A. Available Manufacturers:

1. AMP; Tyco
 2. FCI-Burndy
 3. Gould
 4. Ideal Industries, Inc.
 5. IlSCO
 6. NSI Industries, Inc.
 7. O-Z/Gedney
 8. Panduit
 9. Thomas and Betts
 10. 3-M Electrical Products Division
- B. Compression connectors for conductors No. 8 AWG and larger: Long-barreled, UL 486-listed, circumferential compression type (Burndy "Hylug", or equal), insulated with clamp-on, cold-shrink, or molded covers, or wrapped with multiple over-lapping layers of 3-M Scotch electrical tape.
1. Termination fittings for copper conductors: Tinned copper, 2-hole pad and inspection port.
 2. Termination fittings for aluminum conductors: Tinned aluminum, 2-hole pad.
- C. Mechanical connections for conductors No. 8 AWG and larger: UL-listed, dual-rated, mechanical type, insulated with clamp-on, cold-shrink, or molded covers, or wrapped with multiple over-lapping layers of 3-M Scotch electrical tape.
1. Termination fittings: Tinned copper, 2-hole pad and inspection port.
 2. Termination fittings: Tinned aluminum, 2-hole pad.
- D. Connectors for solid conductors No. 10 AWG and smaller: Insulated winged wire nuts. Color-coded for size, except use green only for grounding connections.
- E. Connectors for stranded conductors No. 10 AWG and smaller: Tinned copper, insulated-sleeve, compression type, UL-listed, with wire insulation grip. Terminations: ring-tongue type.
- F. Connectors and terminations for aluminum conductors and cables No. 1 and larger: UL 486B listed and marked AL7CU for 75 deg C rated conductors and AL9CU for 90 deg C rated conductors.
- G. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- H. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

PART 3 - EXECUTION

3.1 PREPERATION

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping".
- B. Coordinate seals with wall, ceiling, roof or floor materials and rating of the surface (sound, fire, waterproofing, etc.)
- C. Electrical conductor and cable work is schematically represented on the Drawings. Unless otherwise indicated, conductor sizes shown on the Drawings are based on not more than three single current-carrying conductors in a raceway in free air. Current ratings are based on copper at 75 degrees C temperature rating for all power circuits. Modify raceway and conductor sizing as may be necessitated by any deviation from these conditions. Do not decrease the indicated conductor size due to the use of conductors having a temperature rating of 90 degrees C.
- D. Conductor sizes shown are minimum based on code requirements, voltage drop, and/or other considerations. Where approved by the Engineer and at no extra cost to the Owner, larger conductor sizes may be installed at Contractor's option in order to utilize stock sizes, provided raceway sizes are increased where necessary to conform with NFPA 70 (determine the effect of the use of larger conductors on the short circuit current ratings of the electrical equipment, and provide increased short circuit current rated equipment as required).
- E. Where anticipated conductor installed lengths exceed the lengths indicated on the Drawings, notify Contract Administrator. Provide tabulated list of exceeded lengths for review. Increase conductor size, circuit ground size, and conduit size accordingly to meet maximum voltage drop indicated within the calculations.

3.2 INSTALLATION

- A. General
 - 1. Unless otherwise indicated on the Drawings or in other Sections, install all conductors in raceway. Install continuous conductors between outlets, devices and boxes without splices or taps. Do not pull connections into raceways. Leave at least 12 inches of conductor at outlets for fixture or device connections.
 - 2. Install in accordance with manufacturer's instructions.
 - 3. Use manufacturer-approved pulling compound or lubricant where necessary; compound used shall not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
 - 4. Use pulling means, including fish tape, cable, rope, and basket weave conductor/cable grips that will not damage conductors/cables or raceway.
 - 5. Where parallel conductors are shown, install each set of conductors in separate raceways of essentially the same length.

6. Seal around cables penetrating fire-rated elements according to Division 07 Section "Penetration Firestopping".
7. Wiring at Outlets: Install conductors at each outlet with at least 6 inches of slack.
8. Common or Shared Neutrals are not allowed unless shown on the plans or specifically noted to be allowed.
9. Multi-wire branch circuits are not allowed unless noted otherwise on the drawings.
10. Where multi-wire branch circuits are utilized (i.e., shared neutral), shall be provided with a means that will simultaneously disconnect all ungrounded conductors at the point the branch circuit originates. Multi-pole breakers or 3 single pole breakers with a handle tie are two examples.
11. When multiple home runs are combined into a single raceway such that the number of conductors exceeds four (conductor count is made up of any combination of phase and neutral conductors), the following restrictions apply, which are in addition to those in NFPA 70:
 - a. Emergency Power Circuits – includes all circuits covered under Articles 700, 701 and 702.
 - 1) Maximum of eight conductors in a single raceway. Minimum raceway size: ¾-inch. Do not install any other type of circuit in this raceway.
 - 2) Only 15A and 20A branch circuit homeruns may be combined into one raceway.
 - b. Healthcare Critical branch circuits as defined in Article 517.
 - 1) Maximum of eight conductors in a single raceway. Minimum raceway size: ¾-inch. Do not install any other type of circuit in this raceway.
 - 2) Only 15A and 20A branch circuit homeruns may be combined into one raceway.
 - c. Healthcare Life Safety branch circuits as defined in Article 517.
 - 1) Maximum of eight conductors in a single raceway. Minimum raceway size: ¾-inch. Do not install any other type of circuit in this raceway.
 - 2) Only 15A and 20A branch circuit homeruns may be combined into one raceway.
 - d. Healthcare Essential Equipment circuits as defined in Article 517.
 - 1) Maximum of eight conductors in a single raceway. Minimum raceway size: ¾-inch. Do not install any other type of circuit in this raceway.

- 2) Only 15A and 20A branch circuit homeruns may be combined into one raceway.
- e. Normal or Non-Essential circuits.
 - 1) Maximum of 16 conductors in a single raceway. For up to eight conductors in a raceway, minimum raceway size: 3/4 inch. For greater than eight conductors, minimum raceway size: 1 inch. Do not install any other type of circuit in this raceway.
 - 2) The minimum wire size for all conductors in this raceway: No. 10 AWG.
 - 3) Only 15A and 20A branch circuit homeruns may be combined into one raceway.
- f. GFCI-protected circuits.
 - 1) Do not use multi-conductor circuits, with a shared neutral, for any GFCI circuit breaker or receptacle circuit.
12. For branch circuits fed from GFCI circuit breakers, limit the one-way conductor length to 100 feet between the panelboard and the most remote receptacle or load on the GFCI circuit.
13. Where the number of conductors for branch circuits is not shown on the Drawings, determine the number of conductors in accordance with NFPA 70. Provide adequate conductors so as to allow performance of all functions of the device.
14. Branch circuit conductors shall be copper.
15. All essential power systems circuits shall be copper.
16. Provide all conductors with 600V insulation of the following types, unless otherwise noted on the Drawings or in these Specifications:
 - a. Wet or dry locations, in raceways:
 - 1) Service entrance: Type THWN, THHN/THWN-2, or XHHW.
 - 2) Feeders and branch circuits: Type THWN, THHN/THWN-2, or XHHW.
 - 3) Conductors No. 6 AWG and smaller: Types THWN or THHN/THWN-2.
 - b. Direct buried:
 - 1) Service entrance: USE.
 - 2) Feeders and branch circuits: UF or USE.

- c. Fluorescent light fixtures or conductors within three feet of high temperature equipment such as heaters: Type THHN, XHHW, or higher temperature insulation as required for the use.

B. Aluminum Conductor Option:

1. Terminations: Tinned, compression type only; UL-listed for copper and aluminum conductors at 75 degrees C minimum.
2. Increase the raceway size as required, at no additional cost to the Owner, to accommodate the increased size of the aluminum conductors.
3. Aluminum conductor size shall meet or exceed the ampere rating of the scheduled copper conductors at 75 degrees C.
4. Option applies only for the following feeders or services; minimum size as indicated in "Conductors and Cables" materials section above:
 - a. Service and feeder conductors under 200amps shall be copper.
 - b. Normal power service and feeder wiring 200 amps and over shall be aluminum unless prohibited below.
 - 1) Exceptions:
 - a) Feeders connecting directly to motors including, but not limited to, chillers and fire pumps shall be copper to minimize loosening of connectors due to cyclical thermal expansion.
 - c. Service entrance conductors
 - d. Feeders to switchboards
 - e. Feeders to panelboards
 - 1) Exception: Apartment unit load center feeder conductors shall be copper; aluminum is not acceptable.
 - f. Feeders to motor control centers
 - g. Feeders to transformers
5. Where aluminum conductors terminate existing panelboards, switchboards or switchgear that utilize compression connections use hydraulic-compression type connectors with a zinc base, anti-oxidizing compound. Use compression tools of the type that will not release unless the correct pressure has been applied.
6. Measure the temperature of all aluminum conductors at all splices and terminations. Make each test under typical building load conditions after the building is occupied and in operation for a minimum of two weeks. Replace all joints or splices indicating excessive heating.

7. Take measurements with a non-contact type infrared thermometer, with target size not exceeding one inch at five feet and an accuracy of two percent or better. Submit the meter specifications and calibration date with the test results.

C. Flexible Cords

1. Refer to Division 26 Section, "Equipment Wiring Systems", for electrical connections to equipment.

D. Control Wiring

1. Unless otherwise indicated on the Drawings or in other sections, install all control wiring in raceway, regardless of voltage. A qualified Electrician shall install all control wire operating at 120V nominal and above. Control wiring operating at less than 120V (e.g., 12V and 24V) may be installed under the Division furnishing it.
2. Open wiring in air-handling plenums: UL listed and classified for use in air plenums without raceway. Where indicated on the Drawings or otherwise specified, and permitted by local codes, only cable for communication or fire alarm systems and low voltage control wiring may be installed without raceways.
 - a. Low voltage wiring not routed in a race way shall be supported by cable tray or j-hooks secured independently of ceiling supports. Cabling shall not be supported directly by the ceiling system.

E. Connections:

1. Apply a zinc based, anti-oxidizing compound to connections.
2. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
3. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
4. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
5. Use only resin pressure splices and splicing kits that totally encapsulate the splice for splices in underground junction boxes. Arrange the splicing kit to minimize the effects of moisture.
6. Use connectors as indicated in equipment schedules. Where not indicated use connections as noted below.
 - a. Compression – Conductors No. 8 AWG and larger to panelboards, switchboards and apparatus
 - b. Compression – splices, terminals
 - c. Mechanical – where temporary removal is required

7. Do not use terminals on wiring devices to feed through to the next device.

3.3 IDENTIFICATION

- A. General: Provide all identification per Division 26 "Identification for Electrical Systems".
- B. Single Conductors: Identify and color-code conductors to indicate voltage and phase according to Part 2 of this Section. Identification method shall be either:
 1. Factory provided colored insulation
 2. Color-Coding Conductor Tape.
 3. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- C. Power-Circuit Conductor Identification: For primary and secondary conductors 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes identify voltage, source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in the same junction or pull box identify each ungrounded conductor according to voltage, source and circuit number.
- E. Conductors to Be Extended in the Future: Attach identification device to conductors and list source and circuit number.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- G. Conductors for controls (lighting, controls): Label each conductor with Markers for Conductor and Control Cables. – identify conductors using method as noted in Division 26 Section "Identification for Electrical Systems". Note conductor identification on record Drawings.
- H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
- I. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

- J. Low voltage cable sheath labels and related manufacturer information shall remain apparent in all exposed applications.

- 1. Protect exposed cabling labels from painting and overspray (this includes protection of cables in cable tray)

3.4 FIELD QUALITY CONTROL

- A. Do not perform insulation resistance tests of the distribution wiring to equipment with the surge protective devices installed. Disconnect surge protective device before conducting insulation resistance tests and reconnect immediately after the testing is over.
- B. Testing: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- C. Testing: Engage a qualified testing agency to perform the following field quality-control testing:
- D. Testing: Perform the following field quality-control testing:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements. Test all wiring prior to energizing to ensure that it is free from unintentional grounds and shorts, is properly phased, and that all connectors are tight.
 - 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3. Certify compliance with test parameters.
- E. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF DOCUMENT 260519

DOCUMENT 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.
- B. This Section includes:
 - 1. Grounding Electrodes
 - 2. Ground Bars
 - 3. Grounding Conductors
 - 4. Connector Products
 - 5. Equipotential Grounding System
 - 6. Miscellaneous Grounding Materials and Products

1.2 DEFINITIONS

- A. The following apply to this and other Sections of these Specifications:
 - 1. Ground ring: Bare underground grounding conductor encircling the building or structure.
 - 2. NETA ATS: Acceptance Testing Specification.
 - 3. PSF: Pounds per Square Foot
 - 4. EMT: Electrical metallic tubing.
 - 5. ENT: Electrical nonmetallic tubing.
 - 6. FMC: Flexible metal conduit.
 - 7. GRS: Galvanized Rigid Steel Conduit
 - 8. IMC: Intermediate metal conduit.
 - 9. LFMC: Liquidtight flexible metal conduit.
 - 10. LFNC: Liquidtight flexible nonmetallic conduit.
 - 11. RAC: Rigid Aluminum Conduit
 - 12. RMC: Rigid Metal Conduit

13. RNC: Rigid nonmetallic conduit.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Product data for the following products:
 - a. Electrodes, mechanical and compression connectors, and exothermic connectors .
- B. Qualification Data: For a qualified testing and inspecting agency engaged by Contractor.
- C. Quality-Control Test Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Accurately record actual locations of all buried electrodes, bonding conductors and ground rings. Indicate dimensions from fixed structural elements.

1.4 QUALITY ASSURANCE

- A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.
- B. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."
- C. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- D. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 2. Marked for intended use.

3. Comply with UL 467.
- E. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.
- F. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS, CONNECTORS, AND ELECTRODES:

- A. Available Manufacturers:
 1. ABB, Inc.
 2. Advanced Lightning Technology (ALT)
 3. AFL Global
 4. Boggs, Inc.
 5. Burndy; Hubbell.
 6. Cooper Power; Eaton.
 7. Copperweld Corp.
 8. ECN/Korns; Division of Robroy Industries.
 9. Erico; nVent.
 10. Galvan Industries, Inc.
 11. Greaves Corp.
 12. Harger.
 13. Hastings Fiber Glass Products, Inc.
 14. Heary Brothers Lightning Protection Co.
 15. Ideal Industries, Inc.
 16. ILSCO.
 17. Lightning Master Corp.
 18. Lyncole XIT Grounding; Division of VFC.
 19. O-Z/Gedney Co.; Emerson.
 20. Panduit, Inc

21. RACO; Hubbell, Inc.
22. Robbins Lightning, Inc.
23. Superior Grounding Systems, Inc.

2.2 GROUNDING ELECTRODES

A. Ground Rods: UL-listed:

1. Copper-clad steel; bonded copper electrolytically-applied to minimum thickness of 10 mils.
2. Hot-dip galvanized steel; minimum zinc thickness specified per ASTM A-123.
3. Stainless steel; Type [304][416].
4. Size: 5/8 inch by 8 feet. Provide sectional types when longer rods are indicated.

B. Ground Plates: UL-listed, rectangular, bare solid copper plate; minimum 0.032-inch thick.

C. Ground Ring:

1. Bare copper grounding conductor, size as noted on Drawings but not less than #2/0 AWG.

2.3 GROUND BARS

A. General

1. Ground bars described in this section are intended to be wall mounted bars used for grounding and bonding. Equipment ground buses for switchboards, panelboards and miscellaneous equipment are described in the individual equipment sections.
2. Supports: Minimum of two each 1-1/2-inch insulators and 1-inch stainless steel offset mounting brackets.

B. Electrical Room Ground Bars

1. Rectangular Ground Bars: bare, 1/4 inch thick, electrolytic, tough pitch copper bar, 4 inches wide. Length as indicated on the Drawings but not less 24 inches long. Hole spacing as required for conductor lugs.

C. Telecommunications Main Grounding Busbar (TMGB)

1. Rectangular Ground Bars: UL & cUL Listed to UL467 & C22.2 respectively, pre-drilled per TIA/EIA Standard 607A, bare, 1/4 inch thick, electrolytic, tough pitch copper bar, 4 inches wide. Length as indicated on the Drawings but not less than 24 inches long.

D. Telecommunications Grounding Busbar (TGB)

1. Rectangular Ground Bars: UL & cUL Listed to UL467 & C22.2 respectively, pre-drilled per TIA/EIA Standard 607B, bare, 1/4 inch thick, electrolytic, tough pitch copper bar, 2 inches wide. Length as indicated on the Drawings but not less than 24 inches long.

2.4 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".
- B. Material:
 - 1. Aluminum.
 - 2. Copper-clad aluminum.
 - 3. Copper.
- C. Equipment Grounding Conductors: Insulated and identified as indicated in Part 3 of this section.
- D. Isolated Ground Conductors: Insulated and identified as indicated in Part 3 of this section.
- E. Grounding Electrode Conductors: Bare, stranded, unless otherwise indicated.
- F. Underground Conductors:
 - 1. Tinned-copper conductor.
 - 2. No. 2/0 AWG minimum
 - 3. Solid, unless otherwise indicated.
- G. Bare Copper Conductors:
 - 1. Solid Conductors: Comply with Conductors: ASTM B 8.
 - 2. Tinned Conductors: Comply with ASTM B 33.
- H. Copper Bonding Conductors:
 - 1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
 - 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
 - 3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (wide and 1/16 inch thick.
- I. Aluminum Bonding Conductors:
 - 1. Bonding Cable: 10 strands of No. 14 AWG aluminum conductor, 1/4 inch in diameter.
 - 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded aluminum conductor.

3. Bonding Jumper: Aluminum tape, braided bare aluminum conductors, terminated with aluminum ferrules; 1-5/8 inches wide and 1/16 inch thick.

J. Ground Ring:

1. Bare copper grounding conductor, size as noted on Drawings but not less than #2/0 AWG.

K. Ground Conductor and Conductor Protector for Wood Poles: As follows:

1. No. 4 AWG minimum, soft-drawn copper conductor.
2. Conductor Protector: Half-round PVC or wood molding. If wood molding is utilized, use pressure-treated fir, or cypress or cedar.

2.5 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors.
- C. Compression Connectors: Burndy Hyground, or equal, permanent, pure, wrought copper, meeting ASTM 8 1 87, essentially the same as the conductors being connected; clearly and permanently marked with the information listed below:
1. Company symbol and/or logo.
 2. Catalog number.
 3. Conductors accommodated.
 4. Installation die index number or die catalog number is required.
 5. Underwriters Laboratories "Listing Mark:".
 6. The words "Suitable for Direct Burial" or, where space is limited, "Direct Burial" or "Burial" per UL Standard ANSI/UL467.
- D. Cast connectors: copper base alloy according to ASTM B 30.
- E. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.6 MISCELLANEOUS

A. Test Wells:

1. Traffic Areas: Polymer concrete reinforced with heavy weave fiberglass; H-20 load rating; minimum 24 inches deep.
2. Non-traffic Areas: High density polyethylene; 350 PSF minimum load rating; minimum 10.25 inches deep.

3. Cover: Factory-identified by permanent means with word "GROUND".

PART 3 - EXECUTION

3.1 PREPARATION

- A. Examine areas and conditions under which electrical grounding connections are to be made and notify the Contract Administrator and the Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:

1. Provide all materials, labor and equipment for an electrical grounding system in accordance with applicable portions of NFPA 70 and NECA. Coordinate electrical work as necessary to interface installation of electrical grounding systems with other work.
2. Accomplish grounding and bonding of electrical installations and specific requirements for systems, circuits and equipment required to be grounded for both temporary and permanent construction.
3. Where the size of the grounding conductors are not shown, size in accordance with NFPA 70 Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Application:

1. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
2. Underground Grounding Conductors: Unless noted otherwise, bury at least 24 inches below grade, or 6 inches below the official frost line, whichever is greater, or when crossing a duct bank, bury 12 inches above duct bank.

- C. Grounding Electrode System: Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.

1. Provide continuous grounding electrode conductors without splice or joint.
2. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
3. Ground Rod Electrodes:
 - a. Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.

- b. Unless otherwise indicated, install ground rod electrodes vertically.
 - 1) Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
 - 2) Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.
 - c. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70. If depth is unachievable, notify Contract Administrator and Engineer.
 - d. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
 - e. Verify that final backfill and compaction has been completed before driving rod electrodes.
 - f. Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade, pavement, or floor.
- 4. Ground Plate Electrodes: Unless otherwise indicated, install ground plate electrodes at a depth of not less than 30 inches. Use exothermic weld to secure grounding electrode conductor.
 - 5. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare, tinned copper conductor not smaller than No. 4 AWG. If concrete foundation is less than 20 feet long, coil excess conductor within the base of the foundation. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor above footer and foundation and connect to building structural steel or other grounding electrode external to concrete.
 - 6. Metal Water Service Pipe: Provide 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 by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 7. Ground Ring Electrode (Counterpoise):
 - a. Provide a ground ring encircling the building or structure, in direct contact with earth., installed at a depth of not less than 18 inches or 6 inches below the official frost line, whichever is greater.
 - b. Locate ground ring conductor at least 24 inches outside building perimeter foundation, unless noted otherwise on the Drawings.
 - c. Provide ground enhancement material around conductor where indicated.

8. Metal In-Ground Support Structures: Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
 9. Metal Poles Supporting Outdoor Luminaires: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.
- D. Equipment Grounding Conductors:
1. Comply with NFPA 70, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
 2. Install equipment grounding conductors in all feeders and branch circuits.
- E. Ground Bars:
1. Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated on the Drawings.
 - a. Use insulated spacers and mounting brackets, and support from wall 2 feet above finished floor, unless otherwise indicated.
- F. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a ground bar.
 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- G. Separately Derived Systems: Bond the derived neutral (grounded) conductor of all separately derived system (e.g., transformers, generators, UPS) to the nearest available grounding electrode, or back to the service grounding electrode if no approved electrodes are readily available. Size the grounding electrode conductor and bonding jumpers as indicated on the Drawings or as required by NFPA 70, whichever is larger.
- H. Bonding: Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70:
1. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care

not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

2. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.
3. Bond metallic elements likely to become energized or where indicated on the Drawings, including but not limited to fences around electrical equipment and metal drain bodies near pools or electrical equipment.
4. Bond raised flooring systems and static control flooring.
5. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.
6. Common Ground Bonding 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 PVC conduit.
7. Pole Mounted Luminaires: Bond metal enclosures and components of pole mounted luminaires to the grounding system per the Manufacturer's requirements.
8. Bond the components within the following systems to the building grounding system:
 - a. Metallic Cable Tray Systems.
 - b. Photovoltaic Systems.

3.3 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible. Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by the manufacturers for indicated applications. Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, and bonding straps as recommended by the manufacturers for types of service indicated.
 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 2. Make connections with clean, bare metal at points of contact.
 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Replace welds that are puffed up or that show convex surfaces indicating improper cleaning. Use exothermic welded connections for the following:
 - 1. Connecting conductors together.
 - 2. Connecting conductors to ground rods, except at test wells.
 - 3. Connecting conductors to building steel.
 - 4. Connecting conductors to plates.
- C. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
 - 1. Compression Fittings: Permanent compression-type fittings may be used for the following rather than exothermic connections:
 - a. Connecting conductors together.
 - b. Connecting conductors to building steel.
 - c. Connecting conductors to ground rods, except at test wells.
- D. Mechanical Pressure-Type Connections: Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
 - 1. Mechanical Pressure Fittings: Use bolted mechanical (removable) pressure-type clamps for the following:
 - a. Connecting conductors to ground rods at test wells.
 - b. Connecting conductors to pipes.
- E. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- F. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- G. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.

- H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.4 IDENTIFICATION

- A. Provide identification as specified in Division 26 "Low-Voltage Electrical Power Conductors and Cables" and "Identification for Electrical Systems".

3.5 FIELD QUALITY CONTROL

- A. Testing: Engage a qualified testing agency to perform the following field quality-control testing:

- B. Testing: Perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.
3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
4. Inspect and test in accordance with NETA ATS, except Section 4.
5. Perform inspections and tests listed in NETA ATS, Section 7.13.
6. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
7. Perform point-to-point megohmmeter tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
8. Test Values:
 - a. The resistance between the main grounding electrode and earth ground shall be no greater than 5 ohms.
 - b. Equipment Rated 500 kVA and Less: 10 ohms.
 - c. Equipment Rated 500 to 1000 kVA: 5 ohms.
 - d. Equipment Rated More Than 1000 kVA: 3 ohms.

- e. Substations and Pad-Mounted Switching Equipment: 5 ohms.
 - f. Manhole Grounds: 10 ohms.
- 9. Minimum system neutral-to-ground insulation resistance: one megohm.
 - 10. Investigate point-to-point resistance values that exceed 0.5 ohms.
 - a. Check for loose connections.
 - b. Check for absent or broken connections.
 - c. Check for poor quality welds.
 - d. Consider other reasons.
 - 11. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements
 - 12. Excessive Grounding Electrode Resistance: If measured resistance to earth ground value exceeds specified values, add grounding electrodes and additional conductors as required to obtain the specified value.
 - 13. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF DOCUMENT 260526

DOCUMENT 260529 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Contract Administrator of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
6. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
7. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

B. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in path of conduit groups with supports.

2. HVAC items, plumbing items and architectural features in the paths of conduit groups with common supports.

C. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1. Submit fabrication drawings and product literature.

- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 70 and applicable building code.

- B. Installer Qualifications for Powder-Actuated Fasteners: Certified by fastener system manufacturer with current operator's license.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. General:

1. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.

- B. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly. Use corrosion resistant materials suitable for the environment where installed.

1. Manufacturers:

- a. Allied Tube & Conduit; Atkore International.
- b. Eaton
- c. Erico; nVent.
- d. GS Metals Corp.
- e. Thomas & Betts Corporation.

- f. Unistrut; Atkore International.
 - g. Wesanco, Inc.
 - 2. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
- C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.
 - 1. Manufacturers:
 - a. Allied Tube & Conduit.
 - b. Eaton.
 - c. Enduro Composites.
 - d. Fabco Plastics Wholesale Limited.
 - e. Seasafe, Inc.
 - 2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 - 3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
 - 4. Rated Strength: Selected to suit applicable load criteria.
 - 5. Flammability: Fire retardant with NFPA 101, Class A flame spread index (maximum of 25) when tested in accordance with ASTM E84; self-extinguishing in accordance with ASTM D635.
- D. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- E. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
 - 1. Conduit Straps: One-hole or two-hole type.
 - 2. Conduit Clamps: Bolted type unless otherwise indicated.
- F. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- G. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

- H. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Powers Fasteners, Inc;
 - 5) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, [zinc-coated] [stainless] steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Unless specifically indicated or approved by the Contract Administrator and Structural Engineer, do not support from roof deck.
- C. Where support wires are permitted, identify independent electrical component support wires above accessible ceilings with color distinguishable from ceiling support wires in accordance with NFPA 70.
- D. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - 1. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - 2. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
- E. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway:
 - 1. Minimum rod size shall be 1/4 inch (6 mm) in diameter, unless otherwise indicated.
 - a. Equipment Supports: 1/2 inch diameter minimum.
 - b. Busway Supports: 1/2 inch diameter minimum.
 - c. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch diameter minimum.
 - d. Trapeze Support for Multiple Conduits: 3/8 inch diameter minimum.
 - 2. Space supports for EMT, IMC, and RMC as required by NFPA 70.
- F. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with:
 - a. two-bolt conduit clamps
- G. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Install in accordance with manufacturer's instructions.
- E. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- F. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
 - 1. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 1.5. Include consideration for vibration, equipment operation, and shock loads where applicable.
- G. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
- H. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- I. Remove temporary supports when no longer required.
- J. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- K. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Steel:
 - a. Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts

- b. Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69
- c. Spring-tension clamps.
- 5. To Light Steel: Sheet metal screws.
- 6. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- L. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.
- D. Minimize overhanging materials and protrusions, and provide protective caps and fittings on exposed material ends where:
 - 1. Accessible to untrained personnel.
 - 2. Located within confined spaces.
- E. Rooftop support assemblies:
 - 1. Conduit supports: Unless noted otherwise, coordinate installation of support system after roofing materials are complete. Provide adhesive materials to secure conduit supports where required. Where attachment to roof structure is required or otherwise specified, coordinate installation of supports with roofing material installation.
 - 2. Equipment supports: Coordinate installation of supports with roofing material installation.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 "Concrete".
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Comply with requirements in Division 09 "Finishes" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.
- D. Inspect support and attachment components for damage and defects. Correct deficiencies and replace damaged or defective support and attachment components.

END OF DOCUMENT 260529

DOCUMENT 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes:

1. Raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 DEFINITIONS

A. Terminology used in this specification is as defined below:

1. EMT: Electrical Metallic Tubing
2. FMC: Flexible Metal Conduit
3. GRS: Galvanized Rigid Steel Conduit
4. IMC: Intermediate Metal Conduit
5. LFMC: Liquidtight Flexible Metal Conduit
6. LFNC: Liquidtight Flexible Nonmetallic Conduit
7. RAC: Rigid Aluminum Conduit
8. RMC: Rigid Metal Conduit
9. RNC: Rigid Nonmetallic Conduit

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of raceway, boxes, or other potential obstructions within the dedicated equipment spaces and working clearances for equipment installed by other trades in accordance with the codes and manufacturer requirements.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.

6. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate routing of power, low-voltage, and control conduits requiring fire-resistive protective assembly or electrical circuit protective system. Fire-resistive protective assembly or electrical circuit protective system for power, low-voltage, and control circuit conductors and cables shall have a fire-resistance rating of not less than 2 hours and shall be provided where required by NFPA or local building codes. Types of systems requiring a fire-resistive protective assembly include, but are not limited to:
 - a. Feeders for Emergency Power systems
 - b. Smokeproof Enclosure Pressurization systems
 - c. Smoke Control systems
 - d. Smoke Removal systems
 - e. Fire service and Occupant Evacuation Elevator systems

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Product data for the following products:
 1. Floor boxes
- C. Shop drawings for:
 1. Detailing fabrication and installation for custom enclosures.
- D. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 1. Structural members in path of conduit groups with supports.
 2. HVAC items, plumbing items and architectural features in the paths of conduit groups with common supports.
- E. Samples:
 1. Floor Boxes: Provide one sample(s) of each floor box proposed for substitution upon request.
 2. Finishes:
 - a. Submit sample chips, illustrating range of colors available for enclosure manufacturer finish products for approval by the Contract Administrator.

- b. Submit floorbox cover sample in finishes requested by the Contract Administrator for approval prior to purchasing boxes.
- F. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":
 - 1. Accurately record actual routing of all exterior buried raceway and all interior raceways three inches and larger. Indicate dimensions from fixed structural elements.

1.5 QUALITY ASSURANCE

- A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.
- B. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.
 - 2. Marked for intended use.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUITS, SURFACE MOUNTED RACEWAYS AND ACCESSORIES

- A. Metal Conduit and Tubing
 - 1. Available Manufacturers:
 - a. ABB, Inc.
 - b. AFC Cable Systems, Inc.; a division of Atkore International
 - c. Allied Tube and Conduit
 - d. American Conduit
 - e. Anamet Electrical, Inc.
 - f. Electri-Flex Co.
 - g. Nucor Tubular Products.
 - h. O-Z/Gedney Co.; Emerson.
 - i. Republic Raceway.
 - j. Southwire Company, LLC

- k. Western Tube and Conduit Corporation.
 - l. Wheatland Tube Co.
 - 2. RMC:
 - a. GRS: Hot-dip galvanized: ANSI C80.1, UL 6.
 - 1) Plastic-Coated GRS and Fittings: NEMA RN 1, UL-listed. Coating thickness of 0.04 inches (1mm), minimum.
 - b. RAC: ANSI C80.5, UL6A.
 - 3. IMC: ANSI C80.6, UL 1242.
 - a. Plastic-Coated IMC and Fittings: NEMA RN 1, UL-listed.
 - 4. EMT and Fittings: ANSI C80.3, UL 797. Only steel products allowed. Reduced wall EMT is not allowed.
 - a. Fittings: Compression type.
 - 5. FMC: Aluminum: UL 1. Reduced wall FMC is not allowed.
 - 6. LFMC: Flexible steel raceway with PVC jacket: UL 360.
 - a. Fittings: NEMA FB 1; compatible with raceway and tubing materials.
- B. Nonmetallic Raceway
 - 1. Available Manufacturers:
 - a. ABB, Inc.
 - b. AFC Cable Systems, Inc. (Tubing); a division of Atkore International
 - c. Allied Tube and Conduit
 - d. American Pipe and Plastics, Inc.
 - e. Anamet Electrical, Inc.
 - f. Arnco Corp.
 - g. Cantex Inc.
 - h. Champion Fiberglass, Inc.
 - i. Electri-Flex Co.
 - j. FRE Composites.

- k. Hubbell Inc. (Fittings)
 - l. IPEX USA, LLC.
 - m. Phoenix Contact.
 - n. Prime Conduit.
 - o. Southwire Corporation.
 - p. Superflex Ltd.
 - q. United Fiberglass of America, Inc.
- 2. RNC: Schedule 40 and 80 PVC: NEMA TC 2, UL 651.
 - a. Fittings: match to raceway and tubing type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable.
 - 3. ENT: NEMA TC 13, UL-listed.
 - a. Fittings: match to tubing type and material: NEMA TC 13, NEMA TC 6, UL 651, as applicable.
 - 4. LFNC: UL 1660.
 - a. Fittings: match to tubing type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable.
 - 5. RTRC: UL 2420, UL 2515, NEMA TC 14

C. Metal Wireways

- 1. Available Manufacturers:
 - a. BEL Products, Inc.
 - b. Cooper B-Line; Eaton.
 - c. EPI-Electrical Enclosures
 - d. Hoffman.
 - e. Square D.
- 2. Material and Construction: 14 gauge (minimum) sheet steel, sized and shaped as indicated, NEMA 1, 3R, 12, or 4X.
- 3. Fittings and Accessories: Include couplings, offsets, elbows, expansion/deflection joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system. Select features, unless otherwise indicated, as required to

complete wiring system and to comply with NFPA 70. Where indicated, provide a barrier to divide wireway into compartments.

4. Wireway Covers:
 - a. Screw-cover type
5. Finish: Manufacturer's standard phosphate pre-treatment and baked enamel finish.

D. Nonmetallic Wireways

1. Available Manufacturers:
 - a. ABB, Inc.
 - b. Enduro Composite Systems
 - c. Hoffman.
2. Description: Fiberglass reinforced polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Gasketed cover with oil-resistant gasket material.
 - a. Corrosion resistant captive screws
3. Description: PVC, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
4. Fittings and Accessories: Include couplings, offsets, elbows, expansion/deflection joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
5. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

E. Surface Metal Raceways

1. Available Manufacturers:
 - a. ABB, Inc.
 - b. Hubbell, Inc.
 - c. Legrand.
 - d. Mono-Systems; Niedax Group
 - e. Panduit Inc.
2. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.

3. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

F. Surface Nonmetallic Raceways

1. Available Manufacturers:
 - a. ABB, Inc.
 - b. Enduro Composite Systems.
 - c. Hubbell, Inc.
 - d. Legrand.
 - e. Mono-Systems, Inc.
 - f. Panduit Inc.
2. Two-piece construction, manufactured of rigid PVC compound with matte texture and manufacturer's standard color.
3. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.2 BOXES, ENCLOSURES AND CABINETS

A. General

1. Available Manufacturers:
 - a. ABB, Inc.
 - b. American Midwest Power
 - c. Appleton/O-Z Gedney Co.; Emerson.
 - d. BEL Products, Inc.
 - e. Cooper Crouse-Hinds; Eaton.
 - f. Erickson Electrical Equipment Co.
 - g. FSR, Inc.
 - h. Hoffman.
 - i. Hubbell, Inc.
 - j. Legrand.

- k. Molex; Koch Industries.
 - l. Robroy Industries, Inc.; Enclosure Division.
 - m. Spring City Electrical Manufacturing Co.
- 2. Provide products listed, classified, and labeled as suitable for the purpose intended. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
 - 3. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 - 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
 - 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
- 1. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 - 2. Cast Metal Boxes: Comply with NEMA FB 1, Type FD, with gasketed cover. Furnish with threaded hubs.
 - a. List and label as complying with UL 514A for non-hazardous locations;.
 - b. List and label as complying with UL 886 for hazardous locations, where required.
 - 3. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.
 - 4. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 - 5. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
 - 6. Minimum Box Size, Unless Otherwise Indicated:
 - a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 1-1/2 inch deep (100 by 38 mm) trade size.
 - b. Communications Systems Outlets: Comply with Section 27 10 05.
 - c. Communications Systems Outlets: 4 inch square by 2-1/8 inch (100 by 54 mm) trade size.

- d. Ceiling Outlets: 4 inch octagonal or square by 1-1/2 inch deep (100 by 38 mm) trade size.
- 7. Do not use "through-wall" boxes designed for access from both sides of wall.
- 8. Wall Plates: Comply with Division 26 Section "Wiring Devices".
- C. Boxes for telephone, data, telecommunications and audio-video outlets, refer to:
 - 1. Division 27 Section "Common Work Results for Communications"
- D. Junction and Pull Boxes Larger Than 100 cubic inches:
 - 1. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1, and list and label as complying with UL 514A.
 - 2. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast iron or aluminum with gasketed cover.
 - 3. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 - 4. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
 - 5. Terminal Blocks: Where indicated on the Drawings, provide terminal blocks with voltage/current ratings and terminal quantity suitable for purpose indicated, with 25 percent spare terminal capacity.
- E. Floor Boxes
 - 1. General:
 - a. Floor Box Schedule on drawings: Where titles in this section are column or row headings that introduce lists, the requirements listed for that title apply to product selection.
 - b. Basis-of-Design Product: The specified floor box is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the schedule.
 - c. Provide a complete Floor Box Assembly.
 - d. UL514A listed for scrub water exclusion for all floor types.
 - e. Receptacles:
 - 1) Provide receptacles complying with requirement of Division 26 "Wiring Devices"

- 2) Duplex: Include a minimum of one convenience receptacle, or quantity as indicated on schedule, with features as noted on schedule.
 - 3) GFCI: Include quantity of GFCI Receptacles as indicated on schedule, with features as noted on schedule.
 - 4) Isolated Ground: Include quantity of Isolated Ground Receptacle as indicated on schedule, with features as noted on schedule.
 - 5) Special: Include quantity of Special/Miscellaneous Devices as indicated on schedule, with features as noted on schedule.
- f. Communications:
- 1) Provide dedicated mounting space (gang) for each communication device type indicated on schedule. Include provisions for mounting devices in accordance with the requirements of the communication systems provider.
 - 2) The following items are not provided per this specification section:
 - a) Telecommunications outlet termination plate and termination connectors shall be provided per Division 27 Section "Communications Horizontal Cabling". Coordinate all other Assembly components to ensure compatibility.
 - b) Audio Video custom termination plates and connectors shall be provided per Division 27 Section "Audio Video Systems" and/or "Audio Video Systems Equipment". Coordinate all other assembly components to ensure compatibility.
2. For Multi-service Floor Boxes, see Division 27 Section "Common Work Results for Communications".
3. Receptacles:
- a. Provide receptacles complying with requirement of Division 26 section "Wiring Devices"
 - b. Duplex: Include a minimum of one Convenience Receptacle, or quantity as indicated on schedule, with features as noted on schedule.
 - c. GFCI: Include quantity of GFCI Receptacles as indicated on schedule, with features as noted on schedule.
 - d. Special: Include quantity of Special/Miscellaneous Devices as indicated on schedule, with features as noted on schedule.

F. Cabinets and Enclosures:

1. General:
 - a. Compliance: NEMA 250, and list and label as complying with UL 50 and UL50E or 508A, as applicable.
 - b. NEMA 250 Environment ratings:
 - 1) NEMA Type 1: Code-gauge phosphatized steel with continuously welded seams; non-gasketed removable hinged front cover, with flush latch and concealed hinge; collar studs.
 - 2) NEMA Type 12: Code-gauge phosphatized steel with continuously welded seams; external wall-mounting brackets; rolled flanges on door and door opening; continuous-hinged door, with removable steel pin; oil-resistant continuous gasket; hasp and staple for padlocking; collar studs; captive, plated steel door clamps; interior data pocket.
 - 3) NEMA Type 3R: Code-gauge galvanized steel with drip shield top, seam-free front, side, and back; non-gasketed continuous-hinged door, with stainless steel pin; captive, plated steel cover screws; hasp and staple for padlocking; collar studs.
 - 4) NEMA Type 4X: External wall-mounting brackets; rolled flanges on door and door opening; continuous-hinged door, with removable stainless steel pin; seamless continuous gasket; stainless steel hasp and staple for padlocking; collar studs; captive, stainless steel door clamps on 3 sides of door; interior data pocket:
 - a) Metal: Code-gauge Type 304 stainless steel with continuously welded seams.
 - b) Nonmetallic: Fiberglass-reinforced Plastic (FRP) with continuously sealed seams; finished inside with radio-frequency-resistant paint.
 - c. Removable painted steel interior panel mounted on standoffs; metal barriers to separate wiring of different systems and voltages.
 - d. Provide enclosures wider than 36 inches with double doors; removable center posts; internal bracing, supports, or both, as required to maintain their structural integrity; and, accessory feet where required for freestanding equipment.
 - e. Provide clamps, grids, slotted wireways, or similar devices to which or by which wiring may be secured. Provide DIN-rail mounted terminal strips for terminating all incoming and outgoing control wiring, and power terminal blocks for incoming/outgoing power wiring. Provide wire management troughs where practicable.
 - f. Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power and higher-voltage control wiring.

2.3 FACTORY FINISHES

- A. Interior Finish: All interior components shall be factory finished; manufacturer's standard grey unless otherwise noted.
- B. Exterior Finish: For metal wireway and surface raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.
- C. Exterior Finish: For metal wireway and surface raceway, enclosure, or cabinet components, provide ANSI 61 grey or custom color, as specified by the Contract Administrator, applied to factory-assembled metal wireway and surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

- 1. Install in accordance with manufacturer's instructions

3.2 RACEWAYS

A. General

- 1. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on drawings or in this article are stricter.
- 2. Provide sizes and types of raceways as indicated on the Drawings. Sizes are based on THWN insulated copper conductors, except where noted otherwise. Where sizes are not shown on the Drawings or in the Specifications, size raceways in accordance with NFPA 70 requirements for the number, size and type of conductors installed. Minimum raceway size: 3/4 inch (concealed and exposed); 1 inch (underground and under slab).
 - a. 3/4 inch conduit shall contain maximum (5) #12AWG conductors or (3) #10AWG conductors.
 - b. 3/8 inch flexible conduit may be used for light fixture whips.
- 3. Provide all raceways, fittings, supports, and miscellaneous hardware required for a complete electrical system as described by the Drawings and Specifications.
- 4. Install a green-insulated, equipment-grounding conductor, which is bonded to the electrical system ground, in all raceways, with the exception of Service Entrance raceways.
- 5. Install grounding bushings on all conduit terminations and bond to the enclosure, equipment grounding conductor, and electrical system ground.
- 6. Install raceways concealed in walls or above suspended ceilings in finished areas. When approved by the Contract Administrator, raceways may be installed concealed in elevated floor slabs. Do not install raceways horizontally within slabs on grade.

7. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
8. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
9. Make bends and offsets so inside diameters are not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
10. Install raceways:
 - a. To meet the requirements of the structure and the requirements of all other Work on the Project.
 - b. To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.
 - c. Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Contract Administrator.
 - d. Parallel or perpendicular to building lines or column lines.
 - e. Tight to structure.
 - f. When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
11. Raceways Embedded in Slabs:
 - a. Raceways may only be embedded in concrete slabs with written permission from, and only where directed, by the Structural Engineer.
 - b. Install in middle 1/3 of slab thickness, where practical. At a minimum, concrete shall provide at least 2 inches of concrete cover for raceways.
 - c. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - d. Space raceways laterally to prevent voids in concrete.
 - e. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - f. Change from RNC to coated GRS or IMC before rising above the floor.
12. Where masonry walls are left unfinished, coordinate raceway installations with other trades so that the raceways and boxes are concealed and the wall will have a neat and smooth appearance.

13. Support raceways from structural elements of the building as required by NFPA 70, Division 26 Section "Hangers and Supports for Electrical Systems". Do not support raceways by hangers used for any other systems foreign to the electrical systems; and, do not attach to other foreign systems. Do not lay raceways on top of the ceiling system.
 - a. Raceways on roof shall be supported from structure not from the roof deck.
14. Provide support spacing in accordance with NFPA 70 requirements, and at a minimum in accordance with NEMA standards. Support by the following methods:
 - a. Attach single raceway directly to structural steel with beam clamps.
 - b. Attach single raceway directly to concrete with one-hole clamps or clips and anchors. Outdoors and wherever subject to dampness or moisture, offset raceways from the surface by using galvanized clamps and clamp backs, to mitigate moisture entrapment between raceways and surfaces.
 - c. Attach groups of raceway to structural steel with slotted support system attached with beam clamps. Attach raceway to slotted channel with approved raceway clamps.
 - d. Attach groups of raceway to concrete with cast-in-place steel slotted channel fabricated specifically for concrete embedment. Attach raceway to steel slotted channel with approved raceway clamps.
 - e. Hang plumb horizontally suspended single raceway using a threaded rod. Attach threaded rods to concrete with anchors and to structural steel with beam clamps. Attach raceway to threaded rod with approved raceway clamps.
 - f. Hang horizontally suspended groups of raceway using steel slotted support system suspended from threaded rods. Attach threaded rods to concrete with anchors and to structural steel with beam clamps. Attach raceway to steel slotted channel with approved raceway clamps.
 - g. Support conductors in vertical raceway in accordance with NFPA 70 requirements.
 - h. Cross-brace suspended raceway to prevent lateral movement during seismic activity.
 - i. Use pre-fabricated non-metallic spacers for parallel runs of underground or under-slab conduits, either direct buried or encased in concrete.
15. Install electrically- and physically-continuous raceways between connections to outlets, boxes, panelboards, cabinets, and other electrical equipment with a minimum possible number of bends and not more than the equivalent of four 90-degree bends between boxes. Make bends smooth and even, without flattening raceway or flaking the finish.
16. Protect all electrical Work against damage during construction. Repair all Work damaged or moved out of line after rough-in, to meet the Contract Administrator's approval, without additional cost to the Owner. Cover or temporarily plug openings in boxes or raceways to

keep raceways clean during construction. Clean all raceways prior to pulling conductors or cables.

17. Align and install raceway terminations true and plumb.
18. Complete raceway installation before starting conductor installation.
19. Install a pull cord in each empty raceway that is left empty for installation of wires or cables by other trades or under separate contracts. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull cord.
20. Install approved expansion/deflection fittings where raceways pass through or over building expansion joints; or where structures providing a means of support are subject to relative movement greater than acceptable by the raceway manufacturer.
21. Route raceway through roof openings for piping and ductwork or through roof seals approved by the Contract Administrator, the roofing contractor, or both. Obtain approval for all roof penetrations and seal types from the Contract Administrator, Owner, roofing contractor, or all three as required to maintain new or existing roofing warranties.
22. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces or from building exterior to building interior.
 - b. Where otherwise required by NFPA 70.
23. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment as required by other requirements of the construction documents.; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
24. Maintain 2" minimum spacing from bottom of roof deck to prevent raceway penetrations from above
25. Do not route conduits across skylights, access panels, hatched tiles, HVAC diffusers, or equipment working space.
26. Route conduits serving rooftop equipment concealed inside the equipment curb and minimize roof penetrations and exterior conduit runs where practicable.
27. Install all underground conduits/raceways a minimum of 24" below the bottom of slab/paving/grade, unless noted otherwise, where practicable.

28. Provide boxes and raceways for the fire protection system low voltage wiring as required. This includes low voltage wiring exposed less than 96" AFF.
 - a. At a minimum, provide 3/4" conduit.
 - b. Coordinate requirements and locations with system installer and fire alarm specifications.

B. RMC

1. Use GRS or IMC in the following areas:
 - a. Where indicated.
 - b. For Emergency Feeders.
 - c. Exterior applications where above grade and exposed.
 - d. Below grade when concrete-encased, plastic-coated, or provided with a corrosion resistant approved mastic coating.
 - e. All raceways penetrating slabs on grade (use plastic-coated raceway or provide with a corrosion resistant approved mastic coating). This shall include the 90-degree elbow below grade and the entire vertical transition to above grade.
 - f. Concealed within masonry walls.
 - g. Damp or wet locations.
 - h. Interior spaces where exposed to damage. Includes but is not limited to the following areas.
 - 1) Loading dock
 - 2) Corridors used for traffic of mechanized carts, forklifts and pallet handling units.
2. Use RAC in the following areas:
 - a. Only where specifically indicated on the Drawings.
 - b. Indoors above grade.
 - c. Interior wet or damp locations.
 - d. For circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
3. Do not use RAC:
 - a. Below grade.

- b. Imbedded in concrete or other areas corrosive to RAC.

C. EMT

- 1. Use EMT in the following areas:
 - a. Where indicated.
 - b. Interior concealed locations for:
 - 1) Branch circuits.
 - 2) Feeders.
 - 3) Emergency branch circuits.
 - 4) Low-voltage control, security, and fire alarm circuits
 - c. Exposed where not subject to physical damage
 - 1) Mechanical rooms
- 2. Do not use EMT:
 - a. Below grade.
 - b. In exterior applications when exposed.

D. FMC and LFMC

- 1. Use FMC or LFMC:
 - a. For the final 24 inches of raceway to all motors, transformers, and other equipment subject to vibration or movement.
 - b. From outlet boxes (attached to building structure) to recessed light fixtures. Install sufficient length to allow for relocating each light fixture within a 5-foot radius of its installed location.
 - c. Use FMC only in dry locations
 - d. Use LFMC in damp, wet, corrosive, outdoor locations, and food service and kitchen areas.
- 2. Do not use FMC or LFMC:
 - a. For branch circuits, homeruns or feeders.
 - b. In lengths exceeding 6 feet.

E. RNC

1. Solvent-weld RNC fittings and raceway couplings per the manufacturer's instructions and make all connections watertight. Use solvent of the same manufacturer as the raceway.
2. Where installed exposed outdoors or other areas subject to temperature variations, install expansion fittings per NFPA 70, to accommodate thermal expansion in straight runs.
3. RNC is only allowed to be used in the following locations:
 - a. Where specifically indicated.
 - 1) If an adopted code prevents use of RNC in a location where the contract documents specifically allows its use, contractor shall utilize other types of conduit allowed by the specification.
 - 2) Allowed does not mean required.
 - b. Underground, single and grouped, in lieu of GRS or IMC, when indicated.
 - 1) Direct buried
 - 2) Concrete-encased (use approved rigid PVC interlocking spacers, selected to provide minimum duct spacing and cover depths indicated while supporting ducts during concreting and backfilling; produced by the same manufacturer as the ducts).

3.3 RACEWAY FITTINGS:

- A. Compatible with raceways and suitable for use and location.
- B. RMC and IMC: Use threaded rigid steel conduit fittings, unless otherwise indicated.
- C. PVC Externally Coated, Rigid Steel Conduits: Use only fittings and installation tools approved by the manufacturer for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits. Replace all fittings and conduits that have any portion of the coating scraped off to bare metal, at no additional cost to the Owner.
- D. Join raceways with fittings designed and approved for that purpose and make joints tight.
- E. Use insulating bushings to protect conductors at raceway terminations:
 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

3.4 WIREWAYS:

- A. Use flat head screws, clips and straps to fasten wireways to surfaces. Mount plumb and level.

- B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
- C. Close ends of wireway and unused raceway openings.

3.5 BOXES:

A. General

1. Verify locations of device boxes prior to rough in.
2. Set boxes at elevations to accommodate mounting heights as specified or indicated on the Drawings.
3. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Adjust box locations to accommodate intended purpose.
4. Install boxes to preserve fire ratings of walls, floors, and ceilings.
5. Install flush wall-mounted boxes without damaging wall insulation or reducing its effectiveness.
6. Support boxes independently of raceway.
7. Clean the interior of boxes to remove dust, debris, and other material. Clean exposed surfaces and restore finish.
8. Adjust flush-mounted boxes to make front edges flush with finished wall material.
9. Provide boxes of the depth required for the service, device and the application, and with raised covers set flush with the finished wall surface for boxes concealed in plaster finishes. Select covers with the proper openings for the devices being installed in the boxes. Install boxes flush unless otherwise indicated.
10. Install outlet boxes in firewalls complying with UL requirements, with box surface area not exceeding 16 square inches; and, when installed on opposite sides of the wall, separate by a distance of at least 24 inches.

B. NEMA Enclosure ratings: Suitable for the environment in which it is installed. At a minimum, provide the following ratings:

1. NEMA 250, type 3R
 - a. Provide at exterior locations
2. NEMA 250, type 1
 - a. Provide at interior and dry locations
3. NEMA 250 type 4 stainless steel
 - a. Provide at interior damp or wet locations

- b. Provide at interior locations where associated device is labeled as Weather Proof and/or Weather Resistant, unless requirement below already requires box to be rated otherwise.
- 4. NEMA 250 type 4X
 - a. Provide at interior locations subject to corrosion

C. Outlet Boxes

- 1. Locations of outlets on Drawings are approximate; and, except where dimensions are shown, determine exact dimensions for locations of outlets from plans, details, sections, or elevations on Drawings, or as directed by Contract Administrator. Locate outlets generally from column centers and finish wall lines or to centers or joints of wall or ceiling panels.
- 2. Locate outlet boxes so they are not placed back-to-back in the same wall, and in metal stud walls, so they are separated by at least one stud space, to limit sound transmission from room to room. Install outlet boxes in accessible locations and do not install outlets above ducts or behind furring.
- 3. Install all electrical devices, such as plug receptacles, lamp receptacles, light switches, and light fixtures in or on outlet boxes Use sheet-steel boxes for dry locations unless otherwise indicated or required.
- 4. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
- 5. Use cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
- 6. Use cast aluminum boxes where aluminum rigid metal conduit is used.
- 7. Use nonmetallic boxes where exposed rigid PVC conduit is used.
- 8. Use suitable concrete type boxes where flush-mounted in concrete.
- 9. Use suitable masonry type boxes where flush-mounted in masonry walls.
- 10. Use raised covers suitable for the type of wall construction and device configuration where required.
- 11. Use shallow boxes where required by the type of wall construction.
- 12. Install extension and plaster rings as required by NFPA 70.
- 13. Carefully set outlet boxes concealed in non-plastered block walls so as to line up with wall joints. Coordinate the box and raceway installation with the wall construction as required for a flush and neat appearing installation. Outlet box extensions may be used where necessary.
- 14. Do not exceed allowable fill per NFPA 70.

15. Where multiple devices are shown grouped together, gang mount with a common cover plate.

D. Junction and Pull Boxes

1. Install junction and pull boxes above accessible ceilings and in unfinished areas.
2. Provide boxes set flush in painted walls or ceilings with primer coated cover.
3. Where junction and pull boxes are installed above an inaccessible ceiling, locate so as to be easily accessible from a ceiling access panel.
4. Boxes for exterior use shall be:
 - a. PVC with a UV-stabilized PVC cover sealed and gasketed watertight.
 - b. Cast aluminum with a cast aluminum cover sealed and gasketed watertight.
 - c. Cast iron with cast iron cover sealed and gasketed watertight in vehicular traffic areas. Provide box and cover UL listed for use in vehicular traffic areas.
 - d. Install buried boxes so that box covers are flush with grade, unless indicated otherwise.

E. Floor Boxes

1. Use cast or non-metallic floor boxes for installations in slab on grade. Unless otherwise indicated, formed steel boxes are acceptable for slabs above grade.
2. Set metal floor boxes level and flush with finished floor surface.
3. Set non-metallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.6 CABINETS AND ENCLOSURES:

A. Unless otherwise indicated on the Drawings, provide

1. NEMA 1 construction for indoor, dry locations
2. NEMA 12 for indoor, damp and dusty locations
3. NEMA 3R for outdoor locations
4. NEMA 4X for indoor wet and corrosive locations

B. Install flush mounted in the wall in finished spaces, with the top 78 inches above finished floor. The front shall be approximately 3/4-inch larger than the box all around.

C. Install surface mounted in unfinished spaces, with the top 78 inches above finished floor. The front shall be the same height and width as the box.

- D. Electrically ground all metallic cabinets and enclosures. Where wiring to cabinet or enclosure includes a grounding conductor, provide a grounding lug in the interior of the cabinet or enclosure. Cabinets and enclosures specified in this Section are intended to house miscellaneous electrical components assembled in a custom arrangement, such as contactors and relays.
- E. All components that are specified or indicated for assembly in cabinets and enclosures shall each be individually UL listed and labeled. Arrange wiring so that it can be readily identified. Support wiring no less than every 3 inches. Install gauges, meters, pilot lights and controls on the face of the door.
- F. Do not provide cabinets and enclosures smaller than the sizes indicated. Where sizes and types are not indicated, provide cabinets and enclosures of the size, type and classes appropriate for the use and location per the guidelines of the NEC. Provide all items complete with covers and accessories required for the intended use.

3.7 IDENTIFICATION

- A. Refer to Division 26 Section "Identification for Electrical Systems" for identification materials.
- B. Raceway Identification:

- 1. Conduit and raceways are to be color coded for ease of identification. Where a facility standard already exists, that shall be followed. Where no standard exists for color-coding, provide in accordance with table below.
 - a. Conduit shall be color-coded from the factory. Junction boxes, fittings, and connectors are not required to be painted to match.
 - b. As an alternative, submit deduct to omit use of factory-painted conduit. Tape or paint are to be used to identify conduits and junction boxes and/or fittings are to be painted in accordance with facility standard or color table.

Conduit Service	Color Description
Building Automation and Controls	Blue
Fire Alarm	Red
Life Safety Power Branch	Yellow
Critical Power Branch	Orange
Equipment Branch	Green
Emergency Power Distribution Not Listed Above	Purple

- 2. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size. Use the following means of identification:
 - a. Self-Adhesive Vinyl Labels
 - b. Snap-Around Labels
 - c. Snap-Around, Color-Coding Bands
 - d. Self-Adhesive Vinyl Tape

3. Color for Printed Legend:
 - a. Power Circuits: Black letters on an orange field.
 - b. Legend: Indicate system or service and voltage, if applicable
- C. Raceways and Duct Banks More Than 600 V Concealed within Buildings: 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high black letters on 20-inch (500-mm) centers. Stop stripes at legends. Apply to the following finished surfaces:
 1. Floor surface directly above conduits running beneath and within 12 inches (300 mm) of a floor that is in contact with earth or is framed above unexcavated space.
 2. Wall surfaces directly external to raceways concealed within wall.
 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings
- D. Accessible Raceways and Metal-Clad Cables More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches (50 mm) high. Repeat legend at 10-foot (3-m) maximum intervals.
- E. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identification device shall be:
 1. Self-adhesive vinyl label
 2. Snap around label
 3. Self-adhesive vinyl tape applied in bands.
- F. Accessible Raceways of Auxiliary Systems: Identify the following systems using the same identification device as other accessible raceways 600V or less, and with the indicated color scheme for each system:
 1. Fire Alarm System: Red.
 2. Fire-Suppression Supervisory and Control System: Red and yellow.
 3. Combined Fire Alarm and Security System: Red and blue.
 4. Security System: Blue and yellow.
 5. Mechanical and Electrical Supervisory System: Green and blue.
 6. Telecommunication System: Green and yellow.
 7. Control Wiring: Green and red.

- G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
- H. Junction Boxes and Pull Boxes:
 - 1. Junction box and pull box covers shall be spray painted to identify the voltage and system. Circuit numbers and the panel they originate from shall be listed on the cover using permanent, waterproof, black ink marker.

END OF DOCUMENT 260533

DOCUMENT 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:

1. Raceways, fittings, boxes, handholes, and manholes for direct buried and concrete-encased electrical distribution.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements":

1. Product data for the following products:

- a. Raceways, Raceway fittings, separators, duct-bank materials, manholes, handholes, boxes, solvent cement, warning tape and warning planks.

2. Shop drawings for:

- a. Detailing fabrication and installation for custom manholes or handholes including duct entry provisions, reinforcing details, frame and cover design, manhole frame support rings, ladder details, grounding details, sump details, joint details, and cable racks, pulling irons, lifting irons.

B. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":

1. Accurately record actual routing of all exterior buried raceway including coordination with other surrounding utilities and underground structures. Provide scaled plans and sections that Indicate dimensions from finished grade or other fixed structural elements.

1.3 DEFINITIONS

A. Terminology used in this specification is as defined below:

1. GRS: Galvanized Rigid Steel Conduit
2. RMC: Rigid Metal Conduit
3. RNC: Rigid Nonmetallic Conduit

1.4 QUALITY ASSURANCE

A. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 3 years.

B. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.
 2. Marked for intended use.
- C. Comply with NFPA 70 and ANSI C2.
- D. Test and inspect pre-cast concrete utility structures according to ASTM C 1037.
- E. Non-concrete Handhold and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Tests of materials shall be performed by a independent testing agency.
 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.
- 1.5 DELIVERY, STORAGE, AND HANDLING
- A. Deliver ducts to project site with ends capped and store nonmetallic ducts with supports to prevent bending, warping, and deformation.
 - B. Store pre-cast and other factory –fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings, if present, are visible.
 - C. Lift and support pre-cast concrete units only at designated lifting or supporting points.
- 1.6 PROJECT CONDITIONS
- A. Interruption of existing electrical service to occupied facilities shall not occur unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated.
1. Notify Architect no fewer than two days in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without Architects written permission.
- 1.7 COORDINATION
- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
 - B. Coordinate elevations of ducts and duct-bank entrances into manhole, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from

those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by the Architect.

PART 2 - PRODUCTS

2.1 RACEWAYS AND FITTINGS

A. Metal Conduit

1. Available Manufacturers:
 - a. AFC Cable Systems, Inc.
 - b. Alflec Corporation, a Southwire Company
 - c. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - d. Electri-Flex Co.
 - e. Indalex
 - f. Manhattan/CDT/Cole-Flex
 - g. O-Z/Gedney; Unit of General Signal (Fittings)
 - h. Republic Raceway
 - i. Tyco International; Allied Tube & Conduit Div.
 - j. Wheatland Tube Co.
2. RMC:
 - a. GRS: Hot-dip galvanized: ANSI C80.1, UL 6
3. Plastic-Coated GRS and Fittings: NEMA RN 1, UL-listed. Coating thickness of 0.40 inches (1 mm), minimum.
4. Fittings: NEMA FB 1; compatible with raceway and tubing materials.

B. Nonmetallic Raceway

1. Available Manufacturers:
 - a. AFC Cable Systems, Inc. (Tubing)
 - b. American International.
 - c. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - d. Arnco Corp.

- e. Cantex Inc.
 - f. Certainteed Corp.; Pipe & Plastics Group.
 - g. Condux International.
 - h. ElecSYS, Inc.
 - i. Electri-Flex Co.
 - j. Lamson & Sessions; Carlon Electrical Products.
 - k. Manhattan/CDT/Cole-Flex.
 - l. RACO; Division of Hubbell, Inc.
 - m. Spiralduct, Inc./AFC Cable Systems, Inc.
 - n. Superflex Ltd.
 - o. Thomas & Betts Corporation.
2. RNC: Schedule 40 (type EPC-40-PVC) and 80 (type EPC-80-PVC PVC: NEMA TC 2, UL 651.
- a. a. Fittings: match to raceway type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable.

C. DUCT ACCESSORIES

- 1. Duct Separators shall be factory-fabricated rigid interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
- 2. Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."
- 3. Concrete warning planks shall be nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.
 - a. Color: Red dye added to concrete during batching.
 - b. Labeling: Mark each plank with "ELECTRICAL" in 2-inch high, 3/8-inch deep letters.

2.2 PRE-CAST CONCRETE HANDHOLES AND BOXES

A. General

1. Available Manufacturers:
 - a. Carder Concrete Products.
 - b. Christy Concrete Products
 - c. Elmhurst-Chicago Stone Co.
 - d. Oldcastle Pre-cast Group
 - e. Riverton Concrete Products; a division of Cretex Companies, Inc.
 - f. Utility Concrete Products, LLC
 - g. Utility Vault Co.
 - h. Wausau Title, Inc.
- B. Comply with ASTM C858 for design and manufacturing process.
- C. Pre-cast concrete handholes and boxes shall be factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of the handhole or box.
 1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
 - a. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - b. Cover Handle: Recessed.
 4. Frame and Cover: Weatherproof aluminum frame, with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
 - a. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - b. Cover Handle: Recessed.
 5. The cover finish shall be a nonskid finish with a minimum coefficient of friction of 0.50.
 6. The cover shall have the following legend lettering molded into the cover:
 - a. "C.A.T.V."

- b. "COMMUNICATIONS"
 - c. "CONTROLS"
 - d. "ELECTRICAL"
 - e. FIBER OPTICS"
 - f. "LIGHTING"
- 7. Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
 - 8. Extensions and slabs shall be designed to mate with bottom of enclosure and shall be same material as enclosure.
 - a. Extension shall provide increased depth of 12 inches.
 - b. Slab shall be same dimensions as bottom of enclosure, and arranged to provide closure.
 - 9. Windows shall be included as pre-cast openings in walls arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window openings shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No.4 steel reinforcing bars in concrete around each opening.
 - 10. Duct entrances into handhole walls shall have cast end-bell or duct-terminating fittings in the wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
 - 11. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
- 2.3 HANDHOLES AND BOXES OTHER THAN PRE-CAST CONCRETE
- A. General
 - 1. Description: Comply with SCTE 77.

2. Color of Frame and Cover: Gray where installed in concrete or other paved area; Green where installed in grass area.
 3. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated..
 4. Load Ratings:
 - a. Boxes and covers installed in sidewalks and other areas not subject to normal vehicular traffic shall be rated for a design load of 8,000 lbs. minimum.
 - b. Boxes and covers installed in driveways, parking lots, and other off-roadway applications shall be rated for a design load of 15,000 lbs. minimum.
 - c. Boxes and covers installed in roadways and other high vehicular traffic areas shall be rated for a design load of 28,800 lbs.
 5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 7. Cover Legend: Molded lettering, applicable logo from the following:
 - a. "C.A.T.V"
 - b. "COMMUNICATIONS"
 - c. "CONTROLS"
 - d. "ELECTRIC"
 - e. "FIBER OPTICS"
 - f. "LIGHTING"
 8. Duct Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 9. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pullin-in irons.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armorcast Products Company.

- b. Carson Industries LLC.
 - c. CDR Systems Corporation.
 - d. NewBasis.
 - e. Strongwell
- C. Fiberglass Handholes and Boxes with Polymer-Concrete frame and cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. Christy Concrete Products.
 - d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.
- D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carson Industries LLC.
 - b. Christy Concrete Products.
 - c. Nordic Fiberglass, Inc.
- E. High-Density Plastic Boxes: Injection molded of high-density polyethylene of copolymer-polypropylene. Cover shall be polymer concrete.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carson Industries LLC.
 - b. Nordic Fiberglass, Inc.
 - c. PenCell Plastics

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 UNDERGROUND ENCLOSURE INSTALLATION

- A. Handholes and Boxes for 600 volts and Less ,Including Telephone, Communications, and Data Wiring:
 - 1. Units in roadways and Other Deliberate Traffic Paths: Pre-cast concrete. AASHTO HB 17, h-10 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Pre-cast Concrete, AASHTO HB 17, H-20 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate loading by Vehicles: Pre-cast Concrete, AASHTO HB 17, H-10 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced Polyester resin structurally tested according to SCTE 77 with 3000-lbf vertical loading.

3.3 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Cables over 600 V: RNC, NEMA Ttpe EPC-80 PVC, in concrete-encased duct bank, unless otherwise indicated.
- B. Ducts for Electrical Feeders 600volts and Less: RNC, NEMA Type EPC-80 PVC, in concrete-encased duct bank, unless otherwise indicated.
- C. Ducts for Electrical Feeders 600 volts and Less: RNC, NEMA Type EPC-80 PVC, in direct-buried duct bank, unless otherwise indicated.
- D. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-80 PVC, indirect-buried duct bank, unless otherwise indicated.
- E. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40 PVC, in concrete-encased or direct-buried duct bank, unless otherwise indicated.
- F. Undergrond Ducts Crossing Paved Paths, Walks, and Roadways: RNC, NEMA Type EPC-40 PVC, encased in reinforced concrete.

3.4 EARTHWORK

- A. Excavation and Backfilling: Comply with Division 31 Section "Earth Moving" but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling and compaction is complete.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses and "Plants"

- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.5 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48-inches, both horizontally and vertically, at other locations, unless otherwise indicated.
- C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
- D. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."
- E. Sealing: Provide temporary closure at termination of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- F. Pulling Cord: Install 100-lbf test nylon cord in ducts, including spares.
- G. Concrete-Encased Ducts: Support ducts on duct separators.
 - 1. Separator installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and ducts to prevent floating during concreting. Stagger separators approximately 6-inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around the ducts or duct group.
 - 2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to the manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install ¾-inch reinforcing rod dowels 18-inches into concrete on both sides of joint near corners of envelope.
 - 3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of

concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct bank application.

4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured with out soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts: 3-inches between ducts and exterior envelope wall, 2-inches between ducts for like services, and 4-inches between power and signal ducts.
7. Depth: Install top of duct bank at least 24-inches below finished grade in areas not subject to deliberate traffic, and at least 30-inches below finished grade in deliberate traffic paths of vehicles, unless otherwise indicated.
8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3-inches of concrete.
 - b. Stub-ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60-inches from edge of base. Install insulated grounding bushings on terminations at equipment.
9. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3-inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18-inches. Space additional tapes 12-inches apart, horizontally.

H. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6-inches between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6-inches in nominal diameter.
4. Install backfill as specified in Division 31 Section "Earth Moving."

5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4-inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
6. Install ducts with a minimum of 3-inches between ducts for like services and 6-inches between power and signal ducts.
7. Depth: Install top of duct bank at least 36-inches below finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3-inches of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60-inches from edge of base. Install insulated grounding bushings on terminations at equipment.
10. Warning Planks: Bury warning planks approximately 12 inches above all direct-buried ducts in duct banks placing them 24-inches o.c.. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18-inches. Space additional planks 12-inches apart, horizontally.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole Installation:

1. Comply with ASTM C891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Install handholes with bottom below the frost line.

2. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1-inch above grade.
 3. Where indicated, cast handhole cover frame integrally with handhole structure.
- C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
- D. Waterproofing: Apply waterproofing to exterior surfaces of handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section "Elastomeric Sheet Waterproofing." After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days
- E. Dampproofing: Apply dampproofing to exterior surfaces of handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07 Section "Bituminous Dampproofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
- F. Field-Installed Bolting Anchors in Concrete Handholes: Do not drill deeper than 3-7/8-inches for manholes and 2-inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRE-CAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.
- D. Install handholes and boxes with bottom below the frost line.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

- G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box frame. Bottom of ring shall rest on compacted earth.
 - 1. Concrete: 3000psi, 28-day strength, complying with Division 03 Section "Cast-in-Place Concrete," with a troweled finish.
 - 2. Dimensions: 10-inch wide by 12-inches deep.

3.8 GROUNDING

- A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.9 INSTALLATION ACCEPTANCE

- A. Prior to final acceptance of the duct bank and associated structures, pull an aluminum or wood test mandrel through the duct to prove joint integrity and to verify ducts have not been deformed. Provide mandrel equal to 80 percent fill of the duct. Test duct bank, manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems." Correct any deficiencies and retest as specified above. Clean internal surfaces of manholes (including sumps) and handholes and remove foreign materials.

END OF DOCUMENT 260543

DOCUMENT 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes the following:

1. Nameplates.
2. Labels for raceways and metal-clad cable.
3. Labels for junction boxes and pull boxes.
4. Labels for wiring devices and lighting control devices.
5. Markers for conductors, and control cables.
6. Tags.
7. Underground-line warning tape.
8. Warning labels and signs.
9. Arc Flash Warning Labels.
10. Instruction signs.
11. Miscellaneous identification products.
12. Painted Identification.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Where a facility identification standard already exists, that standard shall be continued. Where an identification standard does not exist, color-coding and identification shall be as described herein.
- B. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- C. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- D. Coordinate installation of identifying devices with location of access panels and doors.
- E. Install identifying devices before installing acoustical ceilings and similar concealment.

1.3 SUBMITTALS

- A. Product Data: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements" for each electrical identification product indicated:
 - 1. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

- A. Electrical Equipment, Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, by an NRTL as defined by OSHA in 29 CFR 1910.7 and that are acceptable to authorities having jurisdiction.
 - 2. Marked for intended use.
- B. Comply with requirements of NFPA 70.
- C. Comply with 29 CFR 1910.145.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Location, text, and method of identification to be used is noted in individual sections. Refer to other sections for additional identification requirements.

2.2 NAMEPLATES

- A. Comply with UL RP 9691, Recommended Practice for Nameplates for Use in Electrical Installations.
- B. Engraved, Laminated Acrylic or Melamine Label: Non-conductive phenolic with beveled edges.
 - 1. Adhesive backed.
 - 2. Minimum 1/16 inch (1.6 mm) thick for nameplates with both dimension 4 inches (102 mm) or less and 1/8 inch (3.2 mm) thick for larger sizes.
- C. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
- D. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text
- E. Text: Minimum text height shall be 1/8 inch (3.2 mm) unless otherwise required by local jurisdiction or owner standards. For elevated components, increase sizes of labels and letters to those appropriate for viewing from the floor.
- F. Colors:
 - 1. Normal systems - white letters on a black background.

2. Emergency systems - white letters on a red background.

G. Label Requirements:

1. Service Equipment Label

LINE 1: NOMINAL VOLTAGE AND FREQUENCY IN HERTZ
LINE 2: SERVICE EQUIPMENT BUS RATING IN AMPS
LINE 3: SCCR OF SERVICE EQUIPMENT IN AMPS
LINE 4: MAXIMUM AVAILABLE FAULT CURRENT IN AMPS
LINE 5: DATE CALCULATED

EXAMPLE:

208Y/120V, 60HZ 800A SCCR = 65,000A MAX AVAILABLE FAULT CURRENT = 58,815A CALCULATED: 01/01/2018
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2. Panelboard/Switchboard Label:

LINE 1: PANELBOARD/SWITCHBOARD DESIGNATION
LINE 2: VOLTAGE, PHASE, WIRES, AMPS
LINE 3: FED FROM “ “

EXAMPLES:

L1A 208Y/120V, 3PH, 4W, 225A FED FROM H1A VIA XFMR T1

3. Disconnect Switch Label:

LINE 1: DESIGNATION OF EQUIPMENT SERVED BY DISCONNECT
LINE 2: VOLTAGE, PHASE, WIRES, AMPS
LINE 3: FED FROM “ “

EXAMPLES:

WATER HEATER WH1 480V, 3PH, 3W, 100A FED FROM MDB

2.3 LABELS FOR RACEWAYS AND METAL-CLAD CABLE

A. Factory Painted Raceways:

1. Metal Raceways: Continuous, rust-inhibiting paint factory applied.
2. Non-Metallic Raceways: Factory dyed or colored PVC sleeve.

- B. Factory Painted Metal-Clad Cable: 2-inch wide, factory painted bands at a maximum of 6-foot on center spacing.
- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.4 LABELS FOR JUNCTION BOXES AND PULL BOXES

- A. Junction box and pull box covers shall be spray painted to identify the voltage and system. Circuit numbers and the panel they originate from shall be listed on the cover using permanent, waterproof, black ink marker.

2.5 LABELS FOR WIRING DEVICES AND LIGHTING CONTROL DEVICES

- A. Self-laminating Computer Printable Labels: Clear over-laminate to protect legend for permanent, clean identification. Self-laminating Polyester material with white print-on area.
- B. Engraved, Laminated Acrylic or Melamine Label: adhesive backed. Minimum letter height shall be 3/16 inch (4.76 mm).
 - 1. Normal systems - white letters on a black background.
 - 2. Emergency systems - white letters on a red background
- C. Engraved cover plates: Provide with white letters. White or ivory cover plates shall have black letters.
- D. Permanent Ink: Permanent, waterproof, black ink marker, hand printed legibly.

2.6 MARKERS FOR CONDUCTOR AND CONTROL CABLES

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.
- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- C. Self-laminating Computer Printable Labels: Clear over-laminate to protect legend for permanent, clean identification. Self-laminating Polyester material with white print-on area.

- D. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- (0.35-mm-) thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.
- E. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking nylon tie fastener.

2.7 TAGS

- A. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
 - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.8 UNDERGROUND-LINE WARNING TAPE

- A. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
- B. Foil-backed Detectable Type Tape: 6 inches (152 mm) wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.
- C. Legend: Type of service, continuously repeated over full length of tape.
- D. Color: Tape for Buried Power Lines: Black text on red background.

2.9 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145. Attachment method shall be acceptable to the manufacturers of the equipment to which the nameplates are being applied and shall not compromise any NRTL listing or labeling criteria.
- B. Self-Adhesive Warning Labels: Factory pre-printed or machine-printed multicolor self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
 - 1. Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 - 2. Do not use labels designed to be completed using handwritten text.
- C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 1. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.

1. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning (208 Volts): "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.10 ARC FLASH WARNING LABELS

- A. General: All labels will be based on recommended overcurrent device settings and will be printed after the results of the analysis have been presented and after any system changes, upgrades, or modifications have been incorporated in the system. Refer to Division 26 section "Overcurrent Protective Device Study" for additional requirements.
- B. Materials: Use machine-printed, high adhesion, polyester label; UV, chemical, water, heat, and abrasion resistant, for each work location analyzed.
- C. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer. Labels shall be machine printed, with no field markings. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.
- D. Minimum Size: 3.5 inch by 5 inch (89 mm by 127 mm), unless otherwise noted by Owner.
- E. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment. The label shall include the following information, at a minimum:
 1. Location designation
 2. Nominal voltage
 3. Available fault current
 4. Limited approach boundary
 5. Arc flash boundary
 6. Restricted approach boundary
 7. Hazard risk category
 8. Incident energy
 9. Working distance

10. Site-specific PPE (personnel protective equipment) requirements.
11. Date calculations were performed.
12. Engineering report number, revision number and issue date.

2.11 INSTRUCTION SIGNS

- A. Engraved, Laminated Acrylic or Melamine plastic: Non-conductive phenolic. Unless indicated otherwise, provide with minimum 3/8-inch- (10-mm-) high letters. For elevated components, increase sizes of labels and letters to those appropriate for viewing from the floor.
 1. Minimum 1/16 inch (1.6 mm) thick for nameplates with either dimension greater than 4 inches (102 mm) and 1/8 inch (3.2 mm) thick for larger sizes.
 2. Punched or drilled for mechanical fasteners.
 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
 4. Normal systems: Engraved legend with white letters on black face.
 5. Essential Systems: Engraved legend with white letters on red face.
- B. Stainless Steel Nameplates: Minimum thickness of 1/32 inch ; engraved or laser-etched text.
- C. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text
- D. Colors:
 1. General Information and Operating Instructions – Black letters on white background.
 2. Normal systems - white letters on a black background.
 3. Emergency systems - white letters on a red background.

2.12 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
 1. Minimum Width: 3/16 inch (5 mm).
 2. Tensile Strength: 50 lb (22.6 kg), minimum.
 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 4. Color: Black, except where used for color-coding.
- B. Fasteners for Nameplates, Labels and Signs
 1. Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat lock washers unless otherwise noted.

- C. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlamine, 3 inches wide, with alternating black and white stripes.
- D. Painted identification
- E. Paint materials and application requirements are specified in Division 09 painting Sections.
 - 1. Exterior Concrete, Stucco, and Masonry (Other Than Concrete Unit Masonry):
 - a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Exterior concrete and masonry primer.
 - 2) Finish Coats: Exterior semi-gloss acrylic enamel.
 - 2. Exterior Concrete Unit Masonry:
 - a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
 - 1) Block Filler: Concrete unit masonry block filler.
 - 2) Finish Coats: Exterior semi-gloss acrylic enamel.
 - 3. Exterior Ferrous Metal:
 - a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Exterior ferrous-metal primer.
 - 2) Finish Coats: Exterior semi-gloss alkyd enamel.
 - 4. Exterior Zinc-Coated Metal (Except Raceways):
 - a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Exterior zinc-coated metal primer.
 - 2) Finish Coats: Exterior semi-gloss alkyd enamel.
 - 5. Interior Concrete and Masonry (Other Than Concrete Unit Masonry):
 - a. Semi-gloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior concrete and masonry primer.
 - 2) Finish Coats: Interior semi-gloss alkyd enamel.
 - 6. Interior Concrete Unit Masonry:
 - a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.

- 1) Block Filler: Concrete unit masonry block filler.
 - 2) Finish Coats: Interior semi-gloss acrylic enamel.
7. Interior Gypsum Board:
 - a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior gypsum board primer.
 - 2) Finish Coats: Interior semi-gloss acrylic enamel.
8. Interior Ferrous Metal:
 - a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior ferrous-metal primer.
 - 2) Finish Coats: Interior semi-gloss acrylic enamel.
9. Interior Zinc-Coated Metal (Except Raceways):
 - a. Semi-gloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior zinc-coated metal primer.
 - 2) Finish Coats: Interior semi-gloss acrylic enamel.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify identity of each item before installing identification products.
- B. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.
- C. Provide identification product listed for the location in which it is to be installed.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Painted Identification: Prepare surface and apply paint according to Division 09 painting sections.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. For surfaces that require finish work, apply identification devices after completing finish work. Do not install identification products until final surface finishes and painting are complete.

- C. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed. Replace labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.
- D. Location: Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance without interference with operation and maintenance of equipment. Unless otherwise indicated, locate products as follows:
 - 1. Surface-Mounted Equipment: Enclosure front.
 - 2. Flush-Mounted Equipment: Inside of equipment door.
 - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 - 4. Elevated Equipment: Legible from the floor or working platform.
 - 5. Branch Devices: Adjacent to device.
 - 6. Interior Components: Legible from the point of access.
 - 7. Conduits: Legible from the floor.
 - 8. Boxes: Outside face of cover.
 - 9. Conductors and Cables: Legible from the point of access.
 - 10. Devices: Outside face of cover.
- E. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
 - 1. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
- G. Equipment Nameplates and Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual.
 - 1. Indoor Clean, Dry Locations: Use plastic nameplates, unless noted otherwise.
 - 2. Outdoor Locations: Use aluminum nameplates suitable for exterior use.
- H. Install identification products centered, level, and parallel with lines of item being identified.
- I. Mark all handwritten text, where permitted, to be neat and legible.
- J. For refrigeration systems: Neatly bundle circuits and clearly tag and label each circuit with panelboard, branch circuit designation and refrigeration system number at each termination.

END OF DOCUMENT 260553

DOCUMENT 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This Section includes computer-based studies for the following:
 - 1. Short-circuit analysis.
 - 2. Protective device coordination study.
 - 3. Arc flash and shock risk assessment, including arc flash hazard labels.
- B. Criteria for selection and adjustment of equipment and associated protective devices not specified in this section, as determined by the studies performed.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. The AIC ratings indicated on the Drawings are preliminary and will be finalized based on the results of the short-circuit study. Device ratings for furnished equipment shall be as required by the results of the short-circuit study at no additional cost.
- B. Coordination:
 - 1. Existing Installations: Coordinate with equipment manufacturer(s) to obtain data necessary for completion of studies.
 - 2. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
 - 3. Notify Contract Administrator of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
- C. Pre-Study Meeting: Conduct meeting with Owner to discuss system operating modes and conditions to be considered in studies.
- D. Sequencing:
 - 1. Initial Study:
 - a. Study must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. Do not order equipment until matching study reports and product submittals have both been evaluated by the Contract Administrator.
 - b. If study has not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the Contractor at no additional cost to the project.

2. Final Study:

- a. Study must be completed and submitted for review prior to substantial completion. Do not print arc flash labels until final study has been evaluated by the Contract Administrator.
- b. Verify naming convention for equipment identification prior to creation of final drawings, reports, and arc flash hazard warning labels.

E. Scheduling:

1. Arrange access to existing facility for data collection with Owner.
2. Where work of this section involves interruption of existing electrical service, arrange service interruption with Owner. Refer to Division 26 section "General Electrical Requirements" for additional requirements.

1.3 SUBMITTALS

A. Product Data: In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.

1. Product data for computer software program to be used for studies.
2. Include characteristic time-current trip curves for protective devices.
3. Include impedance data for busway.
4. Include impedance data for engine generators.
5. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
6. Include documentation of listed series ratings upon request.
7. Identify modifications made in accordance with studies to meet the results of the study.

B. Product Certificates: For coordination-study and short-circuit-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data:

1. Study Preparer Specialist qualifications.
2. Field Testing Agency qualifications.

D. Arc Flash Hazard Warning Label Samples: One of each type and legend specified.

E. Other Action Submittals:

1. Initial Study report, stamped or sealed and signed by study preparer, including:
 - a. Cover page including date of study, study methodology, assumptions made and software products used.
 - b. Study input data, including completed computer program input data sheets.
 - c. Short-circuit study report.
 - d. Equipment evaluation report.
 - e. Coordination-study report.
 - f. Settings report.
 2. Final Study report, stamped or sealed and signed by study preparer, including:
 - a. Cover page including date of study, study methodology, assumptions made, software products used, and summary of changes between initial and final studies.
 - b. Study input data, including completed computer program input data sheets.
 - c. Short circuit study report.
 - d. Equipment evaluation report.
 - e. Coordination-study report.
 - f. Settings report.
 - g. Arc-Flash Hazard Analysis, including labels.
 3. Certification that field adjustable protective devices have been set in accordance with requirements of studies.
- F. Record Drawings: Submit Record Drawings as required by Division 01 and Division 26 Section "General Electrical Requirements":
1. Accurately record on the One-Line Diagram actual ratings and settings for all overcurrent devices, both adjustable and non-adjustable, including all changes made during construction, due to the study, or both.
 2. Include computer software files used to prepare studies with file name(s) cross-referenced to specific pieces of equipment and systems.
 3. Include copies of previous studies and existing drawings that were obtained during the data collection phase of the study.

1.4 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Study Preparer Qualifications: An organization experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Professional engineer, licensed in the state in which the Project is located, shall be responsible for the study and with a minimum five years experience in the preparation of studies of similar type and complexity using the specified computer software. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 399 for general study procedures.
- D. Comply with IEEE 141, 242 and 551 for short-circuit currents and coordination time intervals.
- E. Comply with IEEE 1584 and NFPA 70E for arc-flash hazard calculations.
- F. Studies shall include coordination of series-rated devices where series rating is specified in other sections and where indicated on Drawings.
- G. Field Testing Agency Qualifications: Independent testing organization specializing in testing, analysis, and maintenance of electrical systems with minimum five years experience; NETA Accredited Company.
 - 1. Field Supervisor: Certified electrical testing technician; NETA ETT Level III.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:
- B. Computer Software Developers: Subject to compliance with requirements, use the latest commercially available computer software programs utilizing the specified methodologies developed by one of the following:
 - 1. CYME International, Inc.
 - 2. EDSA Micro Corporation.
 - 3. Electrical Systems Analysis, Inc.
 - 4. SKM Systems Analysis, Inc.
 - 5. Operation Technology, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of short-circuit-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399, Table 7-4.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices.
 - 1. Arcing faults.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
- B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices not submitted for approval with coordination study may not be used in study.
- C. Short-circuit study and coordination study to be performed prior to the final submittals for any piece of electrical equipment which has an AIC rating or an over-current protective device so that correct equipment gets ordered for the project conditions.
- D. Arc Flash Study must be performed after conductors and equipment have been installed and after the project's utility company confirms the available fault current. A final short-circuit and coordination study with all device settings shall be submitted with the Arc Flash Study. The goal of the revised settings is to minimize the arc flash hazard while maintaining reasonable coordination and selectivity. For the components of emergency and legally required standby system components, full selectivity must be maintained.

3.2 SYSTEM COMPONENTS TO BE INCLUDED IN STUDIES

- A. Study shall begin with the utility and each alternate power source overcurrent device(s) serving the Project and end at the last branch circuit overcurrent protective device. This includes studies of the complete paths and operating modes on both sides of any transfer switch, contactor or circuit breaker.
- B. Operating modes shall include, where applicable:
 - 1. Utility as a source.
 - 2. Generator as a source.
 - 3. Utility and generator in parallel.

4. Bus tie breaker open/close positions.
5. Maintenance settings.

C. Components include, but are not limited to:

1. Switchgear
2. Switchboards
3. Distribution Panelboards
4. Panelboards
5. Air Handling Equipment
6. Roof Top HVAC equipment

3.3 POWER SYSTEM DATA FOR STUDIES

A. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling. Gather and tabulate the following input data to support studies:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical distribution system diagram showing the following:
 - a. Indicate load current that is the basis for sizing continuous ratings of circuits for cables and equipment.
 - b. Protective Devices: Include circuit-breaker and fuse-current ratings and types;
 - c. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.
 - d. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio. kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor insulation, and length.

- f. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 1 code letter designation.
- 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Magnetic inrush current overload capabilities of transformers.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Ratings, types, and settings of utility company's overcurrent protective devices.
 - e. Special overcurrent protective device settings or types stipulated by utility company.
 - f. Protective Devices:
 - 1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).
 - 2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).
 - g. Time-current-characteristic curves of devices indicated to be coordinated.
 - h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
 - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - j. Panelboards, switchboards, motor-control center ampacity, and interrupting ratings in amperes rms symmetrical.

3.4 SHORT-CIRCUIT STUDY

- A. Source Impedance: Utility company's fault current contribution as indicated.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project and use approved computer software program to calculate values. Include studies of system-switching configurations and alternate operation modes that could result in maximum fault conditions.

- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Comply with IEEE 241 recommendations for fault currents and time intervals.
- E. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:
 - 1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.50.
 - 2. Low-Voltage Fuses: IEEE C37.46.
 - 3. Circuit Breakers: IEEE C37.13.
- F. Study Report:
 - 1. Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of the report.
 - 2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.
 - 3. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault current values for 3-phase, 2-phase, and phase-to-ground faults.
- G. Equipment Evaluation Report: Prepare a report on the adequacy of overcurrent protective devices and conductors by comparing short-circuit current ratings of these devices with calculated short-circuit current momentary and interrupting duties. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.

3.5 COORDINATION STUDY

- A. Perform coordination study and prepare a written report using the results of the short-circuit study and approved computer software program. Comply with IEEE 399.
- B. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.
- C. Comply with IEEE 241 recommendations for fault currents and time intervals.
- D. Analyze alternate scenarios considering known operating modes.
- E. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.

- c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
- 2. Device shall protect transformer according to IEEE C57.12.00, for fault currents.
- F. Motors served by voltages more than 600 V shall be protected according to IEEE 620.
- G. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.
- H. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 - 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 - 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve the level of selective coordination required in the contract documents or by the edition of the National Electrical Code (including any local jurisdiction amendments) the project must comply with. Graphically illustrate that adequate time separation exists between series devices, including power utility company's upstream devices. Show the following specific information:
 - a. For protective Devices:
 - 1) Device tags.
 - 2) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.
 - 3) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.
 - 4) Include ground fault pickup and delay.
 - 5) Include fuse ratings.
 - b. Voltage and current ratio for curves.

- c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Generator full load current, overload curves, decrement curves and short-circuit withstand points.
 - g. Transformer inrush points.
 - h. Maximum fault current cutoff point.
 - i. Capacitor full load current and damage curves.
- 3. Include conclusions and recommendations.
 - 4. Completed data sheets for setting of overcurrent protective devices.

3.6 ARC-FLASH HAZARD ANALYSIS

- A. Determine arc-flash incident energy levels and flash protection boundary distances based on the results of the Short-Circuit and Coordination studies in accordance with IEEE 1584. Perform the analysis under worst-case arc-flash conditions for all modes of operation.
- B. In addition to the requirements outlined in IEEE 1584, the study shall include all equipment rated less than 240 Volts fed by transformers less than 125 kVA in the calculations.
 - 1. Where reasonable, study preparer may assume a maximum clearing time of two seconds in accordance with IEEE 1584, provided that the conditions are such that a worker's egress from an arc flash event would not be inhibited.
 - 2. For single-phase systems, the calculations may be performed assuming a three-phase system in accordance with IEEE 1584, yielding conservative results.
- C. For equipment with main devices mounted in separate compartmentalized sections, perform calculations on both the line and load side of the main device.
- D. Identify all locations and equipment to be included in the arc-flash hazard analysis:
 - 1. Include a copy of the facility one-line in the report.
 - 2. Identify the possible system operating modes including tie-breaker positions, and parallel generation.
 - 3. Calculate the arcing fault current flowing through each branch for each fault location.
 - 4. Determine the time required to clear the arcing fault current using the protective device settings and associated trip curves.
 - 5. Select the working distances based on system voltage and equipment class.

6. Calculate the incident energy at each fault location at the prescribed working distance.
7. Determine the hazard/risk category (HRC) for the estimated incident energy.
8. Calculate the flash protection boundary at each fault location.
9. Document the assessment in reports and one-line diagrams.
10. Provide labels to be placed on each piece of equipment analyzed. Label shall show the calculated incident energy and hazard/risk category for the calculated incident energy.

E. Results of the arc-flash study shall be summarized in a final report containing the following:

1. Basis, method of hazard assessment, description, purpose, scope, and date of the study.
2. Tabulations of the data used to model the system components and a corresponding one-line diagram.
3. Descriptions of the modes of operation evaluated and identification of the worst case scenario used to evaluate equipment ratings.
4. Tabulations of equipment incident energies, hazard risk categories, and flash protection boundaries. The tabulation shall identify and clearly note equipment that exceeds allowable incident energy ratings.
5. Required arc-flash labeling and placement of labels.
6. Conclusions and recommendations, including recommendations for reducing incident energy at locations where calculated maximum incident energy exceeds 8 calories per sq cm.

3.7 OVERCURRENT PROTECTIVE DEVICE SETTING

- A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to set overcurrent protective devices within equipment.
1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:
 - a. Verify that overcurrent protective devices meet parameters used in studies.
 - b. Adjust devices to values listed in final study results.
 - c. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures," and Tables 100.7 and 100.8 in NETA ATS.

3.8 INSTALLATION

- A. Install arc flash warning labels. Refer to Division 26 section Identification for Electrical Systems for additional requirements.

3.9 FIELD QUALITY CONTROL

- A. Field Testing Agency: Engage a qualified testing agency to perform tests, inspections, adjust components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:
 - 1. Inspect and test protective devices in accordance with the NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Overcurrent protection devices will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports, including a certified report that identifies protective device settings have been adjusted in accordance with the requirements of the study. Include notation of conflicts with or deviations made from the studies or the contract documents, deficiencies detected, remedial action taken, and observations after remedial action.

3.10 TRAINING

- A. Provide training for Owner's personnel on electrical safety pertaining to arc flash and shock hazards.
- B. Use site-specific arc flash and shock risk assessment report as training reference, supplemented with additional training materials as required.
- C. Provide minimum of eight hours of training performed by a representative of the entity performing the study.

END OF DOCUMENT 260573

DOCUMENT 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes the following lighting control devices:

1. Line-voltage dimming wall switches.
2. Line-voltage wall switch occupancy sensors.
3. Line-voltage dimming wall switch occupancy sensors.
4. Line-voltage occupancy sensors.
5. Line-voltage photoelectric switches.
6. Stand-Alone Low-voltage occupancy sensors.
7. Stand-Alone Low-voltage photoelectric switches.
8. Stand-Alone Low-voltage power packs.
9. Stand-Alone Low-voltage switches.
10. Outdoor motion sensors.
11. Lighting contactors.
12. Automatic load control relays.
13. Branch circuit transfer switches.
14. Conductors and Cables for Lighting Control Devices.

1.2 DEFINITIONS

- A. Acoustic Type: Occupancy sensor detection type that detects occupancy by listening for acoustic noises.
- B. Closed loop: Photosensor control algorithm designed for influence by both daylight and electric light in a space or area.
- C. DPDT: Double pole, double throw.
- D. DPST: Double pole, single throw.
- E. Dual-Technology Type: Occupancy sensor detection type that detects occupancy by using a combination of PIR and ultrasonic or acoustic detection technologies.

- F. LED: Light-emitting diode.
- G. Open loop: Photosensor control algorithm designed for influence by daylight entering in a space or area.
- H. PIR Type: Passive infrared. Occupancy sensor detection type that detects occupancy by sensing a combination of infrared heat and movement.
- I. SPST: Single pole, single throw.
- J. Ultrasonic Type: Occupancy sensor detection type that detects occupancy by sensing a change in pattern of reflected ultrasonic energy.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

1.4 SUBMITTALS

- A. Product data for the following products:

- 1. Catalog cut sheets, including major and minor motion coverage patterns sensors, time delay and sensitivity adjustability settings, load restrictions, and performance specification items indicating compliance with this specification for all lighting control devices.

- B. Shop Drawings:

- 1. Occupancy sensors and photoelectric switches
 - a. Show installation details.
 - b. Lighting plan showing location, mounting height, orientation and coverage area of each sensor and coordination with other trades.
 - c. Interconnection diagrams showing field-installed wiring.
 - d. Include diagrams for power, signal, and control wiring.
 - e. For any manufacturer submitted other than that listed as the Basis of Design, provide the following information for Engineer review:
 - 1) Factory-generated occupancy sensor and photoelectric switch layouts on project lighting plans with sensor location, orientation and product type clearly marked on plans. Sensor placement shall be coordinated with project reflected ceiling plan layout, ceiling heights, lights, diffusers, and any other ceiling devices and equipment.
 - 2) List of any deviations to this specification or Basis of Design products.

- C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1. Occupancy sensors and photoelectric switches:

- a. Manufacturer's installation instructions, including instructions for storage, handling, protection, examination, preparation, start-up calibration and installation.
- b. Product data clearly showing sensor field adjustments, including dip switch setting definitions and location of settings within sensors.
- c. Manufacturer's maintenance, including operating and adjustment instructions.

2. Timeclocks

- a. Description of programmed timeclock settings at time of substantial completion.

3. Line-voltage wall box dimming switches

- a. Provide operating instructions for each type of dimmer.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Occupancy sensors and photoelectric switches

1. Products supplied shall be from a single manufacturer that has been continuously involved in the manufacturing of occupancy sensors for a minimum of 5 years.
2. Products shall be manufactured by an ISO 9001 certified manufacturing facility.
3. Manufacturer shall test all equipment prior to shipment.

1.6 WARRANTY

A. Manufacturers shall provide a five (5) year warranty for sensors and accessories from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL INFORMATION

A. PIR type requirements:

1. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.
2. Sensor shall utilize pulse count processing and digital signature analysis to respond only to those signals caused by human motion.

3. Sensor shall provide high immunity to false triggering from RFI and EMI.
4. Sensor shall have a multiple-segmented fresnel lens in a multiple-tier configuration, with grooves to eliminate dust and residue buildup. Sensor shall be capable of accepting mask inserts to mask specific portions of the lens to prevent false triggering.

B. Ultrasonic type requirements:

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
2. Detection Frequency (Small Area – 500 sq ft and less): Ultrasonic operating frequency shall be crystal controlled at 40 kHz within +/- 0.005% tolerance to assure reliable performance and eliminate sensor cross-talk.
3. Detection Frequency (Medium and Large Areas – greater than 500 sq ft): Ultrasonic operating frequency shall be crystal controlled at 32 kHz within +/- 0.005% tolerance, to assure reliable performance and eliminate sensor cross-talk.
4. Sensors shall be capable of automatically adapting to airflow conditions or filtering frequency spectrum related to air movement.

C. Acoustic type requirements:

1. Detector Sensitivity: Acoustic type technology shall only be used as secondary to PIR in a Dual-Technology Type sensor. Specific sensitivity is based on PIR technology.
2. Sensors shall distinguish noises made by human activity (typing, talking, eating, etc.) and filter out noises made by the environment or building (HVAC, equipment, cars, etc.).
3. Acoustic technology shall enhance reliability and accuracy of PIR sensor.

D. Dual-Technology type requirements:

1. Dual-Technology sensors using ultrasonic technology shall have field-selectable controls on unit to determine if a particular technology or combination of technologies controls the on-off function.
2. Dual-Technology sensors using acoustic technology shall have the PIR technology initially detect motion and a combination of PIR and acoustic technologies shall keep the load on.
3. Sensitivity Adjustment: Separate for each sensing technology.
4. Different LED indicator colors for each sensing technology
5. PIR sensor component shall comply with all requirements listed under PIR type requirements.
6. Ultrasonic sensor component shall comply with all requirements listed under Ultrasonic Type requirements.

7. Acoustic sensor component shall comply with all requirements listed under Acoustic Type requirements.

2.2 LINE-VOLTAGE DIMMING WALL SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. Dimmer shall be suitable for dimmed load type of connected light fixture. Load types shall be as indicated on Drawings and confirmed per load type for connected luminaire as indicated in Light Fixture Schedule and approved light fixture and dimmer shop drawings.

2.3 LINE VOLTAGE WALL SWITCH OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for Sensors:
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C), unless indicated elsewhere for specific model and application.
 3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
 4. Operations: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply.
 - a. Occupancy Sensor (auto-on): Upon occupancy of space, loads shall be energized. If occupancy is not detected within the time delay period, loads shall be de-energized.
 - b. Vacancy Sensor (manual-on): Upon occupancy of space, loads are enabled such that manual operation of the switch shall energize loads. If occupancy is not detected within the time delay period, loads shall be de-energized.
 5. Operation adjustment: Concealed, field-adjustable for auto-on or manual-on operation.
 6. Time Delay adjustment:
 - a. Concealed, field-adjustable.
 - b. Time delay for de-energizing loads shall be adjustable with multiple increments from 30 seconds up to 30 minutes.
 7. Adaptive technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

8. Mounting: Single-gang wall box switch
9. Finish: Sensor finish shall be as directed by the Architect.
10. Sensor:
 - a. Vandal-resistant lens
 - b. Integral sliding blinders or pre-cut tape strips to block sensor views
 - c. Protrudes no greater than 0.50 inches from wall.
 - d. 180-degree field of view
 - e. Major and minor motion coverage patterns confirmed per Nema WD7 guidelines.
 - f. Detection types: Provide type or types indicated in Lighting Control Device Schedule. Refer to Section 2.1 General Information above for more information.
11. Indicators:
 - a. LED indicator for visual detection of motion
 - b. audible and/or visual alerts for pending shut-off
12. Suitable for switching load types used, including LED, fluorescent, incandescent, magnetic and electronic low voltage and motor load types. UL listed and labeled, zero-cross relay, no minimum load requirement, ground wire.
13. Wall switch shall have no leakage of current to load and integral service switch to permit a maintained off for servicing of lamps for safety purposes
14. Buttons/Relays: Provide control relay and push button quantities as indicated by model listed in Lighting Control Device Schedule.
15. Restriction on leakage to grounding conductor.
 - a. For new construction: Dual-technology wall switch sensor shall have not more than 0.5ma leakage of current to ground per UL requirements. Provide and connect a neutral conductor to these devices.

2.4 LINE-VOLTAGE DIMMING WALL SWITCH OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for Sensors:
 1. Comply with all requirements listed under Line-Voltage Dimming Wall Switches in this specification and,

2. Comply with all requirements listed under Line-Voltage Wall Switch Occupancy Sensors in this specification.

2.5 LINE-VOLTAGE OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors. Integral relay unit for line voltage sensors.
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. UL Listed for dry locations and complies with local codes.
 3. Operation: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply. Upon occupancy of space, loads shall turn on. If occupancy is not detected within the time delay period, loads shall de-energize. Time delay for de-energizing loads shall be adjustable over a minimum range of 1 to 15 minutes with a maximum of 30 minutes.
 4. Switch Rating: As indicated in Lighting Control Device Schedule.
 5. Detection Coverage: As indicated in Lighting Control Device Schedule on Drawings.
 6. Mounting: Suitable for mounting in any position on a standard outlet box.
 7. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 8. Indicator: LED, to show when motion is detected during testing and normal operation of the sensor.
 9. Bypass Switch: Override the "on" function in case of sensor failure, concealed on unit to prevent tampering.
 10. Finish: Sensor finish shall be as directed by the Architect.
 11. Operating temperatures: Unless indicated otherwise for specific models, 32 degree F through 104 degree F, and relative humidity of 0%-95%.
 12. Field selectable time delay and sensitivity settings or the capability for self-adjusting technologies to optimize time delay and sensitivity settings to respond to occupancy usage patterns. Occupancy usage patterns shall be saved in a non-volatile memory that retains settings in the event of a power outage.
 13. Device shall include isolated relay with NO and NC contacts to interface with BMS, HVAC and or other building monitoring systems as indicated on the Drawings
 14. Device and related relays shall be compatible with the specific load types controlled.

15. Sensor:

- a. Coverage pattern: As indicated in Lighting Control Device Schedule, and shall have been confirmed with NEMA WD7 Guide and Robotic test method.
- b. Detection types: Provide type or types indicated in Lighting Control Device Schedule. Refer to Section 2.1 General Information above for more information.

C. High-Bay Model:

1. Detection type: PIR type. Refer to Section 2.1 General Information above for more information.
2. Detection Coverage: Selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet.

D. Extreme Temperature Model:

1. Detection type: PIR type. Refer to Section 2.1 General Information above for more information.
2. Operating Ambient Conditions: Temperatures from minus 40 to plus 125 degree F.

2.6 LINE-VOLTAGE PHOTOELECTRIC SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.

B. Outdoor:

1. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
 - a. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photoelectric switch to prevent fixed light sources from causing turn-off.
 - b. Time Delay: 15-second minimum, to prevent false operation.
 - c. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
 - d. Mounting: Base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.7 STAND-ALONE LOW-VOLTAGE OCCUPANCY/VACANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.

- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensor unit, for use with a separate stand-alone low-voltage power pack containing a line-voltage relay.
1. Occupancy sensors and all other associated system components shall be provided by the same manufacturer and compatible with each other such that the final installation meets all operational and functional requirements in addition to those listed in this specification.
 2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 3. UL Listed for dry locations and complies with local codes.
 4. Operations: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply.
 - a. Occupancy Sensor (auto-on): Upon occupancy of space, loads shall be energized. If occupancy is not detected within the time delay period, loads shall be de-energized.
 - b. Vacancy Sensor (manual-on): Upon occupancy of space, loads are enabled such that manual operation of a separate, associated switch shall energize loads. If occupancy is not detected within the time delay period, loads shall be de-energized.
 5. Switch Rating: As indicated in Lighting Control Device Schedule.
 6. Detection Coverage: As indicated in Lighting Control Device Schedule on Drawings.
 7. Mounting: Suitable for mounting in any position on a standard outlet box.
 8. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 9. Indicator: LED, to show when motion is detected during testing and normal operation of the sensor.
 10. Bypass Switch: Override the "on" function in case of sensor failure, concealed on unit to prevent tampering.
 11. Finish: Sensor finish shall be as directed by the Architect.
 12. Operating temperatures of 32 degree F through 104 degree F, and relative humidity of 0%-95%.
 13. Field selectable time delay and sensitivity settings or the capability for self-adjusting technologies to optimize time delay and sensitivity settings to respond to occupancy usage patterns. Occupancy usage patterns shall be saved in a non-volatile memory that retains settings in the event of a power outage.
 14. Sensors:
 - a. Sensor shall be compatible with lighting control system.

- b. Sensors shall be capable of being combined with additional sensors to achieve adequate coverage.
- c. Sensor coverage pattern: AS indicated on Lighting Control Device Schedule, and shall have been confirmed with Nema WD7 Guide and Robotic test method.
- d. Detection types: Provide type or types indicated in Lighting Control Device Schedule. Refer to Section 2.1 General Information above for more information.

C. High-Bay Model:

- 1. Detection type: PIR type. Refer to Section 2.1 General Information above for more information.

D. Extreme Temperature Model:

- 1. Detection type: PIR type. Refer to Section 2.1 General Information above for more information.
- 2. Operating Ambient Conditions: Temperatures from minus 40 to plus 125 degree F.

2.8 STAND-ALONE LOW-VOLTAGE PHOTOELECTRIC SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.

B. General Requirements for switches: Ceiling-mounted, solid-state indoor photoelectric switch, for use with a separate stand-alone low-voltage power pack, containing a line-voltage relay.

- 1. Switches and all other associated system components shall be provided by the same manufacturer and compatible with each other such that the final installation meets all operational and functional requirements in addition to those listed in this specification.
- 2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 3. UL Listed for dry locations and complies with local codes.
- 4. Operations: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply. Upon ambient light level measurement reading below setpoint, loads shall be de-energized. Upon ambient light level measurement reading above setpoint, loads shall be energized.
- 5. Finish: Sensor finish shall be as directed by the Architect.

C. Indoor:

- 1. Photoelectric switches shall be Open Loop or Closed Loop as indicated on the Lighting Control Device Schedule on the Drawings.

2. Description: Solid state, low voltage with contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the lighting control system or as indicated on the Drawings.
 - a. Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lx), with an adjustment for turn-on and turn-off levels within that range.
 - b. Time Delay: 30-second minimum, to prevent false operation.
 - c. Mounting: Twist lock complying with IEEE C136.10, with base.

D. Outdoor:

1. Description: Solid state, low voltage with contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the power pack.
 - a. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range.
 - b. Time Delay: 30-second minimum, to prevent false operation.
 - c. Lightning Arrester: Air-gap type.
 - d. Mounting: Twist lock complying with IEEE C136.10, with base.

2.9 STAND-ALONE LOW-VOLTAGE POWER PACKS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for power packs: Box mounted, solid-state indoor power pack/relay unit, for use with a separate stand-alone low-voltage sensor and switches.
 1. Power packs and all other associated system components shall be provided by the same manufacturer and compatible with each other such that the final installation meets all operational and functional requirements in addition to those listed in this specification.
 2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 3. UL Listed for dry locations and complies with local codes.
 4. Unit shall include isolated relay with NO and NC contacts to interface with BMS, HVAC and or other building monitoring systems as indicated on the Drawings
 5. Relay shall be compatible with the specific lighting types controlled.
 6. Operations: Refer to drawings for Sequence of Operations or other operational instructions. Unit operates in conjunction with other system components. Refer to operations requirements of associated devices.

7. Switch Rating: As indicated in Lighting Control Device Schedule.

Mounting: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.

8. Operating temperatures of 32 degree F through 104 degree F, and relative humidity of 0%-95%.

2.10 STAND-ALONE LOW-VOLTAGE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for switches: Wall-mounted, solid-state indoor manual switch, for use with a separate stand-alone low-voltage power pack, containing a line-voltage relay.
 1. Switches and all other associated system components shall be provided by the same manufacturer and compatible with each other such that the final installation meets all operational and functional requirements in addition to those listed in this specification.
 2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 3. UL Listed for dry locations and complies with local codes.
 4. Operations: Refer to drawings for Sequence of Operations or other operational instructions. If none appear on drawings, the follow shall apply. Manual push of any button shall energize or de-energize loads.
 5. Mounting: Suitable for mounting in any position on a standard outlet box.
 6. Indicator: LED, for each button to indicate when loads are energized and de-energized.
 7. Finish: Sensor finish shall be as directed by the Architect.
 8. Operating temperatures of 32 degree F through 104 degree F, and relative humidity of 0%-95%.

2.11 OUTDOOR MOTION SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings and complying with all requirements listed.
- B. General Requirements for Sensors: Solid-state outdoor motion sensors.
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Weatherproof, detection technology as indicated in the Lighting Control Device Schedule on the Drawings.

3. Detection type: PIR type. Refer to Section 2.1 General Information above for more information.
4. Detection Coverage: As indicated in Lighting Control Device Schedule on the Drawings.
5. Switch Rating: Line Voltage: Minimum 1000-W incandescent and 500-VA ballast load at 120-V ac; 1000W ballast load at 277-V ac. Voltage as indicated on Drawings and Lighting Control Device Schedule.
6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 1 to 20 FC. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
7. Concealed, field-adjustable, "off" time-delay selector with multiple increments from 30 seconds up to 15 minutes.
8. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from minus 14 to plus 130 deg F, rated as "rain tight" according to UL 773A.
9. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outdoor junction box and ½" threaded nipple for use with standard NEMA weatherproof fixture fitting.
 - b. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
10. Bypass Switch: Override the on function in case of sensor failure.

2.12 LIGHTING CONTACTORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 1. ASCO Power Technologies, LP; a division of Emerson Electric Co.
 2. Eaton Electrical Inc.; Cutler-Hammer Products.
 3. GE Industrial Systems; Total Lighting Control.
 4. Hubbell Lighting.
 5. Lithonia Lighting; Acuity Lighting Group, Inc.
 6. Square D; Schneider Electric.

7. TORK; NSI Industries.

- D. Description: Electrically operated and mechanically held, combination type with non-fused disconnect, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including LED tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation. Refer to FCA value on drawings, at nearest upstream device.
3. Enclosure: Provide with enclosure complying with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

- E. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.

1. Monitoring: On-off status.
2. Control: On-off operation.

2.13 AUTOMATIC LOAD CONTROL RELAYS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings.

- B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. For control of emergency lighting circuits: Loss of normal power shall cause relay to automatically shunt emergency power to lighting circuit regardless of manual or automatic switch position. Emergency lighting circuit shall continue to operate at full power until normal power has been restored.
2. Coil Rating: 120 V, as indicated on Drawings.
3. Mounting: Either a 2-gang outlet box with separation barrier and plaster ring or a wall-mountable box with separate compartments. Mount per manufacturer's instructions.
4. Auxiliary Relay input: Provisions to shunt emergency lighting on upon receiving a signal from an outside system such as security or fire alarm system.

2.14 BRANCH CIRCUIT TRANSFER SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the Lighting Control Device Schedule on the Drawings.

- B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 1008.
 - 1. For control of emergency lighting circuits: Loss of normal power shall cause relay to automatically shunt emergency power to lighting circuit regardless of manual or automatic switch position. Emergency lighting circuit shall continue to operate at full power until normal power has been restored.
 - 2. Coil Rating: 120 V.

2.15 CONDUCTORS AND CABLES FOR LIGHTING CONTROL DEVICES

- A. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables.
- B. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG.
- C. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG.
- D. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG.
- E. Provide all necessary conductor and cabling required for operation of the controls and control systems specified. This includes power and control wiring required for the controls to operate as described.

PART 3 - EXECUTION

3.1 INSTALLATION

A. GENERAL

- 1. Install devices and associated power packs and wiring in accordance with manufacturer's instructions and applicable codes.

B. LINE VOLTAGE WALL SWITCHES

- 1. Install dimming wall switches to achieve full rating specified on Lighting Control Device Schedule taking into account de-rating for ganging as instructed by the manufacturer.
- 2. Provide a separate grounded (neutral) conductor for each circuit controlled by a line voltage switch.
 - a. Do not share neutral conductor on load side of dimmers.
 - b. If neutral termination is not required for the device, cap conductor and tag as "Neutral for future use".

C. OCCUPANCY/VACANCY SENSORS AND PHOTOELECTRIC SWITCHES

1. Arrange a pre-installation meeting with manufacturer's factory authorized field representative, at Owner's facility, to verify placement of sensors and installation criteria.
2. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage areas specified in manufacturer's literature. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms or areas that are to be provided with sensors. Provide additional sensors as required to properly and completely cover the respective areas.
3. 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.
4. Occupancy sensors with ultrasonic or dual-technology sensing technologies shall be located not closer than 4 feet from the nearest edge of air supply devices or similar obstructions that would adversely affect the sensor performance.
5. Adjust time delay setting of occupancy sensors to de-energize loads after space has been unoccupied for period of time indicated on the Drawings.
6. Install outdoor photoelectric switches with clear view of the northern sky unless noted otherwise on the Drawings.
7. Adjust settings of photoelectric switches to turn on lighting at illumination level indicated on the Drawings.
8. Install devices and auxiliary equipment in compliance with manufacturer's instructions and recommendations.
9. Install relay units where concealed from view and where accessible.
10. 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.
11. Install switchbox mounted occupancy sensors at same elevation as other lighting control switches.

D. LIGHTING CONTACTORS

1. Install lighting contactors in locations as indicated on the Drawings.
2. Provide NEMA 1 enclosures for lighting contactors in interior dry locations, NEMA 3R enclosures for lighting contactors in exterior or wet locations.
3. 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.
4. Coordinate connection and programming of BAS Interface with controls contractor.

E. AUTOMATIC LOAD CONTROL RELAYS

1. When used with manual controls, install emergency shunt relay wall mounted within electrical room. Label within enclosure the connected normal and emergency circuits.
2. When used with automatic controls, install where concealed from view in accessible ceiling near the automatic control device or wall mounted within electrical room. Label outlet box cover with connected normal and emergency circuits.

F. BRANCH CIRCUIT TRANSFER SWITCHES

1. Install branch circuit transfer switches where concealed from view in accessible ceiling near the automatic control device or wall mounted within electrical room. Label outlet box cover with connected normal and emergency circuits.

G. WIRING

1. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be [1/2 inch (13 mm)][<insert size>].
2. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
3. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
4. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.2 IDENTIFICATION

- A. General: Provide identification complying with requirements specified in Division 26 Section "Identification for Electrical Systems."
- B. Power and control wiring: Identify using marker tapes.
1. Identify controlled circuits in lighting contactors.
 2. Identify circuits or luminaires controlled by photoelectric switches and occupancy sensors at each sensor.
- C. Components: Label each component with self-laminating computer printed labels, using a unique designation matching control drawing.
- D. Cover plates: Refer to drawings for labeling requirements of certain cover plates for manual switches, or similar devices, requiring labeling for user information.
- E. Buttons/switches:
1. Engraved from manufacturer. Refer to drawings for detailed requirements and text for labeling.

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 - 2. Operational Test: Test all occupancy sensors in test mode to confirm sensor coverage and sensitivity of sensor per manufacturer's instructions. Upon completion of tests, set sensor time delay as indicated on Lighting Control Device Schedule. Follow testing and adjustment procedures as written in the manufacturer's installation instructions for each sensor model.
- B. Lighting control devices that fail tests and inspections are defective work. Remove, replace, and retest devices that fail tests.

3.4 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
- B. Photoelectric switch Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project for this purpose.

3.5 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Lighting Control Systems."
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training" and Division 26 Section "Lighting Control Systems" for additional information

END OF DOCUMENT 260923

DOCUMENT 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes switchboards rated 600 V and less, including the following:
 - 1. Service and distribution switchboards.
 - 2. Surge Protection Devices.
 - 3. Disconnecting and overcurrent protective devices.
 - 4. Instrumentation.
 - 5. Control power.
 - 6. Accessory components and features.

1.2 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. NETA ATS: InterNational Electrical Testing Association Acceptance Testing Specification.
- C. SPD: Surge Protection Device

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Fault-Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section "Overcurrent Protective Device Coordination Study"

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".

- B. Product Data: For each type of switchboard, switching and overcurrent protective device, instrumentation, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, weights, and finishes.
- C. Shop Drawings: For each switchboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details, including required clearances, service space around equipment, and attachments to other work. Show tabulations of installed devices, equipment features, and ratings.
 - a. Tabulate features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 3. Include outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
 4. Detail bus configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus. Indicate mains and branches of phase, neutral, and ground buses.
 5. Detail short-circuit current rating of switchboard assembly and overcurrent protective devices.
 6. Include descriptive documentation of barriers specified for electrical insulation and isolation.
 7. Detail utility company's metering provisions with indication of approval by utility company.
 8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards; include selectable ranges for each type of overcurrent protective device. Submit electronic files, in an SKM-compatible format.
 10. Include schematic and wiring diagrams for power, signal, and control wiring.
 11. Include nameplate legends.
 12. Include list of materials.
- D. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

1. For each equipment room, provide dimensioned layout of the electrical equipment within the space, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved.
 2. Dimensioned concrete base, outline of switchboard, conduit entries, and ground rod locations; including equipment working clearances and manufacturer required access space.
 3. Indicate structural members, light fixtures, sprinkler piping and heads, HVAC equipment, ducts and diffusers, plumbing piping and access fittings. Include maintenance access clearances.
 4. Location of structural supports for structure-supported raceways.
 5. Location and clearance of electrical equipment and raceways impacting equipment installation.
 6. Proposed routing of equipment, in shipping splits, from exterior of the building to the final installed location. Include product weights, width and height restrictions encountered along the path. Include intended construction sequencing to mitigate conflicts.
 7. Proposed routing of equipment for future removal, from within equipment room to exterior of the building without removal of non-related equipment or architectural elements.
- E. Qualification Data: For qualified Installer and testing agency.
- F. Field Quality-Control Reports:
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- G. Manufacturer's field service report.
- H. Sample Warranty: For warranty.
- I. Project Record Documents: Record actual installed equipment and circuiting arrangements. Record actual routing for underground circuits. Record actual installed location of ground rods.
- J. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Routine maintenance requirements for switchboards and all installed components.
 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 3. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

4. Features and operating sequences, both automatic and manual.
5. Video recording of operation training and demonstration.

K. Follow-up service reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E; Employs installers and supervisors who are trained and approved by manufacturer.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."
- D. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- E. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- F. 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.
- G. Comply with NEMA PB 2.1.
- H. Comply with NFPA 70.
- I. Comply with UL 891.

1.6 PROJECT CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.
- B. Environmental Limitations:
 1. Do not install switchboards until spaces are enclosed and weathertight. Equipment shall be protected from any remaining wet work in the space and work above secondary unit substation. Provide temporary HVAC system for maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).
3. Service Conditions: NEMA PB 2, usual service conditions, as follows:
 - a. Ambient temperatures within limits specified.
 - b. Altitude not exceeding 6600 feet (2000 m).

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.
- B. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- C. Coordinate delivery of equipment to allow movement into designated space.
- D. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish. Provide temporary heating according to manufacturer's written instructions.
- E. Handle and prepare switchboard components according to NEMA PB 2.1 and manufacturer's written instructions. Use factory-installed lifting provisions.

1.8 WARRANTY

- A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components and/or products of the switchboards that fail in materials or workmanship within the specified warranty period.
- B. Warranty Period: Three years from date of Substantial Completion.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fuses: Refer to Division 26 section "Fuses" for spare fuse requirements. At a minimum, include spares for the following:
 - a. Primary disconnect fuses.
 - b. Potential transformer fuses.
 - c. Control power fuses.

- d. Fuses for fusible devices.
- 2. Indicating Lights: Four of each type installed.
- 3. Primary Switch Contact Lubricant: One container.
- 4. Touchup Paint: Two containers of paint matching enclosure finish, each 0.5 pint (250 mL).
- 5. Enclosure Keys: Two for each enclosure type. All distribution equipment keyed alike.

PART 2 - PRODUCTS

2.1 GENERAL

A. Available Manufacturers:

- 1. ABB Inc.
- 2. Eaton.
- 3. Schneider Electric.
- 4. Siemens Energy & Automation, Inc.

B. Front-Connected, Front-Accessible Switchboards:

- 1. Main Devices: Fixed, individually mounted.
- 2. Branch Devices: Panel mounted.
- 3. Sections front and rear aligned.

2.2 RATINGS

A. Nominal System Voltage: As indicated on the Drawings.

B. Main-Bus Continuous: Ampacity as indicated on the Drawings.

C. Short-Circuit Current Rating (SCCR):

- 1. Refer to fault-current and coordination study submittal requirements listed in other parts of this section, in addition to specification section "Overcurrent Protective Device Coordination Study".
- 2. Rating value: Rated to interrupt symmetrical short-circuit current available at terminals. Switchgear shall be fully-rated, unless series-rated is indicated on the drawings. SCCR shall not be less than the highest AIC rating of any circuit breaker in switchgear.

2.3 FABRICATION

A. Indoor Enclosures: Steel, NEMA 250, Type 1.

1. Finish: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- B. Front align all sections.
- C. Utility Metering Compartment: Fabricated, barrier compartment and section complying with utility company's requirements; hinged sealed door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.
- D. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.
- E. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- F. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchgear.
- G. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- H. Pull Box on Top of Switchboard:
1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
 2. Set back from front to clear circuit-breaker removal mechanism.
 3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
 4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
 5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.
 6. Enclosure:
 - a. Roof: Downward, rearward sloping
 - b. Rear covers: bolt-on, for each section, with provisions for padlocking.
 7. Personnel Doors: Personnel door at each end of aisle, minimum width of 30 inches (762 mm); opening outwards; with panic hardware and provisions for padlocking.

8. Accessories: LED lighting fixtures, ceiling mounted; wired to a three-way light switch at each end of aisle; ground-fault circuit interrupter (GFCI) duplex receptacle; emergency battery pack lighting fixture installed on wall of aisle midway between personnel doors.
- I. Barriers: Bus bars shall connect between vertical sections and between compartments. Cable connections are not permitted.
1. Bus isolation barriers shall be arranged to isolate each vertical section. Where indicated, horizontal isolation barriers shall be arranged to isolate adjacent compartments within a vertical section.
 2. Insulation and isolation for main bus of main section and main and vertical buses of feeder and tie sections. Barriers between compartments shall extend to the rear of each section.
 3. Isolation barriers shall be fabricated in a manner to permit checking of bus-bolt tightness.
- J. Buses: Bus bars shall connect between vertical sections and between compartments. Cable connections are not permitted.
1. Main Phase Bus: Size: Ampacity as indicated on drawings, with uniform capacity for entire length of switchboard's main and distribution sections
 2. Neutral Bus: 100 percent of phase-bus ampacity, except as indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors.
 3. Vertical Section Bus Size: Ampacity as indicated on drawings, with uniform capacity for entire length of vertical section bus.
 4. Phase- and Neutral-Bus Material: [Silver- or tin-plated, high-strength, electrical-grade aluminum alloy, with copper or tin-plated aluminum circuit-breaker line connections.][Hard-drawn copper of 98 percent minimum conductivity or tin-plated, high-strength, electrical-grade aluminum alloy.][Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.]
 5. Use silver-plated copper or tin-plated aluminum for connecting circuit-breaker line to aluminum bus. Use copper for connecting circuit-breaker line to copper bus.
 6. Contact Surfaces of Buses: Silver plated.
 7. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size required by UL 891. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 8. Supports for Buses: Adequate support for bussing material used. Include supports for bus extensions for busway feeders.
 9. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch (6-by-50-mm) copper bus, arranged to connect neutral bus to ground bus.

10. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.
 11. Provide any available breaker mounting space with bussing.
 12. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.
 - a. Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.
 13. Line-Side Conductor and Feeder Circuit-Breaker Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors unless otherwise indicated on Drawings, suitable for use with conductor material and sizes. Connections shall comply with requirements of Division 26 section "Low-Voltage Electrical Power Conductors and Cables". Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
- K. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.
- L. Service Equipment Equipment:
1. Label: Where used as service entrance equipment, provide NRTL label for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.
 2. Infrared Windows: Provide with infrared windows in quantities and locations to provide line-of-sight viewing of all cable terminations on the line side of the main overcurrent protective device.
- 2.4 SURGE PROTECTION DEVICES
- A. Provide surge protective devices as required by Division 26 Section "Surge Protective Devices".
- 2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES
- A. Arc Flash Mitigation
1. Overcurrent devices, 1200 A and larger, shall be provided with an energy-reducing active arc flash mitigation capability. The energy-reducing active arc flash mitigation system shall allow the operator to enable a maintenance mode using a switch which enables a preset accelerated instantaneous override trip to reduce arc flash energy. An LED on the trip unit shall indicate the trip unit is in the maintenance mode.
- B. Ratings:
1. Continuous ampere rating: as indicated on drawings.
 2. Voltage and frequency rating: same as panelboard.

3. Short-circuit current rating (SCCR): Same as requirements for switchboard.
 4. Ampere Interrupting Current (AIC) rating: Rated to interrupt symmetrical short-circuit current available at terminals. Panelboards shall be fully-rated, unless series-rated is indicated on the drawings.
- C. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
 6. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical or compression style as indicated, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

- d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 - f. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
 - g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 - h. Under voltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - i. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
- D. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
- 1. Fixed circuit-breaker mounting.
 - 2. Two-step, stored-energy closing.
 - 3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time time adjustments.
 - c. Ground-fault pickup level, time delay, and I^2t response.
 - 4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 - 5. Remote trip indication and control.
 - 6. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
 - 7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - 8. Control Voltage: as indicated, or as required by control devices per power supply.

2.6 INSTRUMENTATION

- A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
1. Potential Transformers: IEEE C57.13; 120 V, 60 Hz, single secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
 2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
 3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
 4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Megawatts: Plus or minus 2 percent.
 - e. Megavars: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
 2. Mounting: Display and control unit flush or semi flush mounted in instrument compartment door.
- C. Ammeters, Voltmeters, and Power-Factor Meters: ANSI C39.1.

1. Meters: 4-inch (100-mm) diameter or 6 inches (150 mm) square, flush or semi flush, with antiparallax 250-degree scales and external zero adjustment.
 2. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.
- D. Instrument Switches: Rotary type with off position.
1. Voltmeter Switches: Permit reading of all phase-to-phase voltages and, where a neutral is indicated, phase-to-neutral voltages.
 2. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in a closed-circuit condition at all times.
- E. Feeder Ammeters: 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale. Meter and transfer device with off position, located on overcurrent device door for indicated feeder circuits only.
- F. Watt-Hour Meters and Wattmeters:
1. Comply with ANSI C12.1.
 2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
 3. Suitable for connection to three- and four-wire circuits.
 4. Potential indicating lamps.
 5. Adjustments for light and full load, phase balance, and power factor.
 6. Four-dial clock register.
 7. Integral demand indicator.
 8. Ratchets to prevent reverse rotation.
 9. Removable meter with draw out test plug.
 10. Semi flush mounted case with matching cover.
 11. Appropriate multiplier tag.
- G. Impulse-Totalizing Demand Meter:
1. Comply with ANSI C12.1.
 2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.
 3. Cyclometer.
 4. Four-dial, totalizing kilowatt-hour register.

5. Positive chart drive mechanism.
6. Capillary pen holding a minimum of one month's ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
8. Capable of indicating and recording 15 minute integrated demand of totalized system.

2.7 CONTROL POWER

- A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.
- B. Control Circuits: 120-V ac, supplied from remote branch circuit.
- C. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.
- D. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- E. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.8 ACCESSORY, COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.
- C. Portable Circuit-Breaker Lifting Device: Floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.
- D. Overhead Circuit-Breaker Lifting Device: Mounted at top front of switchboard, with hoist and lifting yokes matching each draw out circuit breaker.
- E. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

2.9 IDENTIFICATION

- A. Nameplates: Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

- B. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram. Refer to Division 26 Section "Identification for Electrical Systems" for additional requirements.
 - 1. Mimic-bus segments coordinated with devices in switchboard sections to which applied, to produce a concise visual presentation of principal switchboard components and connections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine switchboards before installation. Reject equipment that is damaged, or rusted, or have been subjected to water saturation.
- B. Examine areas, surfaces, substrates, and elements to receive switchboards with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that field measurements are as indicated.
 - 2. Verify that manufacturer's written instructions for environmental conditions have been established in spaces where equipment will be installed, before installation begins.
- C. Examine roughing-in of conduits and grounding systems to verify the following:
 - 1. Wiring entries comply with layout requirements.
 - 2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install switchboards and accessories according to NEMA PB 2.1 and manufacturer's instructions.
- B. Coordinate layout and installation of equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- C. Comply with mounting and anchoring requirements specified in Division 26 Section "Seismic Controls for Electrical Systems."
- D. Equipment Mounting: Install switchboards on concrete bases.
 - 1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 3 inches (75 mm) in all directions beyond the maximum dimensions of switchboard unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 3. Install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to switchboards.
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
 - F. Mount equipment plumb and rigid without distortion of enclosure.
 - G. Install overcurrent protective devices, surge suppression devices and instrumentation.
 - H. Install filler plates in unused spaces of panel-mounted sections.
 - I. Arrange conductors in auxiliary compartments and gutters into groups and bundle and wrap with wire ties.
 - J. Comply with NECA 1.
- 3.3 CONNECTIONS
- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
 - C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for control wiring.
- 3.4 IDENTIFICATION
- A. Equipment Nameplates: Label each contiguous main, or entrance, section with equipment nameplate.
 - B. Device Nameplates: Label each main, feeder and branch circuit device with a nameplate.
 - C. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
 - D. Diagram and Instructions:
 1. Engraved, Laminated Acrylic or Melamine Label. Mount on front of switchboard.

- a. Operating Instructions: Printed operating instructions for switchboard, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures.
 - b. System Power One-Line Diagrams: Provide color-coded, large-format one-line diagram showing the new work is to be provided and installed in the associated electrical room. Depict power sources, feeders, distribution components, and major loads.
 - 2. Storage for Maintenance Instructions: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.
- E. Warning Labels: Label each panelboard with a warning label in accordance with NFPA 70 and NFPA 70E.
- 3.5 CLEANING
- A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.
- 3.6 PROTECTION
- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions throughout periods when equipment environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.
- 3.7 ADJUSTING
- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
 - B. Set field-adjustable circuit-breaker trip ranges and protective relay trip characteristics as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."
- 3.8 FIELD QUALITY CONTROL
- A. Testing: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
 - B. Testing: Engage a qualified testing agency to perform the following field quality-control tests and inspections:
 - C. Testing: Perform the following field quality-control tests and inspections:
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, to assist in testing, and to assist in adjusting device settings.
 - D. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

E. Acceptance Testing Preparation:

1. After installing equipment but before equipment is energized, test for compliance with requirements.
2. Verify that grounding system at the equipment tested at the specified value or less.
3. Test insulation resistance for each bus, component, connecting supply, feeder, and control circuit.
4. Test continuity of each circuit.

F. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. After electrical circuitry has been energized, test for compliance with requirements.
2. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.
3. Complete installation and startup checks according to manufacturer's written instructions.
4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
5. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
6. Report results of tests and inspections in writing. Record adjustable settings and measured insulation resistances. Attach a label or tag to each tested component indicating satisfactory completion of tests.

G. Assist in field commissioning of equipment including pretesting and adjusting of equipment and components.

H. Infrared Scanning: Perform the following infrared scan tests and inspections and prepare reports:

1. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove necessary panels so joints and connections are accessible to portable scanner.
2. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
3. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

I. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the main incoming section of each service entrance switchboards. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
 2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
 - a. Rebalance loads.
 - b. Prepare written request for voltage adjustment by electric utility in accordance with Division 26 section "Provisions for Electric Utility Service".
 3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
- J. Switchboard will be considered defective if it does not pass tests and inspections.
- K. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- 3.9 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.
- B. Video record demonstrations presentation for Owner's records.

END OF DOCUMENT 262413

DOCUMENT 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY:

- A. This section includes panelboards rated 600 V and less, including the following:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Disconnecting and Overcurrent Protective Devices.
 - 4. Surge Protection Devices.
 - 5. Accessory Components and Features.

1.2 DEFINITIONS

- A. NETA ATS: InterNational Electrical Testing Association Acceptance Testing Specification.
- B. SVR: Suppressed voltage rating.
- C. SPD: Surge Protection Device

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Fault-Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section "Overcurrent Protective Device Coordination Study"

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Product Data: For each type of panelboard, switching and overcurrent protective device, furnished accessories and components. Include dimensions and Manufacturer's technical data on features, performance, electrical characteristics, ratings, weights, furnished options, specialties, accessories, and finishes.
- C. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances, service space around equipment, and attachments to other work. Show tabulations of installed devices, equipment features, and ratings.
 - a. Tabulate features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 2. Detail enclosure types and details for other than NEMA 250, Type 1.
 3. Include general arrangement drawing showing dimensions and weights of each assembled section.
 4. Detail bus configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus. Indicate mains and branches of phase, neutral, and ground buses.
 5. Detail short-circuit current rating of panelboard assembly and overcurrent protective devices.
 6. Include descriptive documentation of barriers specified for electrical insulation and isolation.
 7. Detail utility company's metering provisions with indication of approval by utility company.
 8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 9. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards; include selectable ranges for each type of overcurrent protective device. Submit electronic files, in an SKM-compatible format.
 10. Include schematic and wiring diagrams for power, signal, and control wiring.
 11. Include nameplate legends.
 12. Include list of materials.
- D. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around panelboards where pipe and ducts are prohibited. Show panelboard layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
1. For each equipment room, provide dimensioned layout of the electrical equipment within the space, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved.
 2. Dimensioned concrete base, outline of panelboard sections, conduit entries, and ground rod locations; including equipment working clearances and manufacturer required access space.

3. Indicate structural members, light fixtures, sprinkler piping and heads, HVAC equipment, ducts and diffusers, plumbing piping and access fittings. Include maintenance access clearances.
 4. Location of structural supports for structure-supported raceways.
 5. Location and clearance of electrical equipment and raceways impacting equipment installation.
 6. Proposed routing of equipment for future removal, from within equipment room to exterior of the building without removal of non-related equipment or architectural elements.
- E. Sustainable Design Documentation: Submit manufacturer's product data on materials and assemblies showing compliance with building rating standard(s) requirements.
- F. Qualification Data: For qualified testing agency.
- G. Field Quality-Control Reports:
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- H. Manufacturer's field service report.
- I. Sample Warranty: For warranty.
- J. Project Record Documents: Record actual installed equipment and circuiting arrangements. Record actual routing for underground circuits. Record actual installed location of ground rods.
- K. Panelboard Schedules: Submit final panelboard directories.
- L. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Routine maintenance requirements for panelboards and all installed components.
 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 3. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.
 4. Features and operating sequences, both automatic and manual.
 5. Video recording of operation training and demonstration.
- M. Follow-up service reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."
- C. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Comply with NEMA PB 1.
- G. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.
- B. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above equipment is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).
- C. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet (2000 m).

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate delivery of equipment to allow movement into designated space.
- B. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish. Provide temporary heating according to manufacturer's written instructions.
- C. Handle and prepare panelboards for installation according to NEMA PB 1 and manufacturer's written instructions. Use factory-installed lifting provisions.

1.8 WARRANTY

- A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components and/or products of the panelboards that fail in materials or workmanship within the specified warranty period.
- B. Warranty Period: Three years from date of Substantial Completion.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fuses: Refer to Division 26 section "Fuses" for spare fuse requirements. At a minimum, include spares for the following:
 - a. Primary disconnect fuses.
 - b. Potential transformer fuses.
 - c. Control power fuses.
 - d. Fuses for fusible devices.
 2. Indicating Lights: Four of each type installed.
 3. Primary Switch Contact Lubricant: One container.
 4. Touchup Paint: Two containers of paint matching enclosure finish, each 0.5 pint (250 mL).
 5. Enclosure Keys: Two for each enclosure type. All distribution equipment keyed alike.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Available Manufacturers:

1. ABB Inc.
 2. Eaton.
 3. Schneider Electric.
 4. Siemens Energy & Automation, Inc.
- B. Additional Manufacturers for Electronics Grade Panelboards
1. Current Technology; a subsidiary of Danahar Corporation.
 2. Vertiv.
- C. Enclosures: Flush- or surface-mounted cabinets as noted.
1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Kitchen and/or Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.
 2. Hinged Front Cover: Entire front trim hinged to box.
 3. Door: Standard door with concealed hinges, within hinged trim cover. Secured with vault-type latch with tumbler lock; keyed alike.
 4. Skirt for Surface-Mounted Panelboards: Same gauge and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 5. Gutter Extension and Barrier: Same gauge and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 6. Finishes:
 - a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
 7. Directory Card: Inside panelboard door, mounted in transparent card holder.
- D. Incoming Mains Location: Top and/or bottom as required.

E. Buses: Three phase, four wire unless otherwise indicated.

1. Phase, and Neutral Buses:

a. Material:

1) Tin-plated aluminum.

- a) Hard-drawn copper, 98 percent conductivity, may be substituted if provided at no additional cost.

2) Hard-drawn copper, 98 percent conductivity.

3) Hard-drawn copper, 98 percent conductivity, silver-plated

b. Size: Ampacity as indicated on drawings, with uniform capacity for entire length of panelboard's sections.

- 1) Neutral bus: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus

2. Ground Bus: Equipped with connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

a. Material: Hard-drawn copper, 98 percent conductivity

b. Size: Minimum-size required by UL 67

3. Split Bus: Vertical buses divided horizontally into individual vertical sections.

4. General: Provide any available breaker mounting space with bussing.

F. Line-Side Conductor Connectors (Lugs):

1. General: Suitable for use with conductor material and sizes. Connections shall comply with requirements of Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".

2. Material: Same as bus material.

3. Capacity rating: Same as associated bus.

4. Type: Provide mechanical type unless otherwise indicated on Drawings, refer to schedules and one-line diagram.

5. Provide properly sized lugs for all equipment, circuit breakers and other electrical devices to accommodate installed conductors. A larger frame, oversized lugs or non-standard product may be required in some instances.

- a. Pin adapters may be utilized only as allowed by manufacturer and the authority having jurisdiction.

G. Feed-Through Lugs:

- 1. General: Suitable for use with conductor material and sizes. Connections shall comply with requirements of Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".
- 2. Location: Locate at opposite end of bus from line side lugs or main device.
- 3. Material: Same as line side conductor connectors.
- 4. Capacity rating: Same as associated bus.
- 5. Type: Same as line side conductor connectors.

H. Subfeed lugs (Double Lugs):

- 1. General: Suitable for use with conductor material and sizes. Connections shall comply with requirements of Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".
- 2. Location: Locate at same end of bus as incoming lugs or main device.
- 3. Material: Same as line side conductor connectors.
- 4. Capacity rating: Same as associated bus.
- 5. Type: Same as line side conductor connectors.

I. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

J. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

K. Short-Circuit Current Rating (SCCR):

- 1. Refer to fault-current and coordination study submittal requirements listed in other parts of this section, in addition to specification section "Overcurrent Protective Device Coordination Study".
- 2. Rating value: Rated to withstand symmetrical short-circuit current available at terminals. Panelboards shall be fully-rated, unless series-rated is indicated on the drawings. SCCR shall not be less than the highest AIC rating of any circuit breaker in panelboard.

2.2 DISTRIBUTION PANELBOARDS

A. Panelboards: NEMA PB 1, power and feeder distribution type.

B. Doors: For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

- C. Mains: As indicated on drawings.
- D. Branch Overcurrent Protective Devices:
 - 1. Connection to bus:
 - a. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
 - b. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
 - 2. Type: Provide types as indicated on drawings and as defined below.
- E. Device Ratings:
 - 1. Continuous ampere rating: as indicated on drawings.
 - 2. Voltage and frequency rating: same as panelboard.
 - 3. Short-circuit current rating (SCCR): Same as requirements for panelboard.
 - 4. Ampere Interrupting Current (AIC) rating: Rated to interrupt symmetrical short-circuit current available at terminals. Panelboards shall be fully-rated, unless series-rated is indicated on the drawings.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Panelboards: Circuit breaker type: NEMA PB 1, lighting and appliance branch-circuit type.
- B. Mains: As indicated on drawings.
- C. Branch Overcurrent Protective Devices:
 - 1. Connection to bus: Plug-in circuit breakers, replaceable without disturbing adjacent units.
 - 2. Type: Provide types as indicated on drawings and as defined below.
- D. Device Ratings:
 - 1. Continuous ampere rating: as indicated on drawings.
 - 2. Voltage and frequency rating: same as panelboard.
 - 3. Short-circuit current rating (SCCR): Same as requirements for panelboard.
 - 4. Ampere Interrupting Current (AIC) rating: Rated to interrupt symmetrical short-circuit current available at terminals. Panelboards shall be fully-rated, unless series-rated is indicated on the drawings.
- E. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Arc Flash Mitigation

1. Overcurrent devices, 1200 A and larger, shall be provided with an energy-reducing active arc flash mitigation capability. The energy-reducing active arc flash mitigation system shall allow the operator to enable a maintenance mode using a switch which enables a preset accelerated instantaneous override trip to reduce arc flash energy. An LED on the trip unit shall indicate the trip unit is in the maintenance mode.

B. Ratings:

1. Continuous ampere rating: as indicated on drawings.
2. Voltage and frequency rating: same as panelboard.
3. Short-circuit current rating (SCCR): Same as requirements for panelboard.
4. Ampere Interrupting Current (AIC) rating: Rated to interrupt symmetrical short-circuit current available at terminals. Panelboards shall be fully-rated, unless series-rated is indicated on the drawings.

C. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).

7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical type unless otherwise indicated on Drawings, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - 1) Mounting: Integral
 - 2) Mounting: Remote
 - e. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
 - f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 - h. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - i. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - k. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
 - l. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
 - m. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - n. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

- D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
 - E. Fuses are specified in Division 26 Section "Fuses."
- 2.5 FUSED LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS (30 TO 400A MAINS)
- A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable products by one of the following, the first listed manufacturer was used as the basis of design:
 - 1. Cooper Bussman Quik Spec Coordination Panelboards type QSCP
 - B. Bus Bars: Shall be tin-plated copper.
 - C. Panelboards: listed to UL 67
 - 1. Provide space behind locking door for a minimum of 6 spaces to store replacement branch circuit fuses.
 - D. Mains:
 - 1. Permanently installed lockout means shall be provided.
 - 2. Quick-make, quick-break type.
 - E. Branch Overcurrent Protective Devices:
 - 1. Device shall have visible circuit ON/OFF indication with colored and international symbol markings
 - 2. Device shall provide open fuse indication via permanently installed neon or LED indicating light.
 - 3. Fuse and disconnect assembly shall be a finger-safe component with trim installed.
 - 4. No special tools shall be required for fuse removal.
 - 5. Devices shall have bolt-on style bus connectors.
 - 6. Device housing shall be clearly marked with device amperage.
 - 7. Permanently installed lockout means shall be provided on the device for lockout tagout procedures. Permanently installed means for locking device in the ON position shall also be provided.
 - 8. Device shall provide fuse amp rating rejection at the following ampacities to ensure continued circuit protection at the specified circuit rating: 15A, 20A, 30A, 40A, 50A, 60A, 70A, 90A & 100A.
 - 9. Branch circuit overcurrent protection shall be 600Vac UL Listed minimum 300kA IR and CSA Certified minimum 200kA IR finger-safe fuse with Class J* performance characteristics. Cooper Bussmann UL class CF CUBEFuse meets this requirement.

F. Device Ratings:

1. Continuous ampere rating: as indicated on drawings.
2. Voltage and frequency rating: same as panelboard.
3. Short-circuit current rating (SCCR): Same as requirements for panelboard.
4. Ampere Interrupting Current (AIC) rating: Rated to interrupt symmetrical short-circuit current available at terminals. Panelboards shall be fully-rated, unless series-rated is indicated on the drawings.

2.6 SURGE PROTECTION DEVICES

- A. Provide surge protective devices as required by Division 26 Section "Surge Protective Devices".
- B. Panelboards requiring SPD and the location of the devices shall be as indicated on the Drawings.

2.7 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

2.8 IDENTIFICATION

- A. Nameplates: Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine panelboards before installation. Reject equipment that is damaged, or rusted, or have been subjected to water saturation.
- B. Examine areas, surfaces, substrates, and elements to receive panelboards with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 1. Verify that field measurements are as indicated.
 2. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.
- C. Examine roughing-in of conduits and grounding systems to verify the following:
 1. Wiring entries comply with layout requirements.
 2. Entries are within conduit-entry tolerances specified by manufacturer.

- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1 and manufacturer's instructions.
- B. Coordinate layout and installation of equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- C. Comply with mounting and anchoring requirements specified in Division 26 Section "Seismic Controls for Electrical Systems."
- D. Wall-Mounted Panelboards: Install panelboards on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For panelboards not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Floor-Mounted Panelboards: Install panelboards on concrete bases.
 - 1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 3 inches (75 mm) in all directions beyond the maximum dimensions of panelboards unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."
 - 2. Anchor panelboards to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Sections "Hangers and Supports for Electrical Systems" and "Seismic Controls for Electrical Systems."
 - 3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
 - 4. Install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 6. Install anchor bolts to elevations required for proper attachment to panelboards.
 - 7. Attach panelboards to the vertical finished or structural surface behind the panelboards.
- F. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- G. Mount top of trim 72 inches (1788 mm) above finished floor unless otherwise indicated.
- H. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

- I. Install overcurrent protective devices and controllers not already factory installed.
- J. Install fuses in fusible devices.
- K. Install filler plates in unused spaces.
- L. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
 - 1. Empty conduits shall be provided with pull strings.
 - 2. Cap and label empty conduits for future use.
- M. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- N. Comply with NECA 1.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for control wiring.

3.4 IDENTIFICATION

- A. Equipment Nameplates: Label each contiguous main, or entrance, section with equipment nameplate.
- B. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate.
- C. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- D. Diagram and Instructions:
 - 1. Engraved, Laminated Acrylic or Melamine Label. Mount on front of panelboard.
 - a. Operating Instructions: Printed operating instructions for panelboard, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures.
- E. Warning Labels: Label each panelboard with a warning label in accordance with NFPA 70 and NFPA 70E.

1. Exception: Do not install NFPA 70 working clearance requirements on flush panelboards and similar equipment in finished spaces.

F. Panel Directories

1. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
2. Note the date the directory was created/updated.
3. Create directory after loads have been balanced to reflect actual as-built conditions.
4. Circuit descriptions shall be per code and shall be distinguishable from all others.
5. Replace existing directories with revised type written directories indicating changes.

3.5 CLEANING

- A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.7 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

3.8 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing: Engage a qualified testing agency to perform the following field quality-control tests and inspections:
- C. Testing: Perform the following field quality-control tests and inspections:
 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, to assist in testing, and to assist in adjusting device settings.
- D. Acceptance Testing Preparation:

1. After installing equipment but before equipment is energized, test for compliance with requirements.
 2. Verify that grounding system at the equipment tested at the specified value or less.
 3. Test insulation resistance for each bus, component, connecting supply, feeder, and control circuit.
 4. Test continuity of each circuit.
- E. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. After electrical circuitry has been energized, test for compliance with requirements.
 2. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.
 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
 5. Report results of tests and inspections in writing. Record adjustable settings and measured insulation resistances. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- F. Assist in field commissioning of equipment including pretesting and adjusting of equipment and components.
- G. Infrared Scanning: Perform the following infrared scan tests and inspections and prepare reports:
1. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 2. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 3. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- H. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:
1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the main incoming section of each service entrance panelboard.

Use voltmeters with calibration traceable to the National Institute of Science and Technology standards. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.

2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
 - a. Rebalance loads.
 - b. Prepare written request for voltage adjustment by electric utility in accordance with Division 26 section "Provisions for Electric Utility Service".
 3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
- I. Panelboards will be considered defective if they do not pass tests and inspections.
 - J. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain panelboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.
- B. Video record demonstrations presentation for Owner's records.

END OF DOCUMENT 262416

DOCUMENT 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Receptacles: Single, duplex, USB/duplex, USB-only, twist-lock, ground-fault circuit interrupters (GFCI), surge protective device (SPD), isolated ground (IG) and tamper resistant (TR).
2. AC Wall Switches: Single- and double-pole, three- and four-way, maintained and momentary, pilot light and lighted toggle.
3. Device Wall Plates.
4. Service/Power Poles and Multi-Outlet Assemblies.
5. Emergency Power Off Buttons

1.2 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. PIR: Passive Infrared.
- C. SPD: Surge Protective Device
- D. USB: Universal Serial Bus
- E. TR: Tamper Resistant

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Product data for the following products:
1. Provide manufacturer's catalog information specifically marked to indicate which devices are being furnished, and showing dimensions, colors, and configurations for all devices, including, but not limited to: Receptacles, AC wall switches, cover plates, power poles, and multi-outlet assemblies.
- C. Shop drawings for:
1. List of legends and description of materials and process used for pre-marking wall plates.
- D. Field quality-control test reports.
- E. Warranty: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated cover plate from a single manufacturer and through one source. Where practical and possible, obtain all wiring devices and associated cover plates from a single manufacturer and one source.
- B. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 10 years.
- C. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that are acceptable to authorities having jurisdiction.
 - 2. Marked for intended use.
- D. Comply with NFPA 70.

1.5 COORDINATION

- A. Receptacles for Equipment Furnished by Owner or Under Other Divisions or Contracts: Match plug configurations.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Wall Plates: One for every 10 of each type (i.e., style, size, and finish) installed, but no fewer than two of each type.

1.7 SPARES

- A. Furnish spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. SPD Receptacles: One for every 10 of each type installed, but no fewer than two of each type
 - 2. SPD Receptacles With Replacement Surge Modules: [One for every 10] <Insert quantities> of each type installed, but no fewer than [two] <Insert quantities> of each type.
 - 3. Wall Plates: One for every 10 of each type (i.e., style, size, and finish) installed, but no fewer than two of each type.
 - 4. Service/Power Poles: One for every 10 of each type installed, but no fewer than one of each type.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Wiring devices are defined as single discrete units of electrical distribution systems, such as convenience receptacles, switches, special purpose receptacles, and similar, which are intended to carry, but not use electrical energy. Install wiring devices as required by the Specifications and where indicated on the Drawings.

2.2 MANUFACTURERS

- A. Available Manufacturers:

- 1. Receptacles and Switches:

- a. Eaton.
 - b. Hubbell Incorporated.
 - c. Legrand.
 - d. Leviton.

- 2. Multioutlet Assemblies:

- a. Hubbell Incorporated.
 - b. Legrand.

- 3. Service/Power Poles:

- a. Hubbell Incorporated.
 - b. Legrand.
 - c. Panduit
 - d. Schneider Electric.

- 4. Emergency Power Off Buttons:

- a. Eaton.
 - b. GE Industrial.
 - c. Schneider Electric.

- B. In other Part 2 articles below, where manufacturers and device catalog numbers are included, the following additional requirements apply to product selection:

1. Product manufacturer and model numbers listed are to establish the quality of the wiring devices. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include manufacturers listed in individual articles below, in addition to those listed in Paragraph "Available Manufacturers" above.
2. Coordinate the proper suffixes in order to provide the correct color as specified below.

2.3 FINISHES

A. Color:

1. Wiring devices connected to normal power systems: As selected by Architect] [<Insert color, unless otherwise indicated or required by NFPA 70. Cover plates: The same as the wiring device.
2. SPD devices: Blue As selected by Architect. Cover plates: The same as the wiring device.

2.4 CONVENIENCE RECEPTACLES

- A. The catalog numbers listed below are generally for 20A rated devices. Where 15A rated devices are indicated on the Drawings or required for circuit rating limitations, provide receptacles equivalent to those specified for 20A, but rated for 15A.
- B. Duplex convenience receptacles: Commercial Specification grade, NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding.
Basis of Design: Legrand CR20.
- C. Duplex tamper resistant convenience receptacles: Commercial Specification grade, NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding.
Basis of Design: Legrand TR20.
- D. Duplex weather resistant convenience receptacles: Commercial Specification grade, NEMA 5-20R, 125V, 20A, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding.
Basis of Design: Legrand WR20TRW.
- E. Twist-Locking type receptacles: NEMA L5-20R, 125V, 20A, grounding type, UL listed and labeled, nylon face, side and back wired, self-grounding.
Basis of Design: Legrand L520-R.
- F. USB/duplex convenience receptacles: NEMA 5-20R, 125V, 20A, tamper resistant, 3-wire, grounding type, UL listed and labeled, smooth nylon face, side and back wired, self-grounding; with integral USB charger having two ports, USB 2.0 compatible, 5VDC, 3A output (min).
Basis of Design: Legrand TR5362USB.

- G. Automatically Controlled receptacles: Where indicated on drawings, provide device type from other applicable category, along with marking for controlled receptacles as required by the current version of the NEC. In the case where the NEC is not applicable to the project, the device shall still be provided with this marking. In that case, the NEC is providing the standard for the marking and this specification is requiring it to be marked above and beyond the application of the code.

2.5 GFCI RECEPTACLES

- A. Ground fault circuit interrupter type receptacles: Specification Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles down stream on the same circuit.

Basis of Design: Legrand2097

- B. Ground fault circuit interrupter type weather-resistant receptacles: Specification Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles down stream on the same circuit.

Basis of Design: Legrand2097TRWR

- C. Ground fault circuit interrupter type tamper and weather-resistant receptacles: Specification Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles down stream on the same circuit.

Basis of Design: Legrand2097TRWR

- D. Ground fault circuit interrupter with Blank Face: Specification Grade UL listed and labeled complying with UL 943, Class A and NEMA WD-1-1.10, 125V, 20A, trip at 4-6mA within 0.025 second, and feed-thru type with integral heavy duty NEMA 5-20R receptacle arranged to protect receptacles down stream on the same circuit.

Basis of Design: Legrand 2085.

2.6 SPD RECEPTACLES

- A. SPD receptacles for 125V (150V maximum continuous operating voltage) service: NEMA 5-20R, 125V, 20A, self-grounding type, RFI/EMI noise filtering, UL 1449 listed & 489; equipped with LED indicator(s) and audible alarm.

Basis of Design: Legrand 5362xSP; IG5362xSP w/Isolated Ground

- B. Suppression module shall protect normal and common modes, with the following mode characteristics, and be suitable for ANSI/IEEE C62.41 A, B installations:

Surge Protective Device Rating	Type 3
Peak Energy	240 joules minimum
Peak Current	13,000A minimum
UL 6kv/3000A (8/20 micro sec. wave form) Test	400V minimum (VPR)

Response Time

Approximately 5 nano-seconds

- C. Special Warranty: Manufacturer agrees to repair or replace SPD receptacles, or replaceable surge modules (if removable), that fail in materials or workmanship within 5 years from date of Substantial Completion.

2.7 SPECIAL/MISCELLANEOUS DEVICES

- A. Special purpose receptacles: Grounding type, UL listed with NEMA configurations as indicated below or on the Drawings.

Basis of Design: Legrand:		
Dryer 14-30R		3864
Range 14-50R		3849
Switch/Receptacle Combo		671
Clock 5-15R		S3733

2.8 SWITCHES

- A. The catalog numbers listed below are generally for 20A rated devices. Where 15A rated devices are indicated on the Drawings or required for circuit rating limitations, provide switches equivalent to those specified for 20A, but rated for 15A.

- B. Switches: Heavy Duty Specification grade, rated for 120/277V, 20A, back and side wired, and UL listed and labeled.

Basis of Design: Legrand:		
1 pole	PS20AC1	
2 pole	PS20AC2	
3-way	PS20AC3	
4-way	PS20AC4	

- C. Pilot Light switches: 20A, single pole switch with clear lighted handle. Toggle shall be illuminated when the switch is in the "ON" position. Provide appropriate voltage option.

Basis of Design: Legrand:		
1 pole	PS20AC1-XPL	
2 pole	PS20AC2-XPL	
3-way	PS20AC3-XPL	

- D. Key operated light switches: Same as standard light switches except toggle handle shall be operated by a factory provided key.

Basis of Design: Legrand:		
1 pole	PS20AC1-L	
2 pole	PS20AC2-L	
3-way	PS20AC3-L	
4-way	PS20AC4-L	

- E. Switches for use with mechanically-held, electrically-operated lighting contactors: Single pole, double throw, momentary, center off switch, rated for 120/277V, and UL listed and labeled.

Basis of Design: Legrand	1251.
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2.9 MULTI-OUTLET ASSEMBLIES

- A. Surface type "plug-in" strips: Extruded aluminum 3-wire, single circuit with single grounding type, 15A, 125V receptacles, pre-wired on 18-inch centers. Provide all fittings, devices, end closures, elbows, boxes and conduit entrance fittings as required for a complete installation.

Basis of Design: Hubbell ALU20

2.10 EMERGENCY POWER OFF BUTTONS

- A. Push/Pull Button Operators: 30MM, watertight/oiltight, heavy duty, 600V maximum ac/dc, 10A continuous, 2 position maintained, non-illuminated, push/pull button operator. Provide with 1 normally open and 1 normally closed contact block.

Basis of Design: Schneider 9001SKR9RH13.

2.11 COVER PLATES

- A. Damp Location Weatherproof Receptacle Cover Plates: UL-listed Wet Location (cover closed, not in use); die-cast, gasketed (factory-installed) self-closing covers, for horizontal or vertical mounting as indicated:

Basis of Design: Legrand [4511 horizontal,][4512 vertical].

- A. Wet Location Weatherproof Receptacle Cover Plates (Outlet Box Hood): NEMA 3R weather resistant recessed or flush mount, die cast aluminum lockable cover. Configure cover for horizontal mounting of receptacle or as indicated otherwise. Back box must be suitable for conduit connections. Coordinate back box with wall depth.

Basis of Design: Leviton IUM1H-GY.

- B. Damp and Wet Location Weatherproof switch cover plates: Fabricated of cast aluminum or cast zinc, sealed water-tight and UL listed for wet locations.

Basis of Design: Appleton FSK.

- C. Other locations: Single and combination types to match corresponding wiring devices and manufacturer of wiring devices specified herein.

1. Plate securing screws: Metal with head color to match finish plate.
2. Material for Finished Spaces: Refer to "Finishes" above for color.
3. Material for Unfinished Spaces and surface mounted wiring devices: Galvanized steel.
4. Masonry walls and oversized wall openings: Jumbo size plates with same material as indicated above.

PART 3 - EXECUTION

3.1 GENERAL

- A. Outlets are only approximately located on the small scale Drawings. Use great care in the actual location by consulting the various large scale detailed Drawings used by other Division trades, and by securing definite locations from the Contract Administrator.
- B. Do not use multi-conductor circuits, with a shared neutral, for any GFCI receptacle circuit. Provide a separate neutral conductor with all GFCI receptacle circuits.
- C. Provide twist-locking type receptacles or other special type receptacles where indicated on the Drawings.

3.2 EXAMINATION

- A. Verify existing conditions prior to beginning work.
- B. Verify that outlet boxes are installed at proper height and are flush with the finished surface.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that floor boxes are adjusted properly and are flush with the finished surface.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.3 PREPARATION

- A. If required, provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean debris from in and around outlet boxes.

3.4 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install all wiring devices plumb, level, and square with building lines. Wiring device bodies shall extend to the finished surface of the walls, ceiling or floor, as applicable, without projecting beyond them.
- C. Connect wiring devices by wrapping conductors around screw terminals. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- D. Connect wiring device grounding terminal to branch circuit equipment grounding conductor and bond to metal outlet box. Exception: Do not bond grounding terminals of isolated ground receptacles to the outlet box.
- E. Install devices shown on wood trim, cases or other fixtures symmetrically and, where necessary, set with the long dimensions of the plate horizontal, or ganged in tandem.

- F. Unless dimensioned otherwise, install wiring devices a minimum of 24 inches from the closest edge of any sink.
- G. Install switches with OFF position down.
- H. Install cover plates on all switches, receptacles, and blank outlets.
- I. Locate wiring devices so that the cover plate does not have to be cut to be installed.
- J. Where devices are shown near wall openings, coordinate location if corner guards are to be installed so that cover plates do not require cutting.
- K. Install cover plates after the wall has been finished (painted, wall paper, etc).
- L. Install device boxes in brick or block walls such that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
- M. Provide engraved nameplate on emergency off buttons.
- N. Provide ground fault circuit interruption capability for all 120V receptacles 50A or less and all 208/240V receptacles 100A or less in code required locations. Locations include, but are not limited to: bathrooms, kitchens/food prep areas, exterior locations and within 6' of sinks. Interruption capability can be achieved via a GFCI circuit breaker or a GFCI receptacle.
- O. Provide type and quantity of normally open and/or normally closed contacts for emergency off buttons to meet the sequence of operations shown.
- P. Install wiring devices shown back-to-back on a common wall offset a minimum of 12" horizontally to reduce sound transmission between rooms.
- Q. Provide safety-type, tamper-resistant receptacles in all areas where receptacles are mounted less than 5'-6" AFF and are easily accessible to children.

3.5 MOUNTING HEIGHTS

- A. Coordinate locations of outlet boxes provided under Division 26 Section "Common Work Results for Electrical".
- B. Unless noted otherwise, install wiring devices at mounting heights indicated in the Electrical Symbols Legend on the construction drawings.

1. Receptacles:

a. General:

- 1) Unless indicated otherwise, install vertically with the ground slot mounted at the top.
- 2) Where Installed horizontally, install neutral slot mounted at the top.

b. Above counters:

- 1) Mount vertically.
 - c. Mechanical and electrical equipment rooms and janitors closets:
 - 1) Mount horizontally.
 - d. Garages:
 - 1) Wet location: Mount horizontally.
 - 2) Other locations: Mount vertically.
 - e. Weatherproof exterior receptacles:
 - 1) Mount horizontally.
 - f. GFCI receptacles: Same as general receptacles.
 - g. SPD receptacles: Same as general.
 - h. Concrete Block Walls: Dimensions above may be adjusted slightly, as required to compensate for variable joint dimensions, such that bottom or top of boxes, as applicable, are at block joints.
2. Switches:
 - a. Above counters: Same as for receptacles.
 - b. Concrete Block Walls: Dimension may be adjusted slightly, as required to compensate for variable joint dimensions, such that bottom of boxes are at block joints.
 - c. Walls with wainscoting: 6 inches minimum above wainscoting, but not exceeding 48 inches above finished floor.
 3. Multi-outlet assemblies:
 - a. As indicated on the Drawings.
 4. Telephone/Data Outlet Boxes:
 - a. General: Match mounting height of adjacent wiring device listed above.
 5. Emergency Power Off Buttons and Break Glass Operators:
 - a. General: Match requirements of switches listed above.
 - b. Wall-mounted telephone: 40 inches above finished floor.

3.6 IDENTIFICATION

- A. Label all devices fed down stream of GFCI protected receptacles as "GFCI PROTECTED".
- B. Comply with Division 26 Section "Identification for Electrical Systems."
 - 1. Receptacles and Switches: Identify panelboard and circuit number from which served, using:
 - a. Hot, stamped or engraved machine printing with white-filled lettering on face of plate.
 - b. Durable wire markers or tags inside outlet boxes.
 - c. Permanent-ink marker, hand-printed legibly, inside outlet boxes.
 - d. Adhesive film label, but with letter/number height of 1/4 inch, on face of plate.
 - e. Adhesive Film Label with Clear Protective Overlay, but with letter/number height of 1/4 inch, on face of plate, for exterior and damp/wet locations.

3.7 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch with circuit energized and verify proper operation.
- C. Verify that each receptacle device is energized. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
- D. Test all wiring devices for electrical continuity and proper polarity of connections.
- E. Test each GFCI receptacle device for proper operation.
- F. Correct wiring devices incorrectly installed.
- G. Repair or replace all damaged items or damaged finishes at no expense to the Owner.

3.8 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.9 CLEANING

- A. Clean exposed surfaces to remove splatters and restore finish.

END OF DOCUMENT 262726

DOCUMENT 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in:
 - a. Control circuits
 - b. Enclosed switches
 - c. Panelboards
 - d. Switchboards
 - e. Enclosed controllers
 - f. Motor-control centers.
2. Plug fuses rated 125-V ac and less for use in plug-fuse-type:
 - a. Enclosed switches
 - b. Fuseholders
 - c. Panelboards.
3. Spare-fuse cabinets.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 2. Current-limitation curves for fuses with current-limiting characteristics.
 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 4. Coordination charts and tables and related data.
 5. Fuse sizes for elevator feeders and elevator disconnect switches.

- B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

- 1. All items requested under "Product Data".

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Comply with UL 248.

1.4 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.5 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.
- B. Coordinate location of and access to spare fuse cabinet(s) with final electrical equipment layouts within electrical equipment rooms.

1.6 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.

- D. Selectivity: Where selectivity is required by the Documents, furnish products as required to achieve selective coordination.

2.2 MANUFACTURERS

A. Available Manufacturers:

1. ABB Ltd.
2. Eaton Corporation Plc
3. Mersen Electrical Power
4. Littelfuse, Inc.
5. Schneider Electric SE
6. Siemens AG

2.3 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.4 ACCESSORIES

A. Provide the following accessories where indicated or where required to complete installation:

1. Fuseholders: Compatible with indicated fuses.
2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.
3. Plug-Fuse Adapters: For using Type S, rejection-base plug fuses in Edison-base fuseholders or sockets; ampere ratings matching fuse ratings; irremovable once installed.

2.5 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
 2. Finish: Gray, baked enamel.
 3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.
- B. Install in accordance with manufacturer's instructions.
- C. Install fuses in fusible devices. Arrange fuses so manufacturer, type and rating information is readable without removing fuse.
- D. Install plug-fuse adapters in Edison-base fuseholders and sockets. Ensure that adapters are irremovable once installed.
- E. Install spare-fuse cabinet(s).

3.3 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Service Entrance:
 - a. Greater than 600A:
 - 1) Class L, time delay
 - b. 600A or less:
 - 1) Class RK1, time delay
 - 2) Class J, time delay
 - 2. Feeders:
 - a. Greater than 600A:
 - 1) Class L, time delay

- b. 600A or less:
 - 1) Class RK1, time delay
 - 2) Class J, time delay
 - 3. Motor Branch Circuits:
 - a. Class RK1 time delay
 - 4. Other Branch Circuits:
 - a. Class RK1, time delay
 - b. Class J, time delay
 - 5. Control Circuits:
 - a. Class CC fast acting
- 3.4 IDENTIFICATION
- A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF DOCUMENT 262813

DOCUMENT 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes enclosed switches and circuit breakers rated 600 V and less, including the following:
 - 1. Fusible switches.
 - 2. Non-fusible switches.
 - 3. Receptacle switches.
 - 4. Shunt trip switches.
 - 5. Molded-case circuit breakers (MCCBs).
 - 6. Molded-case switches.
 - 7. Enclosures.

1.2 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate layout and installation of enclosed switches, circuit breakers and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Fault-Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section "Overcurrent Protective Device Coordination Study".

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensions and Manufacturer's technical data on features, performance, electrical characteristics, ratings, weights, furnished options, specialties, accessories, and finishes.
- C. Shop Drawings: For enclosed switches and circuit breakers.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances, service space around equipment, and attachments to other work. Show tabulations of installed devices, equipment features, and ratings.
 - a. Tabulate features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 2. Detail enclosure types and details for other than NEMA 250, Type 1.
 - 3. Include general arrangement drawing showing dimensions and weights of each assembled section.
 - 4. Detail bus configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus. Indicate mains and branches of phase, neutral, and ground buses.
 - 5. Detail short-circuit current rating of enclosed switch or circuit breaker assembly and overcurrent protective devices.
 - 6. Include descriptive documentation of barriers specified for electrical insulation and isolation.
 - 7. Include time-current coordination curves for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Submit electronic files, in an SKM-compatible format.
 - 8. Include schematic and wiring diagrams for power, signal, and control wiring.
 - 9. Include nameplate legends.
 - 10. Include list of materials.
- D. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around enclosed switches and circuit breakers where pipe and ducts are prohibited. Show enclosed switch and circuit breaker layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- E. Qualification Data: For qualified testing agency.

- F. Field quality-control reports.
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
 - G. Manufacturer's field service report.
 - H. Sample Warranty: For warranty.
 - I. Project Record Documents: Record actual installed equipment and circuiting arrangements. Record actual routing for underground circuits. Record actual installed location of ground rods.
 - J. Operation and Maintenance Data: For enclosed switches and circuit breakers 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. Routine maintenance requirements for enclosed switches, circuit breakers and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - 3. Time-current curves; include selectable ranges for each type of overcurrent protective device.
 - 4. Features and operating sequences, both automatic and manual.
 - 5. Video recording of operation training and demonstration.
 - K. Follow-up service reports.
- 1.5 QUALITY ASSURANCE
- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
 - B. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."
 - C. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.
- B. Environmental Limitations:
 - 1. Do not deliver or install enclosed switches and circuit breakers until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above equipment is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2010 m).

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.
- B. Deliver enclosed switches and circuit breakers in sections or lengths that can be moved past obstructions in delivery path.
- C. Coordinate delivery of equipment to allow movement into designated space.
- D. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish. Provide temporary heating according to manufacturer's written instructions.
- E. Handle and prepare enclosed switches and circuit breakers components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.8 WARRANTY

- A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components and/or products of the enclosed switches and circuit breakers that fail in materials or workmanship within the specified warranty period.
- B. Warranty Period: Three years from date of Substantial Completion.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Refer to Division 26 section "Fuses" for spare fuse requirements. At a minimum, include spares for the following:
 - a. Potential transformer fuses.
 - b. Control power fuses.
 - c. Fuses for fusible devices.
 - 2. Indicating Lights: Four of each type installed.
 - 3. Primary Switch Contact Lubricant: One container.
 - 4. Enclosure Keys: Two for each enclosure type. All distribution equipment keyed alike.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Available Manufacturers:
 - 1. ABB Inc.
 - 2. Eaton.
 - 3. Schneider Electric.
 - 4. Siemens Energy & Automation, Inc.
- B. Type HD, Heavy Duty, Single Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Six Pole, Single Throw, 240-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

- D. Type HD, Heavy Duty, Double Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 5. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 - 6. Hookstick Handle: Allows use of a hookstick to operate the handle.
 - 7. Lugs: Compression type, suitable for number, size, and conductor material.
 - 8. Service-Rated Switches: Labeled for use as service equipment.
 - 9. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

2.2 NONFUSIBLE SWITCHES

- A. Available Manufacturers:
 - 1. ABB Inc.
 - 2. Eaton.
 - 3. Schneider Electric.
 - 4. Siemens Energy & Automation, Inc.
- B. Type HD, Heavy Duty, Single Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Six Pole, Single Throw, 240-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Double Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Compression type, suitable for number, size, and conductor material.
7. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

2.3 RECEPTACLE SWITCHES

A. Available Manufacturers:

1. ABB Inc.
2. Eaton.
3. Hubbell Inc.
4. Schneider Electric.

B. Type HD, Heavy-Duty, Single-Throw Fusible Switch: 240-V ac, 30 A; UL 98 and NEMA KS 1; horsepower rated, with clips or bolt pads to accommodate indicated fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

C. Type HD, Heavy-Duty, Single-Throw Nonfusible Switch: 240-V ac, 30 A; UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

D. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.

E. Receptacle: As indicated on the plans.

2.4 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2.5 IDENTIFICATION

- A. Nameplates: Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine enclosed switches and circuit breakers before installation. Reject equipment that is damaged, or rusted, or have been subjected to water saturation.
- B. Examine areas, surfaces, substrates, and elements to receive enclosed switches and circuit breakers with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 1. Verify that field measurements are as indicated.
 2. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.
- C. Examine roughing-in of conduits and grounding systems to verify the following:
 1. Wiring entries comply with layout requirements.
 2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install enclosed switches and circuit breakers and accessories in accordance with manufacturer's instructions.
- B. Coordinate layout and installation of equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

- C. Wall-Mounted Switches and Circuit Breakers: Install enclosed switches and circuit breakers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For enclosed switches and circuit breakers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Mount equipment plumb and rigid without distortion of enclosure.
- F. Install fuses in fusible devices.
- G. Comply with NECA 1.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for control wiring.

3.4 IDENTIFICATION

- A. Equipment Nameplates: Label each section with equipment nameplate.
- B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- C. Diagram and Instructions:
 - 1. Engraved, Laminated Acrylic or Melamine Label. Mount on front of equipment.
 - a. Operating Instructions: Printed operating instructions for switches and circuit breakers, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures.
- D. Warning Labels: Label equipment with a warning label in accordance with NFPA 70 and NFPA 70E.
 - 1. Exception: Do not install NFPA 70 working clearance requirements on enclosed switches and circuit breakers in finished spaces.

3.5 CLEANING

- A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in

cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.7 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges and protective relay trip characteristics as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

3.8 FIELD QUALITY CONTROL

- A. Testing: Engage a qualified testing agency to perform the following field quality-control tests and inspections:
- B. Testing: Perform the following field quality-control tests and inspections:
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, to assist in testing, and to assist in adjusting device settings.
- C. Acceptance Testing Preparation:
 - 1. After installing equipment but before equipment is energized, test for compliance with requirements.
 - 2. Verify that grounding system at the equipment tested at the specified value or less.
 - 3. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 - 4. Test continuity of each circuit.
- D. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. After electrical circuitry has been energized, test for compliance with requirements.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

4. Report results of tests and inspections in writing. Record adjustable settings and measured insulation resistances. Attach a label or tag to each tested component indicating satisfactory completion of tests.
 - E. Assist in field commissioning of equipment including pretesting and adjusting of equipment and components.
 - F. Infrared Scanning: Perform the following infrared scan tests and inspections and prepare reports:
 1. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 2. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
 3. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - G. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:
 1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the main incoming section of each service entrance equipment. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
 2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
 - a. Rebalance loads.
 - b. Prepare written request for voltage adjustment by electric utility in accordance with Division 26 section "Provisions for Electric Utility Service".
 - H. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
 - I. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- 3.9 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Train Owner's maintenance personnel to adjust, operate, and maintain equipment, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

- B. Video record demonstrations presentation for Owner's records.

END OF DOCUMENT 262816

DOCUMENT 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes transfer switches rated 600 V and less, including the following:
 - 1. Nonautomatic transfer switches.
- B. This section does not include the following:
 - 1. Double throw (manual type) switches. Refer to Division 26 section "Enclosed Switches and Circuit Breakers" for this equipment.

1.2 DEFINITIONS

- A. Closed Transition (Make-Before-Break): In a switching device, a configuration in which the new connection path is established before the previous contacts are opened. This prevents the switched path from ever seeing an open circuit.
- B. Open Transition (Break-Before-Make): A switch that is configured to break (open) the first set of contacts before engaging (closing) the new contacts. This prevents the momentary connection of the old and new circuit paths together.
- C. Withstand duration: The withstand rating value is the level of fault current that must be withstood for a specified length of time, i.e., 42000 amps at 3 cycles.
- D. NETA ATS: InterNational Electrical Testing Association Acceptance Testing Specification.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Fault-Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section "Overcurrent Protective Device Coordination Study"

1.4 SUBMITTALS

- A. Product Data: For each type of transfer switch, switching and overcurrent protective device, instrumentation, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each transfer switch and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances, service space around equipment, and attachments to other work. Show tabulations of installed devices, equipment features, and ratings.
 - a. Tabulate features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 2. Detail enclosure types and details for other than NEMA 250, Type 1.
 - 3. Include general arrangement drawing showing dimensions and weights of each assembled section.
 - 4. Detail bus configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus. Indicate mains and branches of phase, neutral, and ground buses. Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
 - 5. Detail short-circuit current rating of transfer switch assembly and overcurrent protective devices.
 - 6. Include descriptive documentation of barriers specified for electrical insulation and isolation.
 - 7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 8. Include schematic and wiring diagrams for power, signal, and control wiring.
 - 9. Include nameplate legends.
 - 10. Include list of materials.
- C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around transfer switches where pipe and ducts are prohibited. Show transfer switch layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
 - 1. For each equipment room, provide dimensioned layout of the electrical equipment within the space, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved.

2. Dimensioned concrete base, outline of transfer switch, conduit entries, and ground rod locations; including equipment working clearances and manufacturer required access space.
 3. Indicate structural members, light fixtures, sprinkler piping and heads, HVAC equipment, ducts and diffusers, plumbing piping and access fittings. Include maintenance access clearances.
 4. Location of structural supports for structure-supported raceways.
 5. Location and clearance of electrical equipment and raceways impacting equipment installation.
 6. Proposed routing of equipment, in shipping splits, from exterior of the building to the final installed location. Include product weights, width and height restrictions encountered along the path. Include intended construction sequencing to mitigate conflicts.
 7. Proposed routing of equipment for future removal, from within equipment room to exterior of the building without removal of non-related equipment or architectural elements.
- D. Sustainable Design Documentation: Submit manufacturer's product data on materials and assemblies showing compliance with building rating standard(s) requirements.
- E. Qualification Data: For qualified manufacturer and testing agency.
- F. Factory test reports.
- G. Field Quality-Control Reports:
1. Test procedures used.
 2. Test results that comply with requirements.
- H. Results of failed tests and corrective action taken to achieve test results that comply with requirements. Manufacturer's field service report.
- I. Sample Warranty: For warranties.
- J. Project Record Documents: Record actual installed equipment and circuiting arrangements. Record actual routing for underground circuits. Record actual installed location of ground rods.
- K. Operation and Maintenance Data: For enclosed switches and circuit breakers 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. Routine maintenance requirements for panelboards and all installed components.
 2. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

3. Time-current curves; include selectable ranges for each type of overcurrent protective device. Provide relay-settings and calibration instructions, including software, where applicable.
4. Features and operating sequences, both automatic and manual.
5. Video recording of operation training and demonstration.

L. Follow-up service reports.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. Source Limitations: Obtain non-automatic transfer switchesthrough one source from a single manufacturer.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Comply with NEMA ICS 1.
- G. Comply with NFPA 70.
- H. Comply with NFPA 99.
- I. Comply with NFPA 110.
- J. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.6 PROJECT CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.
- B. Environmental Limitations:

1. Do not deliver or install transfer switches until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above equipment is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).
- C. Interruption of Existing Electric Service: Do not interrupt electric service to occupied facilities. Refer to Division 26 Section "General Electrical Requirements" for allowable outages.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.
- B. Deliver transfer switches in sections or lengths that can be moved past obstructions in delivery path.
- C. Coordinate delivery of equipment to allow movement into designated space.
- D. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish. Provide temporary heating according to manufacturer's written instructions.
- E. Handle and prepare transfer switch components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of the Transfer Switch that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Damage from transient voltage surges.
- B. Warranty Period: Cost to repair or replace any parts for two years from date of Substantial Completion.
- C. Extended Warranty Period: Cost of replacement parts (materials only, f.o.b. the nearest shipping point to Project site), for eight years, that failed in service due to transient voltage surges.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Indicating Lights: Four of each type installed.
 2. Switching Contact Lubricant: One container.
 3. Alarm Contacts: Equal to 10 percent of quantity supplied, but no fewer than two of each type.
 4. Touchup Paint: Two containers of paint matching enclosure finish, each 0.5 pint (250 mL).
 5. Enclosure Keys: Two for each enclosure type. All distribution equipment keyed alike.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Available Manufacturers:
1. Contactor Transfer Switches:
 - a. Caterpillar; Engine Div.
 - b. Eaton Electrical Inc.; Cutler-Hammer
 - c. Emerson; ASCO Power Technologies, LP.
 - d. GE Zenith Controls.
 - e. Kohler Power Systems; Generator Division.
 - f. Onan/Cummins Power Generation; Industrial Business Group.
 - g. Russelectric, Inc.
 - h. Spectrum Detroit Diesel.
 - i. <Insert manufacturer's name.>
- B. Indicated Voltage and Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated. Voltage ratings shall be consistent with applications from 115 volts AC to 600 volts and single or three phase as required by the application. Current ratings and the number of poles shall be as indicated on the plans.

- C. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
 - 1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
 - 2. Where the transfer switch internal fault-current protection can not exceed the indicated fault-current values, an enclosed fused switch with current limiting fuses shall be installed ahead of the transfer switch.
- D. Controls: Solid State control having repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C. All internal controls components shall be accessible from the equipment front.
- E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- F. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. Switch Action: Double throw; mechanically held in both directions.
 - 2. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
- H. Neutral Terminal: Solid and fully rated bus bar, unless otherwise indicated.
- I. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. All factory wiring shall be accessible from the equipment front. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."
 - 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
 - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated. Power terminals shall be rated for 90 degree C and copper or aluminum cable.
 - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- J. Enclosures: General-purpose NEMA 250, Type [1] [3R] [12], complying with NEMA ICS 6 and UL 508, unless otherwise indicated.
- K. Bus and Wiring: All Bus and cable /control wire shall be copper.
- L. Cable Entry: Cable entry shall be from the top.

2.2 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.
- D. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.
- E. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.
- F. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

2.3 NONAUTOMATIC TRANSFER SWITCHES

- A. Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternate Source." Switch shall be capable of transferring load in either direction with either or both sources energized.
- B. Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternate Source." In addition, removable manual handle provides quick-make, quick-break manual-switching action. Switch shall be capable of electrically or manually transferring load in either direction with either or both sources energized. Control circuit disconnects from electrical operator during manual operation.
- C. Double-Throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence.
- D. Nonautomatic Transfer-Switch Accessories:
 - 1. Pilot Lights: Indicate source to which load is connected.
 - 2. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and alternate-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Alternate Source Available."
 - 3. Unassigned Auxiliary Contacts: One set of normally closed contacts for each switch position, rated 10 A at 240-V ac.

2.4 SOURCE QUALITY CONTROL

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

2.5 IDENTIFICATION

- A. Nameplates: Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine transfer switches before installation. Reject equipment that is damaged, or rusted, or have been subjected to water saturation.
- B. Examine areas, surfaces, substrates, and elements to receive transfer switches with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that field measurements are as indicated.
 - 2. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.
- C. Examine roughing-in of conduits and grounding systems to verify the following:
 - 1. Wiring entries comply with layout requirements.
 - 2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install transfer switches and accessories in accordance with manufacturer's instructions.
- B. Coordinate layout and installation of equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- C. Comply with mounting and anchoring requirements specified in Division 26 Section "Seismic Controls for Electrical Systems."
- D. Wall-Mounted Switch: Install transfer switches on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel

channels bolted to wall. For transfer switches not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from enclosure and components.
- F. Mount equipment plumb and rigid without distortion of enclosure.
- G. Arrange conductors in auxiliary compartments and gutters into groups and bundle and wrap with wire ties.
- H. Comply with NECA 1.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for control wiring.

3.4 IDENTIFICATION

- A. Equipment Nameplates: Label each contiguous main, or entrance, section with equipment nameplate.
- B. Device Nameplates: Label each main and bypass device with a nameplate.
- C. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- D. Diagram and Instructions:
 - 1. Engraved, Laminated Acrylic or Melamine Label. Mount on front of transfer switch.
 - a. Operating Instructions: Printed operating instructions for transfer switch, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures.
 - b. System Power One-Line Diagrams: Provide color-coded, large-format one-line diagram showing the new work is to be provided and installed in the associated electrical room. Depict power sources, feeders, distribution components, and major loads.
 - 2. Storage for Maintenance Instructions: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

- E. Warning Labels: Label each panelboard with a warning label in accordance with NFPA 70 and NFPA 70E.

3.5 CLEANING

- A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.7 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.8 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control tests and inspections:
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, to assist in testing, and to assist in adjusting device settings.
- B. Acceptance Testing Preparation:
 - 1. After installing equipment but before equipment is energized, test for compliance with requirements.
 - 2. Test insulation resistance for each bus, component, connecting supply, feeder, and control circuit.
 - 3. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. After electrical circuitry has been energized, test for compliance with requirements.
 - 2. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.
 - 3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and

- procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
- a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
- a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
 - f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
 - g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
- a. Verify grounding connections and locations and ratings of sensors.
 - b. Observe reaction of circuit-interrupting devices when simulated fault current is applied at sensors.
6. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
7. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

- D. Assist in field commissioning of equipment including pretesting and adjusting of equipment and components.
- E. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
 - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
 - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- F. Transfer switches will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports, including a certified report that identifies transfer switches included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment, instrumentation, and accessories, and to use and reprogram microprocessor-based control, monitoring, and display functions.
- B. Video record demonstrations presentation for Owner's records.
- C. Coordinate this training with that for generator equipment.

END OF DOCUMENT 263600

DOCUMENT 264313 - SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section includes field-mounted Surge Protective Devices (SPDs) for low-voltage (120 to 600 V) power distribution and control equipment, including:
 - 1. Surge Protection Devices at Service Entrance Equipment
 - 2. Surge Protection Devices at Distribution Equipment
 - 3. Surge Protection Devices at Branch Panelboards
 - 4. Surge Protection Devices at Utilization Equipment
 - 5. Surge Protection Devices in Electronics-Grade Panelboards

1.2 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. *In* or *Inominal*: Nominal Discharge Current. Peak value of surge current, selected by the manufacturer, through the SPD having current wave shape of 8/20 microseconds where the SPD remains functional after 15 surges. *In* is posted on the device UL label.
- C. MCOV: Maximum Continuous Operating Voltage. The maximum continuous operating voltage rating of a Metal Oxide Varistor (MOV) that can be applied without the MOV being damaged and/or destroyed by thermal runaway. MCOV is posted on the device UL label.
- D. SCCR: Short Circuit Current Rating. The maximum current rating the SPD can sustain without being damaged and/or destroyed. SCCR is posted on the device UL label.
- E. SPD: Surge Protective Device. A broad class of protective devices, installed parallel with the distribution panel or service disconnect, meant to protect downstream electrical distribution equipment from the effects of high voltage surges on the line.
- F. SPD Type definitions:
 - 1. TYPE 1: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service equipment overcurrent device, as well as the load side, including watt-hour meter socket enclosures and intended to be installed without an external overcurrent protective device. Type 1 devices are required for Master Certification of Lightning Protection System installations under UL 96A.
 - 2. TYPE 2: Permanently connected SPDs intended for installation on the load side of the service equipment overcurrent device, including SPDs located at the branch circuit panel.
 - 3. TYPE 3: Point-of-utilization SPDs, installed at a minimum conductor length of 10 meters (30 feet) from the electrical service panel to the point of utilization, e.g., cord-connected,

direct plug-in, receptacle type and SPDs installed at the utilization equipment being protected. The distance (10 meters or 30 feet) is exclusive of conductors provided with or used to attach SPD's.

4. TYPE 4: Component SPDs, including discrete components as well as component assemblies for installation on panelboards or control panels.

- G. VPR: Voltage Protection Rating. The average of measured limiting voltage before and after Nominal Discharge Testing (In), rounded up to one of UL's VPR categories (indicated in the latest ANSI/UL 1449 edition) such as 330 volt, 400 volt, 500 volt, etc. VPR is posted on each device UL label.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate SPD devices with Division 26 Section "Electrical Power Monitoring and Control."
- B. Coordinate layout and installation of SPDs and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access.
- C. Fault-Current Study, Coordination Study, and Overcurrent Protective Device Settings report must be completed and submitted for review prior to final order, assembly or shipping of the electrical distribution system components. If studies have not been approved prior to shipping, assembly or final ordering of the electrical distribution system components, all changes to the equipment necessitated by the results of the study will be provided by the contractor at no additional cost to the project. Refer to specification section "Overcurrent Protective Device Coordination Study".
- D. Do not energize or connect any electrical or low voltage equipment to their sources until SPDs are installed and connected.
- E. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests and reconnect immediately after the testing is over.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Division 01 and Division 26 Section "General Electrical Requirements".
- B. Product Data: For each SPD type, accessory, component and enclosure indicated. Include dimensions and Manufacturer's technical data on features, performance, electrical characteristics, ratings, weights, furnished options, specialties, accessories, and finishes. Tabulate model number, SPD type, system voltage, phases, modes of protection, MCOV, VPR, and I_n .
- C. Shop Drawings: For SPDs.
 1. Detail enclosure types and details.
 2. Include general arrangement drawing showing dimensions and weights of each assembled device.

3. Include installation and mounting details for SPDs internal to equipment.
 4. Detail bus connection configuration, current, and voltage ratings, including size and number of bus bars and current rating for each bus.
 5. Detail short-circuit current rating of SPD assembly and overcurrent protective devices.
 6. Include schematic and wiring diagrams for power, signal, and control wiring.
 7. Include nameplate legends.
 8. Include list of materials.
- D. Product Certificates: For SPDs, from manufacturer.
- E. Sustainable Design Documentation: Submit manufacturer's product data on materials and assemblies showing compliance with building rating standard(s) requirements.
- F. Qualification Data: For qualified testing agency.
- G. Field quality-control reports.
1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- H. Manufacturer's field service report.
- I. Sample Warranty: For warranty.
- J. Project Record Documents: Record actual installed equipment and circuiting arrangements.
- K. Operation and Maintenance Data: For SPDs 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. Routine maintenance requirements for SPDs and all installed components.
 2. Manufacturer's written instructions for testing and adjusting SPDs.
 3. Time-current curves for each type of overcurrent protective device.
 4. Features and operating sequences, both automatic and manual.
 5. Video recording of operation training and demonstration.
- L. Follow-up service reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member Company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."
- C. Source Limitations: Obtain SPDs of each type and associated components and accessories through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.
- E. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.
- F. Comply with NEMA LS 1.
- G. Comply with UL 1283 and ANSI/ UL 1449.
- H. Comply with NFPA 70.
- I. The SPDs shall be compliant with the restrictions of the Hazardous Substances (RoHS) Directive 2002/95/EC.

1.6 PROJECT CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.
- B. Environmental Limitations:
 - 1. Do not install SPDs until spaces are enclosed and weathertight. Equipment shall be protected from any remaining wet work in the space and work above equipment. Provide temporary HVAC system for maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
 - b. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).
 - c. Humidity: 0 to 85 percent, noncondensing.
 - d. Altitude: Less than 20,000 feet (6090 m) above sea level.

- C. Interruption of Existing Electrical Service: Refer to Division 26, Section "General Electrical Requirements".

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space, protected from weather and so condensation will not form on or in units. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle carefully in accordance with manufacturer's instructions to avoid damage to equipment components, enclosure, and finish.
- B. Handle and prepare SPD components according to manufacturer's written instructions.

1.8 WARRANTY

- A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.

- 1. Warranty Period: Five years from date of Substantial Completion.

1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

- 1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Available Manufacturers:

- 1. ABB USA.
 - 2. Eaton.
 - 3. Intermatic, Inc.
 - 4. LEA International.
 - 5. Leviton Mfg. Company Inc.
 - 6. Siemens.
 - 7. Schneider Electric.
 - 8. Surge Suppression Incorporated.
 - 9. Vertiv.

- B. Surge Protective Device Ratings: Device type ratings shall be:

1. Type 1 - Service entrances
 2. Type 2 - Service entrance equipment or distribution equipment
 3. Type 3 - Utilization equipment or point of use.
- C. Nominal System Voltage: Match the system voltage to which the SPD is connected, as indicated on the drawings.
- D. Maximum Continuous Operating Voltage: Not less than 125 percent of nominal system voltage for 240V or less power systems, and not less than 115 percent of nominal system voltage for 600V and 480V power systems.
- E. Comply with ANSI/UL 1449.
- F. SPDs for Lightning Protection: For Lightning Protection Systems specified or otherwise required to be "Master Labeled" per UL 96A utilize Type 1 (20kA rated I_n) SPDs.
- G. SPDs for PV systems: For Photovoltaic Systems specified, SPDs shall be either DC rated or Dual Rated for AC and DC.

2.2 SURGE PROTECTION DEVICES AT SERVICE ENTRANCE EQUIPMENT

- A. Surge Protection Devices: Integrally mounted, wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating matching or exceeding the available short-circuit indicated on the plans, and with the following features and accessories:
1. Fuses, rated at 200-kA interrupting capacity.
 2. Fabrication using bolted compression lugs for internal wiring.
 3. Integral disconnect switch.
 4. Redundant suppression circuits; with individually fused metal-oxide varistors,
 5. Redundant replaceable modules.
 6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 7. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
 8. LED indicator lights for power and protection status.
 9. Audible alarm, with silencing switch, to indicate when protection has failed.
 10. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.

11. Six-digit transient-event counter set to totalize transient surges.
- B. Nominal Discharge current (I_n): The SPD shall be tested to meet UL 1449 Nominal Discharge Current requirements. All modes of protection shall be tested including any required overcurrent protection.
 1. Type 1 SPD's shall be tested and labeled at 20kA per mode.
 2. Type 2 SPD's shall be tested and labeled at 20kA per mode.
- C. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 200 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
- D. Protection Modes:
 1. Protection mode VPR for grounded wye circuits 3-phase, 4-wire circuits shall be as follows:

	480Y/277 V	208Y/120 V	600Y/347 V
Line to Neutral	1200	700	1500
Line to Ground	1200	700	1500
Neutral to Ground	1200	700	1500

2. Protection mode VPR for 240/120 V circuits shall be as follows:

	240/120V, 1ph, 3w	240/120V, 3ph, 4w (high leg)
Line to Neutral	700	700, 1400 from high leg
Line to Ground	1000	1000, 1400 from high leg
Neutral to Ground	700	700

3. Protection mode VPR for 3-phase, 3-wire, delta circuits shall be as follows:

	240V	240V (Delta)	480V	600V
Line to Line	1000	1500	2000	2500
Line to Ground	800		2000	2500

2.3 SURGE PROTECTION DEVICES AT DISTRIBUTION EQUIPMENT

- A. Surge Protection Devices: Integrally mounted, wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating matching or exceeding the available short-circuit indicated on the plans, and with the following features and accessories:
 1. Fuses, rated at 200-kA interrupting capacity.
 2. Fabrication using bolted compression lugs for internal wiring.
 3. Integral disconnect switch.
 4. Redundant suppression circuits; with individually fused metal-oxide varistors,

5. Redundant replaceable modules.
 6. EMI filtering: Minimum 45dB at 100kHz for L-N Modes.
 7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 8. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
 9. LED indicator lights for power and protection status.
 10. Audible alarm, with silencing switch, to indicate when protection has failed.
 11. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 12. Six-digit transient-event counter set to totalize transient surges.
- B. Nominal Discharge current (I_n): The SPD shall be tested to meet UL 1449 Nominal Discharge Current requirements. All modes of protection shall be tested including any required overcurrent protection.
1. Type 1 SPD's shall be tested and labeled at 20kA per mode.
 2. Type 2 SPD's shall be tested and labeled at 20kA per mode.
- C. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 150 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
- D. Protection Modes:
1. Protection mode VPR for grounded wye circuits, 3-phase, 4-wire circuits shall be as follows:

	480Y/277 V	208Y/120 V	600Y/347 V
Line to Neutral	1200	700	1500
Line to Ground	1200	700	1500
Neutral to Ground	1200	700	1500

2. Protection mode VPR for 1-phase, 3-wire circuits shall be as follows:

	240/120V, 1ph, 3w	240/120V, 3ph, 4w (high leg)
Line to Neutral	700	700, 1500 from high leg
Line to Ground	1000	1000
Neutral to Ground	700	700

3. Protection mode VPR for 3-phase, 3-wire, delta circuits shall be as follows:

	240V	240V (Delta)	480V	600V
Line to Line	1000	1500	2000	2500
Line to Ground	800		1500	2500

2.4 SURGE PROTECTION DEVICES AT BRANCH PANELBOARDS

- A. Surge Protection Device: Externally mounted, wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating matching or exceeding the available short-circuit indicated on the plans, and with the following features and accessories:
1. Fuses, rated at 200-kA interrupting capacity.
 2. Fabrication using bolted compression lugs for internal wiring.
 3. Integral disconnect switch.
 4. Redundant suppression circuits; with individually fused metal-oxide varistors,
 5. Redundant replaceable modules.
 6. EMI filtering: Minimum 45dB at 100kHz for L-N Modes.
 7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 8. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
 9. LED indicator lights for power and protection status.
 10. Audible alarm, with silencing switch, to indicate when protection has failed.
 11. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
 12. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 13. Six-digit, transient-event counter set to totalize transient surges.
- B. Nominal Discharge current (I_n): The SPD shall be tested to meet UL 1449 Nominal Discharge Current requirements. All modes of protection shall be tested including any required overcurrent protection.
1. Type 2 SPD's shall be tested and labeled at 20kA per mode.

- C. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 100 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.

D. Protection Modes:

1. Protection mode VPR for grounded wye circuits, 3-phase, 4-wire circuits shall be as follows:

	480Y/277 V	208Y/120 V	600Y/347 V
Line to Neutral	1200	700	1500
Line to Ground	1200	700	1500
Neutral to Ground	1200	700	1500

2. Protection mode VPR for 1-phase, 3-wire circuits shall be as follows:

	240/120V, 1ph, 3w	240/120V, 3ph, 4w (high leg)
Line to Neutral	700	700, 1500 from high leg
Line to Ground	1000	1000
Neutral to Ground	700	700

3. Protection mode VPR for 3-phase, 3-wire, delta circuits shall be as follows:

	240V	240V (Delta)	480V	600V
Line to Line	1000	1500	2000	2500
Line to Ground	800		1500	2500

2.5 SURGE PROTECTION DEVICES AT UTILIZATION EQUIPMENT

- A. Surge Protection Device: Externally mounted, wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating matching or exceeding the available short-circuit indicated on the plans, and with the following features and accessories:

1. Fuses, rated at 100-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits; with individually fused metal-oxide varistors,
5. Redundant replaceable modules.
6. EMI filtering: Minimum 45dB at 100kHz for L-N Modes.
7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
8. LED indicator lights for power and protection status.
9. Audible alarm, with silencing switch, to indicate when protection has failed.

10. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
 11. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 12. Six-digit, transient-event counter set to totalize transient surges.
- B. Nominal Discharge current (I_n): For outdoor SPDs, the SPD shall be tested to meet UL 1449 Nominal Discharge Current requirements. All modes of protection shall be tested including any required overcurrent protection.
1. Type 3 SPD's shall be tested and labeled at 10kA per mode.
- C. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 80 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
- D. Protection Modes:
1. Protection mode VPR for grounded wye circuits, 3-phase, 4-wire circuits shall be as follows:

	480Y/277 V	208Y/120 V	600Y/347 V
Line to Neutral	1200	700	1500
Line to Ground	1200	700	1500
Neutral to Ground	1200	700	1500

2. Protection mode VPR for 1-phase, 3-wire circuits shall be as follows:

	240/120V, 1ph, 3w	240/120V, 3ph, 4w (high leg)
Line to Neutral	700	700, 1500 from high leg
Line to Ground	1000	1000
Neutral to Ground	700	700

3. Protection mode VPR for 3-phase, 3-wire, delta circuits shall be as follows:

	240V	240V (Delta)	480V	600V
Line to Line	1000	1500	2000	2500
Line to Ground	800		1500	2500

2.6 SURGE PROTECTION DEVICES IN ELECTRONICS-GRADE PANELBOARDS

- A. Surge Protection Device: Integrally mounted, wired-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules short-circuit current rating matching or exceeding the available short-circuit indicated on the plans, and with the following features and accessories:
1. Fuses rated at 200-kA interrupting capacity.

2. Fabrication using bolted compression lugs for internal wiring.
 3. Integral disconnect switch.
 4. Redundant suppression circuits; with individually fused metal-oxide varistors,
 5. Redundant replaceable modules.
 6. EMI filtering: Minimum 45dB at 100kHz for L-N Modes.
 7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 8. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
 9. LED indicator lights for power and protection status.
 10. Audible alarm, with silencing switch, to indicate when protection has failed.
 11. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 12. Six-digit, transient-event counter set to totalize transient surges.
- B. Nominal Discharge current (I_n): The SPD shall be tested to meet UL 1449 Nominal Discharge Current requirements. All modes of protection shall be tested including any required overcurrent protection.
1. Type 2 SPD's shall be tested and labeled at 20kA per mode.
- C. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 100 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
- D. Protection Modes:
1. Protection mode VPR for grounded wye circuits, 3-phase, 4-wire circuits shall be as follows:

	480Y/277 V	208Y/120 V	600Y/347 V
Line to Neutral	1200	700	1500
Line to Ground	1200	700	1500
Neutral to Ground	1200	700	1500

2. Protection mode VPR for 1-phase, 3-wire circuits shall be as follows:

	240/120V, 1ph, 3w	240/120V, 3ph, 4w (high leg)
Line to Neutral	700	700, 1500 from high leg
Line to Ground	1000	1000
Neutral to Ground	700	700

3. Protection mode VPR for 3-phase, 3-wire, delta circuits shall be as follows:

	240V	240V (Delta)	480V	600V
Line to Line	1000	1500	2000	2500
Line to Ground	800		1500	2500

2.7 ENCLOSURES

- A. All SPD Units shall be fully enclosed unless otherwise noted. Provide enclosures suitable for the locations indicated and as described below:

1. Indoor Enclosures:

- a. NEMA 250 Type 1 constructed of a polymer or steel material
- b. NEMA 250 Type 12 constructed of a polymer or steel material with a gasket to exclude dust.

2. Outdoor Enclosures:

- a. NEMA 250 Type 3R constructed of steel material and with a gasket to exclude dirt, windblown dust, and water (rain, sleet, and snow) from entering the enclosure when shut.
- b. NEMA 250 Type 4 constructed of steel material and with a gasket to exclude dirt, windblown dust, and water (rain, sleet, snow, splashing water or hose directed water) from entering the enclosure when shut.
- c. NEMA 250 Type 4X constructed of stainless steel material and with a gasket to exclude dirt, windblown dust, and water (rain, sleet, snow, splashing water or hose directed water) from entering the enclosure when shut.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surge suppression devices before installation. Reject equipment that is damaged, or rusted, or have been subjected to water saturation.
- B. Examine areas, surfaces, substrates, and elements to receive SPDs with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 1. Verify that field measurements are as indicated.

2. Verify that manufacturer's written instructions for environmental conditions have been established in spaces where equipment will be installed, before installation begins.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install SPDs and accessories in accordance with manufacturer's instructions.
- B. Coordinate layout and installation of equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access.
- C. Wall-Mounted Surge Protective Devices: Install SPDs on walls adjacent to equipment served, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For SPDs not at walls, mount to similar support structure for equipment served by device. Comply with Division 26 Section "Hangers and Supports for Electrical Systems."
- D. Install SPD devices at service entrance on load side, with ground lead bonded to service entrance ground.
- E. Install SPD devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
 1. Provide circuit breaker as a dedicated disconnecting means for SPD unless otherwise indicated.
- F. Mount equipment plumb and rigid without distortion of enclosure.
- G. Install fuses in fusible devices.
- H. Comply with NECA 1.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Connect to building automation system according to Division 26 Section "Electrical Power Monitoring and Control."
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools for control wiring.

3.4 IDENTIFICATION

- A. Nameplates: Label external device enclosures with equipment served.

- B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

- C. Warning Labels: Label device with a warning label in accordance with NFPA 70 and NFPA 70E.

3.5 CLEANING

- A. After completing equipment installation and before energizing, inspect unit components. Vacuum dirt and debris from interior of equipment; do not use compressed air to assist in cleaning. Remove paint splatters and other spots. Repair exposed surfaces to match original finish.

3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.7 FIELD QUALITY CONTROL

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

- B. Testing: Engage a qualified testing agency to perform the following field quality-control tests and inspections:

- C. Testing: Perform the following field quality-control tests and inspections:

- 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, to assist in testing, and to assist in adjusting device settings.

- D. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

- E. Acceptance Testing Preparation:

- 1. After installing SPD but before equipment is energized, test for compliance with requirements.
 - 2. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
 - 3. Complete startup checks according to manufacturer's written instructions.
 - 4. Test continuity of each circuit.

- F. Tests and Inspections:

- 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Report results of tests and inspections in writing. Attach a label or tag to each tested component indicating satisfactory completion of tests.

G. SPDs will be considered defective if they do not pass tests and inspections.

H. Prepare test and inspection reports. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment, overcurrent protective devices, instrumentation, and accessories.

B. Video record demonstrations presentation for Owner's records.

END OF DOCUMENT 264313

DOCUMENT 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Included in the work of this section are labor, material, and appurtenances required to complete the work of this Section as specified herein, including, but not limited to:
 - 1. Interior light fixtures, lamps, LEDs, reflectors, lenses or faceplates, ballasts, transformers, drivers and power supplies (includes exterior light fixtures normally installed on exterior surfaces of buildings).
 - 2. Emergency lighting units.
 - 3. Exit signs.
 - 4. Light fixture supports.
 - 5. Retrofit kits for fluorescent light fixtures.
 - 6. Emergency Lighting Mini-Inverter.
 - 7. Coordination.
 - 8. Quality assurances.
 - 9. Specific requirements.

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING:

- A. Division 26 Section "General Electrical Requirements" for general requirements and related documents that apply to this Section.
- B. Division 26 Section "Common Work Results for Electrical" for raceways, conductors, cables, and cords.
- C. Division 26 Section "Exterior Lighting" for exterior light fixtures, except those normally mounted on exterior surfaces of buildings.
- D. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
- E. Division 26 Section "[Central Dimming Controls] [Modular Dimming Controls]" for architectural dimming systems.
- F. Division 26 Section "Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.
- G. Division 26 Section "Wiring Devices" for manual wall-box dimmers.

- H. Division 26 Section "Theatrical Lighting" for theatrical lighting fixtures and their controls.

1.3 SUBMITTALS

A. General:

1. Only those light fixtures and manufacturers per each fixture type designated and listed in the Light Fixture Schedule or on the Drawings, and approved in accordance with paragraph 1.4-SUBSTITUTIONS of this Section, or both, will be accepted. Where the Light Fixture Schedule indicates an allowance to be made for a specific light fixture, the price is a contractor price and monies shall be allotted for freight, installation, and lamping (if designated). Alternate manufacturers presented at bid shall be disqualified.
2. Submit all light fixtures, specified for use on this Project, in a single submittal package of portfolios, so that all light fixtures can be reviewed at one time.
3. Prepare portfolios from manufacturer's standard specification sheets, and include the fixture tag indicated on the Light Fixture Schedule to identify each light fixture. Do not combine more than one light fixture type on a single sheet.
4. Fixture or other materials shall not be shipped, stored, or installed into the work without approval of shop drawings.
5. Modifications to fixtures shall be in accordance with Architect's comments.

B. Product Data: For each type of light fixture, collated and bound in sets, and arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Summary page with the following for each light fixture type
 - a. The number, type and wattage of the light fixture lamps or LEDs (including, but not limited to, assemblies, arrays, bars or modules).
 - b. Light fixture ballast, driver or auxiliary device manufacturer, number and type.
2. Fixture cut sheets with name of manufacturer and options to be provided marked, including, but not limited to, voltage, lensing, and finish/color.
 - a. Descriptive information providing physical characteristics of light fixture, including, but not limited to, materials, dimensions, fixture efficacy and/or efficiency, and verification of indicated parameters.
 - b. For LED fixtures, include also L70 lifetime and wattage of luminaire including driver/power supply losses.
 - 1) Include MacAdam ellipse step information for:
 - a) All interior light fixtures
 - b) Exterior luminaires installed on exterior building surfaces specified with 80 CRI or greater.

3. Light fixture mounting details, including non-standard outlet boxes.
 4. Construction of light fixture housing and door (if applicable).
 5. Ballast cut sheet with options marked, providing physical description of ballast including, but not limited to, voltage, lamp, ballast factor, power factor, amperage and wattage.
 6. Power supply, transformer, and/or driver cut sheet with options marked, providing physical description of auxiliary device including, but not limited to, voltage, power factor, amperage, wattage, and maximum remote distance charts between device and light fixture.
 7. Light fixture finish and color (if applicable).
 8. Air and Thermal Performance Data: For air-handling light fixtures. Furnish data required in "Submittals" Article in Division 23 Section "Diffusers, Registers, and Grilles."
 9. Sound Performance Data: For air-handling light fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Division 15 Section "Diffusers, Registers, and Grilles."
 10. Lamp cut sheet with options marked, providing physical description of lamps, including, but not limited to, voltage, wattage, efficacy, CCT, CRI, lumens, and life expectancy.
 - a. For LED lamps, include also number of MacAdam ellipse steps and L70 lifetime.
 11. Photometric data, in IESNA format, including LM-79 for LED luminaires, based on laboratory tests of each light fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the light fixture as applied in this Project.
 - a. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
 12. Emergency ballast cut sheet: Descriptive cut sheets providing physical description of emergency ballasts for use in normal light fixtures, including, but not limited to, complete battery information, lumens, and method for testing per NFPA 101.
- C. Shop Drawings: Show details of non-standard or custom light fixtures. Indicate dimensions, finish color, including, but not limited to, custom color, weights, methods of field assembly, components, features, accessories, and modifications. Scaled documents shall be provided for custom fixtures.
- D. Submittal Schedule
1. Within 30 days of Division 26 contractor award, shop drawings covering all light fixtures within this section shall be forwarded to architect to begin approval process. Any shop drawings submitted after the required time frame will require the contractor to submit only the 1st named manufacturer and associated specification data listed on the fixture schedule as the only approved manufacturer. No substitutions will be allowed after the specified time frame.

2. Within 15 days of "approved" and "approved as noted" shop drawings, contractor shall forward to Architect a guaranteed ship date for each specified fixture.
3. Within 15 days after contractor's receipt of "reject and resubmit" or "not approved" shop drawings, contractor shall provide Architect with resubmitted shop drawings for only those fixtures deemed unacceptable.
4. Contractor is responsible to call to the attention of the Architect any submittals that have not been returned to him in a timely manner that may affect delivery of fixtures or as otherwise affecting Section 1.4.D of this specification.

E. Control Wiring

F. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.

G. Qualification Data: For agencies providing photometric data for light fixtures.

H. Field quality-control test reports.

I. Operation and Maintenance Data: For lighting equipment and fixtures to include in operation and maintenance manuals.

J. Warranties: Special warranties specified in this Section.

1.4 SUBSTITUTIONS

A. Refer to Division 26 Section "General Electrical Requirements".

B. Prior to the Bid Date, substitutions will not be considered unless the Architect/Engineer have received written request for approval at least ten calendar days prior to the date for receipt of Bids. Include in each such request the Light Fixture Schedule designation, name of the material or equipment for which it is to be substituted and complete Product Data for the proposed substitute, as defined in SUBMITTALS above, and all other information necessary for an evaluation. Provide interior point-by-point photometric calculations, under both normal and emergency lighting conditions, as applicable, if required by the Engineer. Submit a \$100.00 review fee to the Engineer with each such point-by-point calculation for use of electronic base files. The fee will be returned if the substitution is added to the specification.

C. During the Bid

1. Any proprietary, sole-sourced light fixture listed in the fixture schedule shall be unit priced only. Unit prices shall be clearly identified on the bid form.
2. Representative agents shall be allowed to offer mini-lot pricing (MLP). MLP shall be defined as:
 - a. Agents can group only specified fixtures they represent, and
 - b. Only represent in the region where the specification originated, and

- c. Exclude all fixtures outside their represented lines from the MLP, and
 - d. Sole-sourced (proprietary) light fixtures shall not be included in the MLP.
3. Packaging of light fixtures will not be considered nor approved. Packaging is defined as: distributor(s) providing a single price for a light fixture package made up of specified and non-specified light fixtures. Any submittal package containing non-specified light fixtures or inclusion of lighting control systems will be immediately rejected in its entirety.
- D. After the Bid Date, proposals to substitute light fixtures for those shown on the Drawings or specified herein, will only be considered as a deduct. Submit proposed substitutions separately, in Submittal form, with a list of proposed substitutions together with a deduct price for each substitution. Proposed substitutions will then be reviewed by the Architect/Engineer.
- E. During the construction period, no substitutions shall be considered if product delay is due to contractor's failure to order products in a timely manner after presentation of fixture schedules and specifications. Additional costs associated with air freight or special factory runs to meet schedule due to contractor's error shall be at the expense of contractor.
- F. The Architect/Engineer has the final authority as to whether the light fixture is an acceptable replacement to the specified item. The proposed substitution may also be rejected for aesthetic reasons if felt necessary or desirable. In the event the proposed substitutions herein described are rejected, provide the specified item(s).

1.5 DEFINITIONS

- A. BF: Ballast factor.
- B. CCT: Correlated color temperature
- C. CFL: Compact Fluorescent
- D. CRI: Color-rendering index.
- E. CU: Coefficient of utilization.
- F. L70: minimum 70% maintained initial-rated lumens at average rated life for LEDs
- G. LED: Light Emitting Diode
- H. LED Lamp: Replaceable LED light source with an integral driver within envelope of lamp. Lamp/Base types may include MR16/bi-pin, PAR/medium base, etc.
- I. LED Module: Light source that contains LEDs, and may include additional components such as lenses, reflectors, or refractors, however do not include drivers.
- J. LER: Light fixture (Luminaire) efficiency rating.
- K. Light Fixture: Complete light fixture, including ballast housing if provided.
- L. RCR: Room cavity ratio.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 2. Marked for intended use.
- B. Comply with NFPA 70.
- C. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- D. Luminaire Photometric Data Testing Laboratory Qualifications: 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.
- E. Regulatory Agencies: Provide fixtures conforming to nationally- or internationally-recognized accredited testing agencies, such as U.S., ETL, ARL, or others in acceptance with local code enforcement policy.
- F. Electrical Components and Devices: Provide only fixtures that comply with National Electric Code (NEC), and in particular to Section 410. All ceiling recessed fixtures, whether indicated in a catalog number or not, shall be equipped with an integral thermal protection device.

1.7 COORDINATION

- A. Unless otherwise noted, perform all electrical Work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other Divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.
- B. Give ample notice of any special openings or rough-in work required for placing electrical/lighting work so as to avoid cutting or removal of completed work.
- C. Where work of this Section is to be flush or concealed, install it so it does not project beyond finished lines of walls, ceilings or floor surface.
- D. Verify all ceiling systems and coordinate light fixture type and accessories prior to ordering light fixtures. Coordinate and cooperate with ceiling installer in regards to the location and installation of light fixtures.

1.8 WARRANTY

- A. General Guarantee: For a period of one year after Owner's initial acceptance and establishment of the beginning date of the guarantee period, and at no cost to the Owner, Contractor shall promptly furnish and install replacements for any fixtures or components deemed by the Owner as defective in workmanship under normal operating conditions, excluding lamp replacement as noted in Section 1.10.A.1. Contractor shall repair installed equipment on the job site to Owner's

satisfaction. For any time during said guarantee period that fixtures are not fully functional due to defects in material or workmanship, Contractor shall provide or pay for suitable temporary light fixtures, and shall remove said temporary fixtures upon installation of replacement elements. Contractor shall furthermore guarantee replacement fixtures for a period of one year following replacement.

- B. Contractor shall not be held responsible for damage of fixtures or equipment components occurring after the beginning of the guarantee period due to acts of vandalism, acts of war, or acts of God.
- C. LED Warranties: Shall be free from defects in materials and workmanship for the period indicated from date of factory shipment.
 - 1. LED Luminaires, including LED modules, arrays and drivers: Five years.
 - 2. LED Lamps: Three years.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Additional light fixtures and accessories as scheduled on the Drawings.
- B. Where light fixtures are specified with tamper proof hardware, provide the Owner with three tools for each different type of hardware.

1.10 SPARES

- A. Furnish spare materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Plastic Diffusers and Lenses: 1 for every of each type and rating installed. Furnish at least one of each type.
 - 3. Battery and Charger Data: One for each emergency lighting unit.
 - 4. Ballasts and/or Drivers: 2 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 5. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In Light Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Basis-of-Design Product: The design for each light fixture is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified that meets or exceeds performance characteristics of the named product.
2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 LIGHT FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Provide light fixtures as shown on the drawings and/or specified. This shall include all lamps, material and labor to securely hang light fixtures, clean them and make them completely ready for use. Provide all hangers, supports, and miscellaneous hardware required to install light fixtures. Provide additional tie wires connected to structure to conform to applicable seismic requirements where required.
- B. Light fixture models scheduled on the Drawings are to show the manufacturer, grade and style of light fixtures required. Regardless of the manufacturer's catalog number suffixes indicated, provide all options and features as described in the Light Fixture Schedule.
- C. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures. Manufacturer of recessed fixtures shall provide mounting brackets suitable for connection to ceiling system structure. Modifications to standard mounting brackets shall be coordinated with contractor and delivered with fixture so that no delays to product delivery shall be allowed.
- D. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A. Minimum gauge of sheet steel to be 18 gauge.
- E. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable. Minimum gauge of sheet steel to be 22 gauge.
- F. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- G. Metal Parts: Free of burrs and sharp corners and edges.
- H. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- I. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 1. White Surfaces: 85 percent.
 2. Specular Surfaces: 83 percent.
 3. Diffusing Specular Surfaces: 75 percent.

4. Laminated Silver Metallized Film: 90 percent.
- K. Plastic Diffusers, Covers, and Globes:
1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
 - b. UV stabilized.
 2. Glass: Annealed crystal glass, unless otherwise indicated.
- L. Where located within structural concrete, light fixture housing and any other luminaire components in direct contact with concrete shall be effectively coated and/or covered to prevent chemical reactions with the concrete in accordance with the American Concrete Institute Code.
- M. Fixture Finishes:
1. Apply fixture finishes after fabrication in a manner that assures a durable wear-resistant surfacing. Give exposed metal surfaces (brass, bronze, aluminum and others) and finished castings, except chromium-plated or stainless steel parts, an even coat of high-grade meth/acrylate lacquer or transparent epoxy.
 2. For corrosive or salt water environments, manufacturer shall provide fixtures with low copper/zinc cast aluminum (AB-47100 aluminum with less than 0.6% copper – classified for corrosive areas) housings to prevent salts from “pitting” aluminum housing. Manufacturer shall provide, in addition to or in lieu of, AB-47100 aluminum, ion added or pre-anodized polyester powder cast finish for “marine grade” applications. Manufacturer shall otherwise provide all stainless steel housing in conjunction with stainless steel hardware.
 3. Recessed downlights in corrosive or salt water interior environments shall be equipped with a “natatorium” finish comprised of a zinc-chromated and phosphated process, then powder-coated on the exterior of the housing.
- N. Reflectors:
1. Provide aluminum reflectors or reflecting cones for downlight style fixtures comprised of #12 aluminum reflector sheet, 0.57 inch (15 gauge) or heavier and free of tool-making indentations, including spinning lines caused by assembly techniques. All reflectors shall be of first-quality, anodized finish :Alzak” with specular or semi-specular finish and color as selected. Provide specular reflectors with no apparent brightness above 45 degrees from Nadir and semi-specular, diffuse reflectors with no apparent brightness above 75 degrees from Nadir.
- O. Mounting hardware and trims:
1. Coordinate as need to suit ceiling conditions.

2. Light fixtures near or in contact with insulation shall comply with code.
 3. Maintain a 3" minimum working clearance between non-IC rated light fixture housings and insulation on all adjacent ductwork, piping, walls and ceilings.
- P. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps, LEDs, ballasts and/or drivers. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp, LEDs, ballast and/or driver characteristics:
 - a. "USE ONLY" and include specific lamp or LED type.
 - b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
 - c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires. Indicate maximum allowed wattage.
 - d. LED type, wattage, beam angle (if applicable) for LED luminaires. Indicate maximum allowed wattage.
 - e. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
 - f. ANSI ballast type (M98, M57, etc.) for HID luminaires.
 - g. CCT and CRI for all luminaires.
- Q. Emergency lights and exit signs with integral battery back-up shall be connected to a separate unswitched conductor bypassing all other controls and contactors. Exit signs shall not be switched. Allow battery to charge for a minimum of [48] hours before light level testing. In order to prevent battery damage, do not turn off power for extended periods of time after the emergency light has been powered.
- 2.3 BALLASTS GENERAL
- A. General: Whenever possible, provide all ballasts by the same manufacturer for Owner's ease of maintenance. Ballasts by a different manufacturer may be acceptable where required to meet project requirements.
- B. Unless specific manufacturers and ballast types are called for in the Light Fixture Schedule, ballast provided for this project shall be manufactured by:
1. Fluorescent Ballasts (Linear and Compact Fluorescent)
 - a. Non-Dim:
 - 1) Advance, a division of Philips – Optanium Series (linear) and SmartMate Series (CFL)

- 2) Fulham (cold-temperature CFL)
- 3) G.E.
- 4) Osram/Sylvania
- 5) Robertson (cold-temperature CFL)
- 6) Universal

b. Dimming:

- 1) Advance, a division of Philips.
- 2) G.E.
- 3) Lutron
- 4) Osram/Sylvania
- 5) Universal

c. Electronic

- 1) Advance, a division of Philips
- 2) Aromat
- 3) Fulham
- 4) Hatch

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

- A. Description: Electronic programmed rapid-start type, complying with UL 935 and ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: A.
4. Total Harmonic Distortion Rating: 20 percent or less.
5. Transient Voltage Protection: IEEE C62.41, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.

8. BF: 0.95 or higher, unless otherwise indicated.
9. Power Factor: 0.95 or higher.
10. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
11. Ballast Case Temperature: 75 deg C, maximum.

B. Operating Characteristics: Electronic Ballasts

1. Ballasts shall be universal voltage, operating at either 120V or 277V supplied voltage.
2. Ballasts shall be universal wattage, capable of operating 26 Watt or 32 Watt lamps without replacing ballast.
3. Electronic ballasts shall be used for all 4-pin bases, including, but not limited to: 2G11, G24Q-1, 2, 3 and GX24Q-1, 2, 3, 4, 5 and 6, and GR10Q-4.

C. Operating Characteristics: Magnetic Ballasts

1. Said ballasts shall be used and coordinated with 2-pin bases, including, but not limited to, G23, GX23, G23-2, GX23-2 and G24D-1, 2, 3.

D. Ballasts for Dimmer-Controlled Light Fixtures: Electronic type.

1. Dimming Range: As indicated on Light Fixture Schedule.
2. Ballast Input Watts: Can be reduced to percentage indicated on Light Fixture Schedule.
3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
4. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, dimming module, and/or wallbox dimmer and connecting wiring are compatible.

2.5 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.

- b. Charger: Fully automatic, solid-state type with sealed transfer relay.
- c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
- d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
- e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
- f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
- g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.6 EMERGENCY LIGHTING UNITS

A. Description: Self-contained units complying with UL 924.

- 1. Battery: Sealed, maintenance-free, lead-acid type.
- 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
- 3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
- 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
- 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
- 6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
- 7. Integral Time-Delay Relay: Holds unit on for fixed interval of [15] <Insert period> minutes when power is restored after an outage.
- 8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.7 DRIVERS FOR LED LUMINAIRES

- A. Description: Designed for type and quantity of LED diodes of light fixture. Drivers shall tolerate sustained open circuit and short circuit output conditions without damage. Driver shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Sound Rating: A.
2. Total Harmonic Distortion Rating: Less than 20 percent. Shall comply with ANSI C82.77.
3. Transient Voltage Protection: IEEE C62.41, Category A or better.
4. Power Factor: 0.90 or higher at full load.
5. Interference: Comply with 47 CFR, Chapter 1, Part 15, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
6. Driver shall operate with maximum sustained variations of +/-[10] <Insert value>% input voltage and frequency with no damage to driver.
7. Driver output shall be regulated to maximum +/- 5% published load range or requirements of downstream LED fixture.
8. LED Current Crest Factor: 1.5 or less.
9. LED drivers shall not over-drive LEDs at a current or voltage above LED rated values in order to increase LED lumen output.
10. Meets EN610000 for input harmonics.
11. ROHS Compliant.

- B. Dimming Drivers:

1. Dimming Range: Visually flicker-free, strobe-free, continuous dimming of source as follows, unless specifically noted otherwise in the Light Fixture Schedule whichever is more stringent:
 - a. Luminaires: 100 to 10 percent of rated lumens.
 - b. Lamps: 100 to 20 percent of rated lumens.
2. 0-10V dimming drivers: Compliant with IEC 60929 standard for 4-wire dimming.
3. Compatibility: Certified by manufacturer for use with specific dimming control system and LED indicated.

4. Control: Coordinate to ensure that the dimming driver, power supply, controller, dimming module, and/or wallbox dimmer and connecting wiring are compatible.

2.8 EMERGENCY LIGHTING MINI-INVERTER

A. Manufacturer

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Bodine (by Signify),
 - b. Carpenter Emergency Lighting,
 - c. Chloride (by Signify),
 - d. Controlled Power Company,
 - e. Cooper Lighting,
 - f. DSPM, Inc,
 - g. Dual Lite,
 - h. Emergi-Lite,
 - i. Iota Engineering (Acuity Brands),
 - j. Inverter Systems, Inc (ISI),
 - k. Myers Emergency Power Systems,

B. Description – Self-contained uninterruptible or fast-transfer inverter designed for normal and emergency operation of connected lighting loads. Unit shall be capable of operating HID, incandescent, fluorescent, induction and LED fixtures with no break or interruption of illumination. UL 924 listed and meets NFPA 101, NFPA 70 and local codes.

1. Battery: Sealed, maintenance-free lead-calcium or lead-acid type. 68 deg F to 86 deg F optimum operating temperature.
2. Charger and Electronics: Fully automatic, thermal compensating variable rate battery charger. AC lockout feature, low battery voltage disconnect; DC overload, short circuit and brownout protection. 32 deg F to 104 deg F electronics operating temperature.
3. Operation: Inverter shall allow connected emergency lighting fixtures to be normally on. Upon loss of normal utility power, the emergency lighting fixtures will be delivered emergency power for their full lumen output rating with no break (<2 ms) in illumination for a minimum of 90 minutes.
4. 120V, single phase input and output voltages. Input voltage shall match output voltage, and +/- 3% voltage regulation, 60 Hz.

5. Maximum remote mounting distance of 1000'-0".
 6. Housing: Designed for surface mounting installation to floor or wall. 16 gauge steel housing with scratch-resistant powder coat paint finish..
 7. Testing: Integral testing means by either manual test switch or self-testing, self-diagnostic with manual testing capabilities.
 8. Onboard LED indicating lights for inverter status indication.
 9. Manufacturer's warranty or minimum 2 year warranty on electronics and battery and seven-year prorata warranty on battery, whichever is greater.
 10. Overload and short circuit protection on input and output of inverter. Circuit breakers or fusing on output side.
- C. Where wattage of inverter is different from Basis-of-Design manufacturer's selected wattage, provide quantity of inverters as required to meet design intent. If additional inverters are required, confirm additional equipment will fit within available space constraints.
- D. Where physical size of inverter is different from Basis-of-Design manufacturer, confirm equipment will fit within available space constraints.

2.9 LAMPS GENERAL

- A. Unless specific manufacturers and lamp types are called for in the Light Fixture Schedule, all lamps provided for this project shall be by the same manufacturer. Lamps shall be manufactured by:
1. Eiko
 2. General Electric
 3. Osram/Sylvania
 4. Philips
 5. Sora
 6. Venture
- B. All lamps shall be new and shall be delivered to the project in manufacturer's original sealed package.
- C. Substitutions of specific lamp manufacturer as addressed in Fixture Schedule shall not be allowed. Costs associated with re-lamping due to non-compliance with specification, for both labor and material costs, shall be the sole responsibility of the contractor. For those fixtures with lamp included in fixture, contractor shall coordinate with manufacturer to ensure only approved lamp(s) is (are) installed. Lamp manufacturers indicated on Fixture Schedule are for reference. Where required, contractor shall coordinate with Owner regarding national purchasing agreement of

specific lamp manufacturers. Purchasing of lamps, whether through competitive bidding of listed manufacturers or proprietary supply, shall be at the discretion of the Owner.

2.10 FLUORESCENT LAMPS

A. General

1. Low-Mercury: Comply with EPA's toxicity characteristic leaching procedure test ; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.
2. Unless noted otherwise in the Light Fixture Schedule, color temperature shall be consistent for all lamps through project: 3500K CCT.

B. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature, average rated life of 10,000 hours, unless otherwise indicated.

1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
6. 55 W: T4, triple tube, rated 4300 initial lumens (minimum).

2.11 LED LAMPS AND LUMINAIRES

A. Comply with ANSI C78.377 for white light LED color range. Unless noted otherwise in the Light Fixture Schedule, LED color quality characteristics shall be 80 CRI minimum and 3500K CCT.

B. LED binning specification tolerance to be within 3 MacAdam ellipses of rated values or as indicated in the Light Fixture Schedule, whichever is more stringent. All LEDs used for same fixture type throughout the project to originate from same production bin.

C. Unless indicated otherwise in the Light Fixture Schedule, minimum 70% maintained initial-rated lumens at average rated life of as follows:

1. LED lamps: 20,000 hours
2. LED luminaires: 50,000 hours

D. ROHS compliant

E. Manufacturer of LED chips will be evaluated based on the manufacturer's product literature and data. At a minimum, LED fixtures or lamps will incorporate Bridgelux, Cree, Nichia, Osram or Xicato LEDs; additional manufacturers may be considered however the Architect or Engineer has the authority to reject other manufacturers for technical or aesthetic reasons if felt necessary or desirable.

2.12 AUXILIARY DEVICES FOR LOW VOLTAGE AND LED FIXTURES

- A. Provide remote power supplies, drivers and/or transformers for light fixtures as required for a complete and operational system. Where equipment is not indicated as plenum rated, provide an additional enclosure for the device(s) suitable for the installed environment.

2.13 LIGHT FIXTURE SUPPORT COMPONENTS

- A. Comply with Sections "260548 Seismic Controls for Electrical" and "260529 - Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gauge.
- F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.14 TRANSFORMERS FOR LOW VOLTAGE FIXTURES

- A. Provide transformers to low voltage lamps which are suitable for the electrical characteristics of the supply circuits to which they are to be connected. For remote electronic or magnetic transformers, contractor shall remote transformers so as to reduce voltage drop. For 25 amp low-voltage linear systems, contractor shall not daisy-chain 25A loaded runs together. Contractor shall provide home-run from end of run to remote transformer.

2.15 COLD CATHODE TUBING

- A. Surface or recessed cold cathode shall be installed at locations indicated on drawings to form a continuous line of light, without noticeable breaks at tube ends. Recommended porcelain socket ends and support elements shall be illustrated on shop drawing submittal. Tube colors shall be selected by Architect, lighting designer, or interior designer, based on manufacturer's standard palette of colors and shall be indicated on Fixture Schedule. Contractor shall not order cold cathode tubes without written confirmation of said color by Architect or Owner based on sample, mockup, or other verification means. Failure of contractor to obtain written approval of color shall hold contractor solely responsible for financial obligations to provide approved color.
- B. Lamps shall be made from 1-inch diameter glass. Lamps showing end darkening, stains, discolorations, spiraling or sputtering shall be rejected. Manufacturer shall comply with NEC regulations regarding lighting service over or under 1000 volts. For said systems requiring under 1000V, manufacturer shall supply only 200MA ballasted cold cathode system.

- C. Bidding cold cathode manufacturers shall be U.L. IFAY 48 listed and shall have an approved IFAY 48 number given by U.S. prior to bidding. WZBL installers of cold cathode shall be disqualified. Failure to comply with specifications for U.L. IFAY manufacturers shall deny payment to WZBL manufacturer and contractor. Contractor shall be financially and legally responsible for providing an IFAY 40 system.
- D. Shop drawings shall be submitted for approval. These drawings shall include scale plans and details showing the method of installation of ballasts or transformers, intermediate feeds and connections. A copy of this approved shop drawing shall be submitted to the Owner for his use in lamp replacement and maintenance.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify conditions of equipment and installation prior to beginning work.
- B. Verify that equipment is ready for connecting, wiring, and energizing.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Light Fixtures: All work shall be executed to present a neat appearance. Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- C. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- D. Support for Light Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
 - 1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from light fixture corners.
 - 2. Support Clips: Fasten to light fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
 - 4. Install at least one independent support rod or wire from structure to a tab on light fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- E. Suspended Light Fixture Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.

3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end. Provide suitable connectors or collars to connect adjoining units to appear as a continuous unit.
4. Decorative pendant mounted light fixtures
 - a. Provide cord and/or stem lengths to match elevations above finished floor as indicated on architectural elevations. If architectural elevations do not indicate suspension heights, coordinate with Architect to determine final suspension heights. Regardless, contractor shall not field cut pendants or order rigid stems without elevation approval from Architect. Pendant suspensions on electrical documents are for reference only.
 - 1) Cord-mounted: Manufacturers shall supply luminaires with flexible, field cutting cords. Contractor shall field cut cords as required.
 - 2) Field-cuttable, rigid-stem mounted: Manufacturers shall supply luminaires with field cutting rigid stems. Contractor shall field cut stems as required.
 - 3) Factory-cut rigid stem mounted: Contractor shall provide rigid stem dimensions to the manufacturer as required.
 - b. Junction boxes used to feed light fixtures shall be covered by manufacturer supplied canopy plates.
- F. Installation within non-standard ceilings, including, but not limited to, wood and metal ceilings.
 1. For recessed downlight light fixtures, specification is based on standard throats to accommodate ceiling thicknesses of $\frac{3}{4}$ " or less. If non-standard ceiling (such as wood, thickened gypboard ceilings and metal plank type) require throats greater than $\frac{3}{4}$ ", modifications to manufacturer's standard $\frac{3}{4}$ " throat shall be determined by Architect and Contractor prior to shop drawing submission.
 2. For light fixtures recessed into metal ceilings, rigidly support light fixture to ensure that trim fits flush with ceiling plane.
- G. Manufacturer shall supply contractor with a complete list of component elements to comply with design intent for either 20-amp (flexible low voltage track systems or line voltage track) or 50-amp bus bar track systems. Contractor shall install track systems based on design requirements outlined herein or Light Fixture Schedule.
- H. Connect wiring according to Section "260519 - Low-Voltage Electrical Power Conductors and Cables."
- I. Through wiring of recessed light fixtures, in suspended ceilings, is not permitted. Connect each light fixture by a whip to a junction box. The whip shall be of sufficient length to allow the light fixture to be relocated within a 6-foot radius.
- J. Wall Mounted Light fixtures

1. Unless otherwise noted, conceal all raceways and back boxes for wall mounted light fixtures. Coordinate all wall-mounted light fixtures with interior elevations. Where specific elevations or dimensions are not indicated, verify the correct location with Architect prior to installation. Contractor shall supply structure to support weight of fixture.
- K. Contractor shall construct light coves according to architectural details. Contractor shall ensure, unless otherwise directed, that top of fixture lamp is flush with top of cove lip. Contractor shall provide blocking as needed under fixture to ensure stated requirement.
- L. Auxiliary Devices for low voltage and LED Fixtures
 1. Install device within maximum remote distances and with wiring sized per manufacturer's recommendations.
 2. In public areas or other areas where remote device visibility is undesirable, install device where concealed from view, well ventilated and accessible. Provide access panels as required.
 3. Provide label on device indicating fixture type and location/room served along with panelboard circuit number.
 4. Properly support remote lighting devices, including transformers, power supplies, and drivers, per Code and manufacturer's recommendations.

3.3 DIMMING

- A. For dimmable light fixtures, provide both control and power wiring between light fixture and control device and between light fixtures. Quantity of low voltage and line voltage wiring and wire type shall be per manufacturer's recommendations. At a minimum, provide the following based on control type at either 120V or 277V, unless recommended otherwise by the manufacturer:
 1. 0-10V – two low voltage conductors and two line voltage conductors plus ground
 2. 2-Wire dimming – two line voltage conductors plus ground
 3. 3-Wire dimming – three line voltage conductors (1 for control and two for power) plus ground
 4. DALI – two low voltage conductors and two line voltage conductors plus ground
 5. Proprietary digitally addressable – as required per the manufacturer
 6. DMX – two line voltage conductors plus ground and DMX cabling
- B. Coordinate light fixture and control device dimming types for compatibility.

3.4 COORDINATION

- A. Light fixtures shown on the Electrical Drawings represent general arrangements only. Refer to Architectural Drawings for exact locations.

- B. Coordinate the installation and location of light fixtures with other work and all other trades before installation to avoid conflicts. Coordinate light fixture locations in mechanical rooms with final installed piping and ductwork layouts.
- C. Verify all ceiling systems and coordinate light fixture type and accessories prior to ordering light fixtures. Coordinate and cooperate with ceiling installer in regards to the location and installation of light fixtures.
- D. Coordinate final light fixture locations in walk-in coolers and freezers with refrigeration coils and other trades.
- E. Wall-Mounted Light fixtures
 - 1. Coordinate all wall-mounted light fixtures with the architectural features of the building. Where specific elevations or dimensions are not indicated, verify the correct location with the Architect prior to beginning any work.

3.5 ADJUSTING

- A. Contractor shall adjust all light fixture sockets to match the lamp specified and aim all adjustable light fixtures as directed by the Architect.
- B. At the time of substantial completion, aim all track lights, flood lights, spot lights, and other fixtures requiring aiming per the Architect's direction. Contractor shall make provisions for supplying all scaffolds, lifts, and other tools and equipment as required.
- C. Where required, focusing shall be done during hours of darkness. Upon notification by contractor that all fixtures are correct as per shop drawings and functioning, that specified lamps have been verified, lighting designer or Architect shall coordinate with contractor as to a mutually agreed upon time to complete focusing. Failure of contractor to notify Architect during substantial completion will result in failure to comply with specifications.

3.6 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Clean light fixtures of dirt and debris upon completion of the installation. Protect installed light fixtures from damage during the remainder of the construction period.
- C. Upon completion of the installation of light fixtures, and after building circuits have been energized, energize lighting branch circuits to demonstrate capability and compliance with the requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- D. At the time of final acceptance of this project by the Owner, ensure that all lamps are in working order and all light fixtures are fully lamped.
- E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.7 STARTUP SERVICE

- A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.8 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
 - 1. Adjust aimable luminaires in the presence of Architect.

END OF DOCUMENT 265100

DOCUMENT 265600 - EXTERIOR AREA LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following lighting equipment:

1. Exterior light fixtures with lamps and ballasts.
2. Exterior LED light fixtures with LED modules and drivers.
3. Light fixture lowering devices.

1.2 SUBMITTALS

A. General:

1. Only those light fixtures and manufacturers per each fixture type designated and listed in the Light Fixture Schedule or on the Drawings, and approved in accordance with paragraph 1.4-SUBSTITUTIONS of this Section, or both, will be accepted. Where the Light Fixture Schedule indicates an allowance to be made for a specific light fixture, the price is a contractor price and monies shall be allotted for freight, installation, and lamping (if designated). Alternate manufacturers presented at bid shall be disqualified.
2. Submit all light fixtures, specified for use on this Project, in a single submittal package of portfolios, so that all light fixtures can be reviewed at one time.

B. Prepare portfolios from manufacturer's standard specification sheets, and include the number indicated on the Light Fixture Schedule to identify each light fixture. Do not combine more than one light fixture type on a single sheet.

1. Fixture or other materials shall not be shipped, stored, or installed into the work without approval of shop drawings.
2. Modifications to fixtures shall be in accordance with Architect's comments.

C. Product Data: For each light fixture, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Summary page with the following for each light fixture type
 - a. The number, type and wattage of the light fixture lamps or LEDs (including, but not limited to, assemblies, arrays, bars or modules).
 - b. Light fixture ballast, driver or auxiliary device manufacturer, number and type.
2. Fixture cut sheets with name of manufacturer and options to be provided marked, including, but not limited to, voltage, lensing, and finish/color.

- a. Descriptive information providing physical characteristics of light fixture, including, but not limited to, materials, dimensions, effective projected area, fixture efficacy and/or efficiency, and verification of indicated parameters.
 - b. For LED fixtures, include also L70 lifetime and wattage of luminaire including driver/power supply losses.
3. Light fixture mounting details, including, but not limited to, non-standard outlet boxes.
4. Construction of light fixture housing and door (if applicable).
5. Ballast cut sheet with options marked, providing physical description of ballast including, but not limited to, voltage, lamp, ballast factor, power factor, amperage and wattage.
 - a. For dimming ballasts, also include dimming type technology and dimming range/limits.
6. Power supply, transformer, and/or driver cut sheet with options marked, providing physical description of auxiliary device including, but not limited to, voltage, power factor, amperage, wattage, and maximum remote distance charts between device and light fixture.
 - a. For dimming LED, also include dimming type technology and dimming range/limits.
7. Lamp cut sheet with options marked, providing physical description of lamps, including, but not limited to, voltage, wattage, efficacy, CCT, CRI, lumens, and life expectancy.
 - a. For LED lamps, include also number of MacAdam ellipse steps and L70 lifetime.
8. Emergency ballast cut sheet: Descriptive cut sheets providing physical description of emergency ballasts for use in normal light fixtures, including, but not limited to, complete battery information, lumens, and method for testing per NFPA 101.
9. Photoelectric relays.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For light fixtures to include in operation and maintenance manuals.
- F. Warranty: Special warranties specified in this Section.

1.3 SUBSTITUTIONS

- A. Refer to Division 26 Section "General Electrical Requirements".
- B. Prior to the Bid Date, substitutions will not be considered unless the Architect/Engineer have received written request for approval at least ten calendar days prior to the date for receipt of Bids. Include in each such request the Light Fixture Schedule designation, name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including cut sheets, photometric data, and all other information necessary for an evaluation.

Provide interior point-by-point calculations if required by the Engineer. Submit a \$100.00 review fee to the Engineer with each such point-by-point calculation for use of electronic base files. The fee will be returned if the substitution is added to the specification.

C. During the Bid

1. Any proprietary, sole-sourced light fixture listed in the fixture schedule shall be unit priced only. Unit prices shall be clearly identified on the bid form.
2. Representative agents shall be allowed to offer mini-lot pricing (MLP). MLP shall be defined as:
 - a. Agents can group only specified fixtures they represent, and
 - b. Only represent in the region where the specification originated, and
 - c. Exclude all fixtures outside their represented lines from the MLP, and
 - d. Sole-sourced (proprietary) light fixtures shall not be included in the MLP.
3. Packaging of light fixtures will not be considered nor approved. Packaging is defined as: distributor(s) providing a single price for a light fixture package made up of specified and non-specified light fixtures. Any submittal package containing non-specified light fixtures or inclusion of lighting control systems will be immediately rejected in its entirety.

D. After the Bid Date, proposals to substitute light fixtures for those shown on the Drawings or specified herein, will only be considered as a deduct. Submit proposed substitutions separately, in Submittal form, with a list of proposed substitutions together with a deduct price for each substitution. Proposed substitutions will then be reviewed by the Architect/Engineer.

E. The Architect/Engineer have the final authority as to whether the light fixture is an acceptable replacement to the specified item. The proposed substitution may also be rejected for aesthetic reasons if felt necessary or desirable. In the event the proposed substitutions herein described are rejected, provide the specified item(s).

1.4 DEFINITIONS

- A. BF: Ballast factor.
- B. CCT: Correlated color temperature
- C. CFL: Compact Fluroescent
- D. CRI: Color-rendering index.
- E. CU: Coefficient of utilization.
- F. CV: Coefficient of Variance. The ratio of standard deviation for all illuminance values to the mean illuminance value.

- G. Delegated-Design Submittals: Documents, including, but not limited to, drawings, calculations, and material and product specifications prepared as a responsibility of Contractor to obtain acceptance by Owner and authorities having jurisdiction.
 - H. Horizontal Illuminance: Measurement in foot-candles (lux), on a horizontal surface 36 inches above the ground, unless otherwise indicated.
 - I. L70: minimum 70% maintained initial-rated lumens at average rated life for LEDs
 - J. LED: Light Emitting Diode
 - K. LED Lamp: Replaceable LED light source with an integral driver within envelope of lamp. Lamp/Base types may include MR16/bi-pin, PAR/medium base, etc.
 - L. LED Module: Light source that contains LEDs, and may include additional components such as lenses, reflectors, or refractors, however do not include drivers.
 - M. LER: Light fixture efficacy rating.
 - N. Light fixture: Complete light fixture, including ballast housing if provided.
 - O. LLD: Lamp Lumen Depreciation.
 - P. LLF: Light Loss Factor.
 - Q. Luminaire: Complete lighting fixture, including ballast housing if provided.
 - R. Pole: Light fixture support structure, including tower used for large area illumination.
 - S. Standard: Same definition as "Pole" above.
 - T. Target Illumination: Average maintained illumination level, calculated by multiplying initial illuminance by LLF.
 - U. UG: Uniformity Gradient; the rate of change of illuminance over a lighted area, expressed as a ratio between the illuminances of adjacent measuring points on a uniform grid.
 - V. Vertical Illuminance: Measurement in foot-candles (lux), in [two] [four] directions on a vertical surface, at an elevation coinciding with plane height of horizontal measurements.
- 1.5 QUALITY ASSURANCE
- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this project.
 - B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within <Insert number> miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
 - 1. Manufacturer's responsibilities include fabricating sports lighting and providing professional engineering services needed to assume engineering responsibility.

2. Engineering Responsibility: Preparation of delegated-design submittals and comprehensive engineering analysis by a qualified professional engineer.
- C. Light Fixture Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- D. Light Fixture Photometric Data Testing Laboratory Qualifications: 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.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Comply with IEEE C2, "National Electrical Safety Code."
- G. Comply with NFPA 70.

1.6 COORDINATION

- A. Unless otherwise noted, perform all electrical Work required for the proper installation and operation of equipment, furnishings, devices and systems specified in other Divisions of these Specifications, furnished under other contracts, and/or furnished by the Owner for installation under this Contract.

1.7 WARRANTY

- A. General Guarantee: For a period of one year after Owner's initial acceptance and establishment of the beginning date of the guarantee period, and at no cost to the Owner, Contractor shall promptly furnish and install replacements for any fixtures or components deemed by the Owner as defective in workmanship under normal operating conditions, excluding lamp replacement as noted in Section 1.12.A.1. Contractor shall repair installed equipment on the job site to Owner's satisfaction. For any time during said guarantee period that fixtures are not fully functional due to defects in material or workmanship, Contractor shall provide or pay for suitable temporary light fixtures, and shall remove said temporary fixtures upon installation of replacement elements. Contractor shall furthermore guarantee replacement fixtures for a period of one year following replacement.
- B. Contractor shall not be held responsible for damage of fixtures or equipment components occurring after the beginning of the guarantee period due to acts of vandalism, acts of war, or acts of God.
- C. LED Warranties: Shall be free from defects in materials and workmanship for the period indicated from date of factory shipment.
 1. LED Luminaires, including LED modules, arrays and drivers: Five years.
 2. LED Lamps: Three years.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch deep. Do not apply tools to section of pole to be installed below ground line.
- D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation.
- E. Retain factory-applied pole wrappings on metal poles until right before pole installation.
- F. Handle all poles with web fabric straps.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Additional light fixtures, poles, and accessories as scheduled on the Drawings.
- B. Where light fixtures are specified with tamper proof hardware, provide the Owner with three tools for each different type of hardware.

1.10 SPARES

- A. Furnish spare materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Glass and Plastic Lenses, Covers, and Other Optical Parts: 5 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Ballasts and/or Drivers: 2 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Globes and Guards: 2 for every 20 of each type and rating installed. Furnish at least one of each type.
 - 5. Fuses: 10 for every 100 of each type and rating installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In Light Fixture Schedule (on the drawings) where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 - 1. Basis-of-Design Product: The design for each light fixture is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified that meets or exceeds performance characteristics of the named product.
 - 2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 LIGHT FIXTURES, GENERAL REQUIREMENTS

- A. Light fixture models scheduled on the Drawings are to show the manufacturer, grade and style of light fixtures required. Regardless of the manufacturer's catalog number suffixes indicated, provide all options and features as described in the Light Fixture Schedule.
- B. Light fixtures shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- C. Comply with IES BUG ratings where indicated on the Light Fixture Schedule.
- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- F. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed light fixtures.
- G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- H. Exposed Hardware Material: Stainless steel for latches, fasteners, and hinges.
- I. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- J. Light Shields: Metal baffles or louvers, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- K. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
 2. Specular Surfaces: 83 percent.
 3. Diffusing Specular Surfaces: 75 percent.
- L. Gaskets for Lenses and Refractors: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in light fixture doors.
- M. Where located within structural concrete, light fixture housing and any other luminaire components in direct contact with concrete shall be effectively coated and/or covered to prevent chemical reactions with the concrete in accordance with the American Concrete Institute Code.
- N. Light Fixture Finish: Manufacturer's standard paint applied to factory-assembled and -tested light fixture before shipping. Where indicated, match finish process and color of pole or support materials.
- O. Factory-Applied Finish for Steel Light Fixtures: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As indicated on the Light Fixture Schedule.
- P. Factory-Applied Finish for Aluminum Light Fixtures: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

- a. Color: As indicated on the Light Fixture Schedule.

Q. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps, LEDs, ballasts and/or drivers. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp, LEDs, ballast and/or driver characteristics:

- a. "USES ONLY" and include specific lamp or LED type.
- b. Lamp diameter code (T-4, T-5, T-8), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
- c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
- d. LED type, wattage, beam angle (if applicable) for LED luminaires. Include maximum allowed wattage.
- e. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
- f. ANSI ballast type (M98, M57, etc.) for HID luminaires.
- g. For LED luminaires, includes CCT and CRI.

2.3 BALLASTS GENERAL

- A. General: Whenever possible, provide all ballasts by the same manufacturer for Owner's ease of maintenance. Ballasts by a different manufacturer may be acceptable where required to meet project requirements.
- B. Unless specific manufacturers and ballast types are called for in the Light Fixture Schedule, ballast provided for this project shall be manufactured by:

1. Fluorescent Ballasts (Linear and Compact Fluorescent)

- a. Non-Dim:
 - 1) Advance, a division of Philips – Optanium Series (linear) and SmartMate Series (CFL)
 - 2) Fulham (cold-temperature CFL)
 - 3) G.E.
 - 4) Osram/Sylvania
 - 5) Robertson (cold-temperature CFL)
 - 6) Universal

- b. Electronic
 - 1) Advance, a division of Philips
 - 2) Aromat
 - 3) Fulham
 - 4) Hatch

2.4 LAMPS GENERAL

- A. Unless specific manufacturers and lamp types are called for in the Light Fixture Schedule, all lamps provided for this project shall be by the same manufacturer. Lamps shall be manufactured by:
 - 1. Eiko
 - 2. General Electric
 - 3. Osram/Sylvania
 - 4. Philips
 - 5. Soraa
 - 6. Venture
- B. All lamps shall be new and shall be delivered to the project in manufacturer's original sealed package.
- C. Substitutions of specific lamp manufacturer as addressed in Fixture Schedule shall not be allowed. Costs associated with re-lamping due to non-compliance with specification, for both labor and material costs, shall be the sole responsibility of the contractor. For those fixtures with lamp included in fixture, contractor shall coordinate with manufacturer to ensure only approved lamp(s) is (are) installed. Lamp manufacturers indicated on Fixture Schedule are for reference. Where required, contractor shall coordinate with Owner regarding national purchasing agreement of specific lamp manufacturers. Purchasing of lamps, whether through competitive bidding of listed manufacturers or proprietary supply, shall be at the discretion of the Owner.

2.5 FLUORESCENT BALLASTS AND LAMPS

- A. Electronic Ballasts: Comply with UL 935 and ANSI C82.11; [instant][programmed]-start type, unless otherwise indicated, and designed for type and quantity of lamps served.
 - 1. High, efficiency, electronic type with NEMA premium label for linear lamps.
 - 2. Sound Rating: A.
 - 3. Total Harmonic Distortion Rating:
 - a. Linear: 10 percent or less.

- b. CFL: 20 percent or less.
- 4. Transient-Voltage Protection: Comply with IEEE C62.41 Category A or better.
- 5. Operating Frequency: 20kHz or higher.
- 6. Ballast Factor: Unless indicated otherwise in the Light fixture schedule, provide with normal ballast factor ballasts as follows:
 - a. CFL: Nominal 1.00
- 7. Power Factor: 0.95 or higher.
- 8. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
- 9. Ballasts for Low-Temperature Environments:
 - a. Temperatures 0 Deg F and Higher: Electronic type rated for 0 deg F starting and operating temperature with indicated lamp types.
 - b. Temperatures Minus 20 Deg F and Higher: Electronic type designed for use with indicated lamp types. Electronic type shall be for use with T8 lamps instant start, universal voltage 120V-277V, less than 10% THD, Class P and Type 1 Outdoor, with automatic-reset thermal protection.
- B. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures 0 deg F and higher.
- C. Fluorescent Lamps:
 - 1. Low-mercury type. Comply with the EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.
 - 2. Unless noted otherwise in the Light Fixture Schedule, color temperature shall be consistent for all lamps through project: 3500K CCT.

2.6 DRIVERS FOR LED LUMINAIRES

- A. Description: Designed for type and quantity of LED diodes of light fixture. Drivers shall tolerate sustained open circuit and short circuit output conditions without damage. Driver shall be designed for full light output unless dimmer or bi-level control is indicated:
 - 1. Sound Rating: A.
 - 2. Total Harmonic Distortion Rating: Less than 20 percent. Shall comply with ANSI C82.77.
 - 3. Transient Voltage Protection: IEEE C62.41, Category A or better.
 - 4. Power Factor: 0.90 or higher at full load.

5. Interference: Comply with 47 CFR, Chapter 1, Part 15, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
6. Driver shall operate with maximum sustained variations of +/- 10% input voltage and frequency with no damage to driver.
7. Driver output shall be regulated to +/- 5% published load range.
8. LED Current Crest Factor: 1.5 or less.
9. LED drivers shall not over-drive LEDs at a current or voltage above LED rated values in order to increase LED lumen output.
10. Meets EN610000 for input harmonics.
11. ROHS Compliant.
12. Suitable for use in outdoor light fixtures.
13. Dimming Drivers
 - a. Dimming Range: Visually flicker-free, strobe-free, continuous dimming of source as follows, unless specifically noted otherwise in the Light Fixture Schedule whichever is more stringent:
 - 1) Luminaires: 100 to 10 percent of rated lumens.
 - 2) LED Lamps: 100 to 20 percent of rated lumens.
 - b. 0-10V dimming drivers: Compliant with IEC 60929 standard for 4-wire dimming.
 - c. Compatibility: Certified by the manufacturer for use with specific dimming control system and LED indicated.
 - d. Control: Coordinate to ensure that the dimming driver, power supply, controller, dimming module, and/or wallbox dimmer and connecting wiring are compatible.

2.7 LED LAMPS AND LUMINAIRES

- A. Comply with ANSI C78.377 for white light LED color range. Unless noted otherwise in the Light Fixture Schedule, LED color quality characteristics shall be 70 CRI minimum and 4000K CCT. . All LEDs used for same fixture type throughout the project to originate from same production bin.
- B. LED binning specification tolerance to be within 3 MacAdam ellipses of rated values for color as indicated in the Light Fixture Schedule.
- C. Unless indicated otherwise in the Light Fixture Schedule, minimum 70% of maintained initial-rated lumens at the average rated life as follows:
 1. LED outdoor pole mounted area lights: 100,000 hours

2. LED lamps: 20,000 hours
3. Other LED luminaires: 50,000 hours

D. ROHS compliant

- E. Manufacturer of LED chips will be evaluated based on the manufacturer's product literature and data. At a minimum, LED fixtures or lamps will incorporate Bridgelux, Nichia, Cree, Xicato or Osram LEDs; additional manufacturers may be considered however the Architect or Engineer has the authority to reject other manufacturers for technical or aesthetic reasons if felt necessary or desirable.

2.8 AUXILIARY DEVICES FOR LOW VOLTAGE AND LED FIXTURES

- A. Provide remote power supplies, drivers and/or transformers for light fixtures as required for a complete and operational system.

2.9 LIGHT FIXTURE-MOUNTED PHOTOELECTRIC RELAYS

- A. Comply with UL 773 or UL 773A.
- B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay.
1. Relay with locking-type receptacle shall comply with NEMA C136.10.
 2. Adjustable window slide for adjusting on-off set points.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 EXAMINATION

- A. Verify conditions of equipment and installation prior to beginning work.
- B. Verify that equipment is ready for connecting, wiring, and energizing.

3.3 LIGHT FIXTURE INSTALLATION

- A. Install lamps in each light fixture.
- B. Fasten light fixture to indicated structural supports.
1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Adjust light fixtures that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

- D. Baffles and Louvers for Spill Light Correction: Install on lighting fixtures with fasteners provided by the manufacturer. Install and adjust to correct out-of-limit spill-light and glare measurements.
- E. Install controls and remote ballast or driver housings in cabinets mounted on support structure at least 10 feet above finished grade.
- F. Auxiliary devices for low voltage and LED fixtures installation
 - 1. Install device within maximum remote distances and with wiring sized per manufacturer's recommendations.
 - 2. In public areas or other areas where remote device visibility is undesirable, install device where concealed from view, well-ventilated and accessible. Provide access panels as required.
 - 3. Provide label on device indicating fixture type and location/room served along with panelboard circuit number.
 - 4. Properly support remote lighting devices, including, but not limited to, transformers, power supplies, and drivers, per Code and manufacturer's recommendations.
 - 5. Provide enclosures suitable for installation environment as required.

3.4 DIMMING

- A. For dimmable light fixtures, provide both control and power wiring between light fixture and control device and between light fixtures. Quantity of low voltage and line voltage wiring and wire type shall be per manufacturer's recommendations. At a minimum, provide the following based on control type at either 120V or 277V, unless recommended otherwise by the manufacturer:
 - 1. 0-10V – two low voltage conductors and two line voltage conductors plus ground
 - 2. 2-Wire dimming – two line voltage conductors plus ground
 - 3. 3-Wire dimming – three line voltage conductors (1 for control and two for power) plus ground
 - 4. DALI – two low voltage conductors and two line voltage conductors plus ground
 - 5. Proprietary digitally addressable – as required per the manufacturer
 - 6. DMX – two line voltage conductors plus ground and DMX cabling
- B. Coordinate light fixture and control device dimming types for compatibility.

3.5 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

- B. Steel Conduits: Comply with Division 26 Section "Raceways and Boxes for Electrical Systems", including use of coated conduits in concrete foundations.

3.6 GROUNDING

- A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole, unless otherwise indicated.
 - 2. Install grounding conductor pigtail in the base for connecting light fixture to grounding system.
- B. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole.
 - 2. Install grounding conductor and conductor protector.
 - 3. Ground metallic components of pole accessories and foundations.

3.7 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Adjust all light fixture sockets to match the lamp specified and aim all adjustable light fixtures as directed by the Architect.
- C. Upon completion of the installation of light fixtures, and after building circuits have been energized, apply electrical energy to demonstrate capability and compliance with the requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- D. Clean light fixtures of dirt and debris upon completion of the installation. Protect installed light fixtures from damage during the remainder of the construction period.
- E. At the time of Substantial Completion, aim all adjustable fixtures, such as flood and spot lights, per the Architect's direction. Provide all necessary equipment to support this effort, such as scaffolds and lifts, as required.
- F. At the time of Final Acceptance of this Project by the Owner, all lamps shall be in working order and all light fixtures shall be fully lamped.
- G. Illumination Observations: Verify normal operation of lighting units after installing light fixtures and energizing circuits with normal power source.
 - 1. Verify operation of photoelectric controls.
- H. Illumination Tests Areas other than Sports Playing Fields:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
 - a. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
 - b. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
 - c. IESNA LM-64, "Photometric Measurements of Parking Areas."
 - d. IESNA LM-72, "Directional Positioning of Photometric Data."

3.8 CORRECTION OF DEFICIENCIES

- A. Correction of Illumination Deficiencies: Make corrections to illumination quality or quantity measured in field quality-control tests that vary from specified illumination criteria by plus or minus 10 percent or more; add or replace lighting fixtures, or change mounting height, revise aiming, or install louvers, shields, or baffles. If lighting fixtures are added or mounting height is changed, revise aiming and recalculate and modify or replace support structures, if indicated. Retest as specified above after repairs, adjustments, or replacements are made. Report results in writing.
- B. Correction of Excessive Illumination in Spill-Light-critical Areas: If measurements indicate that specified limits for spill light are exceeded, make corrections to illumination quantity measured in field quality-control tests that reduce levels to within specified maximum values. Replace lighting fixtures, or change mounting heights, revise aiming, or install louvers, shields, or baffles. Obtain Architect's approval to replace luminaires with units of higher or lower wattage. If mounting height is changed, revise aiming and recalculate and modify or replace support structures, if indicated. Retest as specified above after repairs, adjustments, or replacements are made. Report results in writing.
- C. Exterior athletic lighting will be considered defective if it does not pass tests and inspections.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain light fixtures. Refer to Division 01 Section "Demonstration and Training."

END OF DOCUMENT 265600

DOCUMENT 270010 - GENERAL COMMUNICATIONS REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section and to all following sections within Division 27.

1.2 SECTION INCLUDES

- A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.
- B. Division 27 of these Specifications, and Drawings numbered with prefixes TN and/or TY, generally describe these systems, but the scope of the Communications Work includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical and Telecommunications Drawings and Specifications; and Addenda.
- C. Drawings are graphic representations of the Work upon which the Contract is based. They show the materials and their relationship to one another, including sizes, shapes, locations, and connections. They also convey the scope of Work, indicating the intended general arrangement of the equipment, fixtures, outlets and cabling without showing all of the exact details as to elevations, offsets, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.
- D. Specifications define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

1.3 ABBREVIATIONS AND ACRONYMS

- A. ADA Americans with Disabilities Act
- B. AFF Above Finished Floor
- C. AHJ Authority Having Jurisdiction
- D. ANSI American National Standards Institute
- E. ASTM American Society for Testing and Materials
- F. BICS Building Industry Consulting Service International

G.	ETL	Electrical Testing Laboratories, Inc.
H.	FCC	Federal Communications Commission
I.	FM	Factory Mutual
J.	GE	Grounding Equalizer
K.	IEEE	Institute of Electrical and Electronic Engineers
L.	LED	Light Emitting Diode
M.	NEC	National Electrical Code
N.	NESC	National Electrical Safety Code
O.	NEMA	National Electrical Manufacturers Association
P.	NFPA	National Fire Protection Association
Q.	NRTL	Nationally Recognized Testing Laboratory
R.	OEM	Original Equipment Manufacturer
S.	OFCI	Owner Furnished Contractor Installed
T.	OSHA	Occupational Safety and Health Administration
U.	OSP	Outside Plant
V.	RCDD	Registered Communications Distribution Designer
W.	TBB	Telecommunications Bonding Backbone
X.	TGB	Telecommunications Grounding Bus-bar
Y.	TIA	Telecommunications Industries Association
Z.	TMGB	Telecommunications Main Grounding Bus-bar
AA.	UL	Underwriters Laboratories
BB.	UON or UNO Unless Otherwise Noted	

1.4 DEFINITIONS

- A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:
1. AHJ - The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.

2. Approved Equivalents or Equal - For specific products, materials, equipment, or systems for which this Division specifically identifies the Contractor shall use as the basis for their bid. Where the term approved equivalent or equal is listed the contractor may submit documentation for review by the Design Consultant for approval. The Design Consultant's acceptance or rejection is final.
3. As Directed - means as directed by the Contract Administrator, or his representative.
4. Communications Room - means the location of a floor-serving facility for housing telecommunication equipment, cable terminations, and cross-connect wiring, as well as those for audio video systems and potentially other low-voltage systems such as security and fire alarm (electronic safety and security). This room is recognized in ANSI/TIA-569 as the transition point between the telecommunications horizontal (station) pathway facilities and the backbone (riser) pathway facilities.
5. Concealed - means embedded in masonry or other construction, installed behind wall furring or within drywall partitions, or installed within hung ceilings.
6. Conditionally Approved – the manufacturer has been found reputable by the design professional, but the design professional has not verified that the product offering by manufacturer meets to all specification requirements. Contractor shall adhere to submittal review process for final approval on products.
7. Contract Administrator: Where referenced in this Division, "Contract Administrator" is the primary liaison between the Owner and the Contractor. Specifically, for this project this is "the Owner's Representative"
8. Design Consultant - Where referenced in this Division, "Design Consultant" is the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Contract Administrator, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Design Professional, in addition to involvement by, and obligations to, the "Contract Administrator".
9. Furnish - "To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations."
10. Furnished by Owner (or Owner-Furnished) or Furnished by Others: "An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division.
11. Install - "To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use."
12. NRTL - Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having

Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTL's that are acceptable to the AHJ, and standards that meet the specified criteria.

13. Provide - "To furnish and install complete, and ready for the intended use." When 'furnish', 'install', 'perform', or 'provide' is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, "provide" is implied.
 14. Submit - means submit to Contract Administrator for review.
 15. Substitution - means a product meeting all requirements and specifications and having been approved by the Design Consultant to replace another product specifically identified herein.
 16. Wet Location - means a pathway that does not protect cables from moisture levels that are beyond the intended operating range of "inside" premises cable.
 - a. For example: Slab-on-grade construction where pathways are installed underground or in concrete slabs that are in direct contact with soil (e.g., sand and gravel) is considered a "wet location."
 - b. Also refer to the:
 - 1) Telecommunications Distribution Methods Manual (TDMM) for definitions of Wet locations
 17. (*) – Where appearing in product part or model numbers; shall represent wild card character to be filled in by the contractor to meet required specifications.
- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Design Consultant as equivalent to the item or manufacturer specified".
- C. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.
- D. The following definitions apply to excavation operations:
1. Additional Excavation: Where excavation has reached indicated sub-grade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
 2. Sub-base: as used in this Section refers to the compacted soil layer used in pavement systems between the sub-grade and the pavement base course material.
 3. Sub-grade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.

4. Unauthorized excavation consists of removal of materials beyond indicated sub-grade elevations or dimensions without specific direction from the Contract Administrator.

1.5 REFERENCE STANDARDS

- A. Execute all Work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the particular class of Work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes. Bring all conflicts observed between codes, ordinances, rules, regulations and these documents to the Contract Administrator's and Design Consultant's attention in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.
- B. If the conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Contract Administrator and Design Consultant, without additional compensation. Contractor will be held responsible for any violation of the law.
- C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.
- D. All material, manufacturing methods, handling, dimensions, methods of installation and test procedures shall conform to industry standards, acts, and codes, including, but not limited to the following, except where these Drawings and Specifications exceed them.
- E. The references to the following codes, references and standards represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts and their addenda. The Contractor is responsible for following the latest revision or printing (UON):
 1. ANSI/TIA-569 – "Commercial Building Standard for Telecommunications Pathways and Spaces"
 2. NFPA 70 – National Electrical Code (NEC)
 3. IEEE National Electrical Safety Code (NESC)
 4. Americans with Disabilities Act (ADA) of 1990, as amended

1.6 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with other Divisions for Communications work to be included but not listed in Division 27 or indicated on Communications Drawings.

- B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any Work covered by this Division.
- C. Refer to Communications Drawings and Divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Follow these drawings as closely as the actual construction and the work of other trades will permit. Provide all offsets, fittings, and accessories, required to clear equipment, beams and other structural members which may be required but not shown on the Drawings.
- D. Provide materials with trim that will fit properly the types of ceiling, wall, or floor finishes actually installed.
- E. Maintain a project manager, as specified by the Quality Assurance sections of these specifications, on the jobsite at all times to coordinate this Work with other trades so that various components of the Communications systems are installed at the proper time, fits the available space, allows proper service access to all equipment, and meets all required codes and standards.
- F. Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
- G. Carry on the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.
- H. Work of this Division shall progress according to the "Construction Schedule" as described in Division 01 and as approved by the Contract Administrator. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of all schedule dates.
- I. Examine and compare the Contract Drawings and Specifications with the Drawings and specifications of other trades, and report any discrepancies between them to the Contract Administrator and obtain written instructions for changes necessary in the work. Install and coordinate the work in cooperation with other related trades. Before installation, make proper provisions to avoid interferences.
- J. Before commencing work, examine adjoining work on which this work is in any way affected and report conditions, which prevent performance of the work. Become thoroughly familiar with actual existing conditions to which connections shall be made or which shall be changed or altered.
- K. In cases of doubt as to the work intended, or in the event of need for explanation, request supplementary instructions from the Contract Administrator.
- L. Measurements and Layouts: The Drawings are schematic in nature but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of

other trades, and by reviewing all Contract Documents. Correct, at no additional costs to the Owner, errors that could have been avoided by proper checking and inspection.

1.7 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to the requirements of individual Sections. Additionally, prepare coordination drawings as required scope of installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one trade.
1. Information shall be project specific and drawn accurately to a scale large enough to resolve conflicts. Do not base coordination drawings on standard dimensional data.
 2. Prepare floorplans, sections, elevations, and details as needed to adequately describe relationship of various systems and components.
 3. Clearly indicate functional and spatial relationships of components of all systems specified in the Contract Documents, including but not limited to: architectural, structural, civil, mechanical, electrical, fire protection, and specialty systems.
 4. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 5. Show location and size of access doors required for access to concealed equipment, fittings, controls, terminations, and cabling.
 6. Indicate required installation sequence to minimize conflicts between entities.
 7. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contract Administrator indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
 8. The details of the coordination are the responsibility of the Contractor and, where indicated on the Drawings, minor adjustments in raceway routing, device placement, device type, or equipment arrangement are not to be considered changes to the Contract.
- B. Equipment Room Coordination Drawings: In accordance with the submittal procedures outlined within these Specifications, provide dimensioned layouts of communications equipment locations within communications (telecom and AV) rooms, electrical rooms/closets, mechanical rooms, generator rooms, and fire pump rooms with equipment drawn to scale and identified therein.
1. Clearly identify all required working clearances and access provisions required for installation and maintenance.
 2. Equipment layouts should be arranged accounting for considerations for required door openings and the clearances required by the equipment manufacturer.

3. Indicate path to allow the future removal of each large piece of equipment (including but not limited to communications racks and cabinets) without removal of nonrelated equipment or architectural elements.
 4. Include work provided by others routed through the equipment rooms.
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
 2. BIM File Incorporation: Develop and incorporate coordination drawing files into Building Information Model established for Project.
 - a. Perform three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Indicate where conflict resolution requires modification of design requirements by Contract Administrator.
 3. Where the Engineer's digital data files are provided to the Contractor for use in preparing coordination digital data files, the Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to the Drawings or Specifications.
 4. Submit coordination drawings in accordance with the submittal procedures outlined within these Specifications.
- D. Refer to Coordination requirements in specific sections for additional information.

1.8 SUBMITTALS

- A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.
- B. Refer to Division 01 for acceptance of electronic submittals. If not specified by Division 01, provide electronic submittals. If Division 01 requires paper submittals, provide the quantity of submittals required, but no fewer than seven (7) sets.
- C. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Contract Administrator and Design Consultant that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, username and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator's and Design Consultant's designated representatives. Contractor shall allow for the Design Consultant Review Time as specified. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.
- D. Design Consultant Review Time: Transmit submittals as early as required to support the project schedule. Allow two weeks for Design Consultant review time plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.

- E. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.
- F. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in each individual Section. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- G. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.
- H. Unless noted otherwise within each individual section, submittals shall be provided for approval in four distinct phases:
 - 1. Pre-bid
 - a. Required no less than two weeks prior to the due date for the submission of bids, such as:
 - 1) Product substitutions, approved alternate or equivalent requests to be reviewed for approval (Prior to Bid)
 - 2) Alternate personnel credentials to be reviewed for approval
 - 3) And as required by individual sections in this Division
 - 2. Bid
 - a. Required at the time of the submission of bids, such as:
 - 1) Bid Response Forms
 - 2) Unit Pricing (if required by sections in this Division)
 - 3) Personnel Qualifications
 - 4) Contractor Qualifications (Previous project references)
 - 5) Voluntary Bid Alternates
 - 6) And as required by individual sections in this Division
 - 3. Pre-construction
 - a. Required after the award of the project to the winning bidder and prior to starting construction.

- b. Submit the following items no longer than four weeks after receiving the notice to proceed:
 - 1) Division of Labor amongst sub-contractors. Include:
 - a) Company Name
 - b) Address
 - c) Name of project manager for this project, including:
 - i) E-mail
 - ii) Telephone number
 - 2) Construction schedule showing important milestone dates and activities. Schedule shall be coordinated with overall project construction schedule.
 - 3) Updated Personnel and Contractor Qualifications where different from those submitted during the Bid phase.
 - 4) A typed list, indexed by Specification section, of products specifically identified by part number (no wild card characters) within each specification section in this Division. Products are to be listed in the same order as in the specification. List is to include length of manufacturer warranty for each product.
 - 5) Manufacturers' cut-sheets:
 - a) Cut-sheets are to be in the same order as in the specification sections.
 - b) At a minimum all cut-sheets shall contain the following:
 - i) Cross-reference to the specification section and/or drawings for which the product is to be reviewed for compliance and acceptance
 - ii) Every product cut-sheet submitted for review shall contain the manufacturers' name and logo somewhere on the page
 - iii) All parts, pieces, and equipment submitted for review shall be clearly identified by stamp, markup, or highlight in such a manner that the product(s) being submitted are clearly identifiable and distinguished from all other materials, parts, or equipment that may be on the submittal.
 - iv) For cut-sheets with accessories, additional parts, or derivations of the product being submitted, all shall be clearly identified for the reviewer and acceptance.
 - v) Sufficient detail for reviewer to identify all required information, such as size, weight, color, NRTL listings, approval or certification

information, and other necessary identifying information to confirm product meets specifications.

6) Samples – refer to individual sections for specific sample requirements.

a) Samples requested shall be physical examples that represent materials, equipment or workmanship and establish standards by which the work will be judged. Contractor or Manufacturer shall cover all associated fabrication and shipping costs.

c. Submit the following items sufficiently prior to installation of each respective portion of work:

1) Shop Drawings

a) Shall be furnished per the requirements of each Division 27 specification Section.

4. Project Completion

a. Required after the substantial completion but prior to final approval for completion, such as:

1) Record Drawings

2) Operation and Maintenance Data

3) Project test reports

4) Cable Databases (as applicable)

5) Warranty Certificate(s)

6) Lead Installer / Project manager letter with signature stating the project has been installed in accordance with referenced industry standards and contract documents.

7) And as required by individual sections in this Division

I. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

J. Refer to individual Sections for additional submittal requirements.

K. No part of the work shall be started in the shop or in the field until the shop drawings and /or samples for that portion of the work have been submitted and accepted.

L. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment

furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

M. Submittals shall contain the following information:

1. The project name.
2. The applicable specification section and paragraph.
3. Equipment identification acronym as used on the drawings.
4. The submittal date.
5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
6. Submittals not so identified will be returned to the Contractor without action.

N. The checking and subsequent acceptance by the Design Consultant and/or Contract Administrator of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Design Consultant and Contract Administrator prior to implementing any deviation.

1.9 SUBSTITUTIONS

- A. Refer to Division 1 and General Conditions for substitutions in addition to requirements specified herein.
- B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.
- D. Request for Substitution:
1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
 2. The burden of proof of the merit of the proposed substitution is upon the proposer.
 3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Contract Administrator, and Owner the following:
 - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.

- b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
- c. Proposed substitution has received necessary approvals of the Authorities Having Jurisdiction.
- d. Same warranty will be furnished for proposed substitution as for specified Work.
- e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
- f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

- 1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
- 2. No substitutions will be considered prior to receipt of bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of bids.
- 3. If the proposed substitution is approved prior to receipt of bids, such approval will be stated in an addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
- 4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.10 ELECTRONIC DRAWING FILES

- A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet.
- B. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form.
- C. Contact the Contract Administrator for written authorization.
- D. The following must be received before electronic drawing files will be sent:
 - 1. Contract Administrator's written authorization
 - 2. Engineer's release agreement form
 - 3. Payment

1.11 QUALITY ASSURANCE

- A. Execute all work under this Division in a thorough and professional manner by competent and experienced workmen duly trained to perform the work specified.
- B. Install all work in strict conformance with all manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.
- C. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Provide all material and equipment of the same type from the same manufacturer whenever practicable.
- D. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.

1.12 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 1 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.
- B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.
- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Prior to Substantial Completion of the project, furnish to the Contract Administrator, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.
- E. Each manual shall contain equipment data, approved submittals, shop drawings, diagrams, capacities, spare part numbers, manufacturer service and maintenance data, warranties and guarantees.
- F. Refer to Division 1 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Contract Administrator and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives.

1.13 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections of this Division.

1.14 RECORD DRAWINGS

- A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.
- B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.
- C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Contract Administrator.

1.15 DELIVERY, STORAGE AND HANDLING

- A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.
- B. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Contract Administrator.
- D. Be responsible for the safe storage of tools, material and equipment.

1.16 WARRANTIES

- A. Refer to Division 01 and General Conditions for Warranties in addition to requirements specified herein.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- C. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific

items are noted to carry a longer warranty in these Construction Documents or manufacturer's standard warranty exceeds 12 months. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions and Division 01.

- D. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.
- E. Perform the remedial work promptly, upon written notice from the Contract Administrator or Owner.
- F. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.17 TEMPORARY FACILITIES

- A. Refer to Division 1 and General Conditions for Temporary Facilities requirements.
- B. Temporary Utilities: The types of services required include, but are not limited to, electricity, telephone, and internet. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

1.18 FIELD CONDITIONS

- A. Conditions Affecting Excavations: The following project conditions apply:
 - 1. Maintain and protect existing building services that transit the area affected by selective demolition.
 - 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
- B. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.
- C. Use of explosives is not permitted.
- D. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits specified by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 EXISTING CONDITIONS

- A. Existing conditions indicated on the Drawings are taken from the best information available from the Owner, existing record drawings, and from limited, in-situ, visual site observations; and, they are not to be construed as "AS BUILT" conditions. The information is shown to help establish the extent of the new Work.
- B. Verify all actual existing conditions at the project site and perform the Work as required to meet the existing conditions and the intent of the Work indicated.

3.3 EXISTING UTILITIES

- A. Existing utility services not specifically indicated to be removed or altered shall remain as they presently exist.
- B. Where existing services interfere with demolition or construction, alter or reroute such existing equipment to facilitate demolition or construction after obtaining written permission from the Contract Administrator. Notify in writing giving two weeks advance notice or planned alteration prior to altering any existing condition is required.
- C. Schedule and coordinate with the utility company, Owner and with the Contract Administrator all connections to, relocation of, or discontinuation of normal services from any existing service provider line. Include all premium time required for all such work in the Bid.
- D. Preserve continuity of service of existing facilities (related to damage or alteration due to new construction). Unauthorized alteration to existing equipment shall be corrected without additional cost to the Owner.
- E. Repair all existing utilities damaged due to construction operations to the satisfaction of the Owner or Utility Company without additional cost.
- F. Do not leave utilities disconnected at the end of a workday or over a weekend unless authorized by representatives of the Owner or Contract Administrator.
- G. Make repairs and restoration of utilities before workmen leave the project at the end of the workday in which the interruption takes place.
- H. Include in Bid the cost of furnishing temporary facilities to provide all services during interruption of normal utility service.

3.4 EXAMINATION OF SITE

- A. Prior to the submitting of bids, visit the project site and become familiar with all conditions affecting the proposed installation and make provisions as to the cost thereof.
- B. The Contract Documents do not make representations regarding the character or extent of the sub-soils, water levels, existing structural, mechanical, electrical, communications, and Electronic Safety and Security installations, above or below ground, or other sub-surface

conditions which may be encountered during the work. Evaluate existing conditions, which may affect methods or cost of performing the work, based on examination of the site or other information. Failure to examine the Drawings or other information does not relieve the Contractor of responsibility for satisfactory completion of the work.

3.5 WORK IN EXISTING FACILITIES

- A. The Drawings describe the general nature of remodeling to the existing facilities; however, visit the Site prior to submitting a Bid, to determine the nature and extent of Work involved.
- B. Schedule Work in the existing facility with the Owner.
- C. Certain demolition work shall be performed prior to the remodeling. Perform the demolition that involves communications systems, conduit, wiring, equipment, equipment supports or foundations and materials.
- D. Remove all of these articles that are not required for the new Work. Unless otherwise indicated, each item removed during this demolition shall be removed from the premises and disposed of in accordance with all state and local regulations.
- E. Interruption of Existing Communications Service: Do not interrupt communication service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary communication service according to requirements indicated:
 - 1. Notify Contract Administrator and the Owner no fewer than 7 days in advance of proposed interruption of communication service.
 - 2. Do not proceed with interruption of communication service without Contract Administrator and the Owner's written permission.
 - 3. Owner reserves the right to require Contractor to cease work in any area Owner requires access to on an emergency basis.
- F. Reconnect communication circuits serving equipment required to remain in service to other cable termination fields, patch panels or splices as indicated on the Drawings or as appropriate. Provide additional cable and termination hardware where there is insufficient available capacity in remaining existing equipment for reconnection.
- G. Relocate and reconnect all communications facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where communications devices or equipment are removed, cap all unused raceways behind the floor line or wall line to facilitate restoration of finish, and, remove all existing wiring from abandoned raceways.
- H. Finish materials are specified in other divisions.
- I. Where removal of existing wiring interrupts continuity of communication circuits that are to remain in use, provide necessary wiring, raceways, junction boxes, etc., to ensure continued communication continuity.

- J. Channel walls and floors as required to produce the desired result; however, obtain permission from the Contract Administrator for all channeling not specifically noted on the Drawings.

3.6 PERMITS AND FEES

- A. Secure and Pay all required fees and obtain all required permits related to the Communications Infrastructure installation.
- B. Pay royalties or fees in connection with the use of patented devices and systems.

3.7 SELECTIVE DEMOLITION

- A. Refer to Division 01, Division 02, and General Conditions for Selective Demolition requirements.
- B. General: Demolish, remove, demount, and disconnect abandoned communications materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- C. Materials and Equipment to Be Salvaged:
 - 1. Communications Infrastructure equipment to be removed that is in good working order shall be carefully removed and offered to the Owner. Items rejected by the Owner shall be removed from the project site and legally and properly disposed of.
 - 2. Remove, demount, and disconnect existing communications materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
- D. Remove existing conduit and wire back to the Communications Equipment room, unless a specific extent of removal is indicated on the Drawings.
- E. Communications Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
 - 1. Inactive and obsolete raceways, fittings, supports and specialties, equipment, wiring, controls, fixtures, and insulation:
 - a. Raceways and outlets embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Cut embedded raceways to below finished surfaces, seal, and refinish surfaces as specified or as indicated on the Architectural Finish Drawings. Remove materials above accessible ceilings. Cap raceways allowed to remain.
 - b. Perform cutting and patching required for demolition in accordance with Division 01, General Conditions and "Cutting and Patching" portion of this Section in Division 27.

3.8 ACCESS TO EQUIPMENT

- A. Locate all pull boxes, junction boxes and controls so as to provide easy access for operation, service inspection and maintenance. Provide an access door where equipment or devices are located above inaccessible ceilings. Refer to Division 26 Section "Common Work Results for Electrical".

- B. Maintain all code required clearances and clearances required by manufacturers.

3.9 PENETRATIONS

- A. Unless otherwise noted as being provided under other divisions, provide sleeves, box frames, or both, for openings in floors, walls, partitions and ceilings for all electrical work that passes through construction. Refer to Division 27 Section "Common Work Results for Communications".
- B. Provide sleeves, box frames, or both, for all conduit, cable, and cable trays that pass through masonry, concrete or block walls.
- C. The cutting of new and/or existing construction will not be permitted except by written approval of the Contract Administrator.

3.10 EXCAVATION AND BACKFILLING

- A. Refer to Division 01, Division 02 and General Conditions for Excavation and Backfilling in addition to the requirements specified herein.
- B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this division. Excavation shall be in conformance with applicable Divisions and sections of the Specifications.
- C. Restore roads, alleys, streets and sidewalks damaged during this work to the satisfaction of Authorities Having Jurisdiction.
- D. Do not excavate trenches close to walks or columns without prior consultation with the Contract Administrator.
- E. Erect barricades around excavations, for safety, and place an adequate number of amber lights on or near the work and keep those burning from dusk to dawn. Be responsible for all damage that any parties may sustain in consequence of neglecting the necessary precautions in prosecuting the work.
- F. Slope sides of excavations to comply with local, state and federal codes and ordinances. Shore and brace as required for stability of excavation.
- G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
 - 1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.
- H. Install sediment and erosion control measures in accordance with local codes and ordinances.
- I. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
 2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.
- J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.
1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
 2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.
- K. Excavation for Underground Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.
1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of one inch in diameter and larger with emulsified asphalt tree paint.
 2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- L. Trenching: Excavate trenches for electrical installations as follows:
1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of six to nine inches clearance on both sides of raceway and cables.
 2. Excavate trenches to depth indicated or required for raceway and cables to establish slope, away from buildings and indicated elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.
 3. Limit the length of open trench to that in which raceway and cables can be installed, tested, and the trench backfilled within the same day.
 4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceway and cables. Provide a minimum of six inches of stone or gravel cushion between rock bearing surface and raceway and cables.
 5. Excavate trenches for raceway, cables, and equipment with bottoms of trench to accurate elevations for support of raceway and cables on undisturbed soil.

- M. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.
- N. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.
 - 1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
 - 2. Under building slabs, use drainage fill materials.
 - 3. Under raceway and cables, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
 - 4. For raceway and cables less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support. After installation and testing of raceway and cables, provide a 4-inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.
 - 5. Other areas use excavated or borrowed materials.
- O. Backfill excavations as promptly as work permits, but not until completion of the following:
 - 1. Inspection, testing, approval, and locations of underground utilities have been recorded.
 - 2. Removal of concrete formwork.
 - 3. Removal of shoring and bracing, and backfilling of voids.
 - 4. Removal of trash and debris.
- P. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
 - 1. For vertical and diagonal raceway installations, thoroughly support raceways from permanent structures or undisturbed earth at no less than 10-foot intervals, while placing backfill materials, so that raceways are not deflected, crushed, broken, or otherwise damaged by the backfill placement.
- Q. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- R. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.
- S. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below:

1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).
 - a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - c. Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.
 2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.
- T. Subsidence: Where subsidence occurs at mechanical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.
- 3.11 CUTTING AND PATCHING
- A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.
 - B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.
 - C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.
 - D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.
 - E. Patch around openings to match adjacent construction, including fire ratings, if applicable.
 - F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

3.12 PAINTING

- A. Refer to Division 09 Section "Painting" for painting requirements.
- B. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under individual sections and Division 09 of the Specifications; colors shall be as selected by the Contract Administrator.
- C. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.
- D. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.
- E. Where factory finishes are provided and no additional field painting is specified, touch up or refinish, as required by, and to the acceptance of, the Contract Administrator, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Contract Administrator, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.

3.13 CLEANING

- A. Remove dirt and refuse, resulting from the performance of the Work, from the premises as required to prevent accumulation. Cooperate in maintaining reasonably clean premises at all times.
- B. Immediately prior to final inspection, make a final cleanup of dirt and refuse resulting from Work and assist in making the premises vacuum clean. Clean all material and equipment installed under this Division.
- C. Remove dirt, dust, plaster, stains, and foreign matter from all surfaces.
- D. Touch up and restore damaged finishes to their original condition.
- E. All communications equipment shall be thoroughly vacuumed and wiped clean prior to startup and at the completion of the project. Equipment shall be opened for observation as required.

3.14 ADJUSTING, ALIGNING AND TESTING

- A. Adjust, align and test all equipment furnished and/or installed under this Division.
- B. Check and test protective devices for specified and required application, and adjust as required.
- C. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.
- D. Notify the Contract Administrator immediately of all operational failures caused by defective material, labor or both.
- E. Refer to individual Sections for additional and specific requirements.

3.15 START-UP OF SYSTEMS

- A. Prior to start-up of each system, check all components and devices to confirm compliance with manufacturers' recommended installation procedures.
- B. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.
- C. Refer to individual Sections for additional and specific requirements.

3.16 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:
 - 1. Submit results of systems tests and adjustments per each individual section.
 - 2. Submit complete Operation and Maintenance Data.
 - 3. Submit complete Record Drawings.
 - 4. Perform all required training of Owner's personnel.
 - 5. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.
 - 6. Perform start-up tests of all systems.
 - 7. Remove all temporary facilities from the site.
 - 8. Comply with all requirements for Substantial Completion in the Division 1 and General Conditions.
- B. Request in writing a review for Substantial Completion and scheduling of final acceptance. Provide a minimum of five (5) business days notice prior to the review for project sites within a 4-hour drive from the office where the design was created; provide a minimum of eight (8) business days notice for sites beyond a 4-hour drive.
- C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Contract Administrator will either proceed with the review or advise the Contractor of unfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, then provide reimbursement to the Contract Administrator and Design Consultant for time and expenses incurred for the visit.
- F. Upon completion of the review, the Contract Administrator and Design Consultant will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.

- G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.
- H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

3.17 EARLY OCCUPANCY

- A. Failure to meet the Substantial Completion date can result in the Owner needing to take early occupancy. Complete the systems which are necessary to allow partial early occupancy of the building by original Substantial Completion date.
 - 1. Refer to individual sections for additional requirements.
- B. Verify and comply with requirements for temporary occupancy with the local Building and Fire Departments.

END OF DOCUMENT 270010

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER

Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

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

Reason for not providing specified item: _____

Similar Installation:

Project: _____ Architect: _____

Address: _____ Owner: _____

Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

- ▲ A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
- B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
- C. Proposed substitution does not affect dimensions and functional clearances.
- D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
- E. Same warranty will be furnished for proposed substitution as for specified Work.
- F. Same maintenance service and source of replacement parts, as applicable, is available.
- G. Proposed substitution will not adversely affect other trades or delay construction schedule.
- H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

_____ Submitting Contractor	_____ Date	_____ Company
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Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

_____ Manufacturer's Representative	_____ Date	_____ Company
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Engineer Review and Recommendation Section

Recommend Acceptance	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Additional Comments:	<input type="checkbox"/> Attached	<input type="checkbox"/> None

Acceptance Section:

_____ Contractor Acceptance Signature	_____ Date	_____ Company
_____ Owner Acceptance Signature	_____ Date	_____ Company
_____ Architect Acceptance Signature	_____ Date	_____ Company
_____ Engineer Acceptance Signature	_____ Date	_____ Company

DOCUMENT 270500 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This Section includes general construction materials and methods, communications equipment coordination, and common communications installation requirements for Division 27 systems as follows:
 - 1. Grounding and Bonding for Communications
 - 2. Pathways for communications systems.
 - a. Cable Supports
 - b. Conduit
 - c. Surface Raceways
 - d. Outlet Boxes
 - e. Floor Boxes and Poke Throughs
 - f. Pull Boxes
 - g. Cable Tray
 - 3. Firestopping Systems
 - 4. Access Panels
 - 5. Identification

1.2 RELATED REQUIREMENTS

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in the following Sections: 27 Section "General Communications Requirements"
- B. Division 07 Section "Penetration Firestopping" for fire stopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
- C. Division 26 for reference regarding materials and methods for additional requirements.
- D. Division 27 "General Communications Requirements"

1.3 DEFINITIONS

- A. ASTM - American Society for Testing and Materials
- B. AV – Audio Video

- C. Cable Tray System – A unit or assembly of units or sections and associated fittings forming a structural system used to securely fasten or support cables and raceways.
- D. Common Work – all Work specified in this section.
- E. Conduit Body – A separate portion of a conduit or tubing system that provides access through a removeable cover(s) to the interior of the system at a junction of two or more sections of the system or at a terminal point of the system. Boxes such as FS and FD or larger cast or sheet metal boxes are not classified as conduit bodies.
- F. Conveniently Accessible – Capable of being reached from the floor or via the use of an 8 foot step ladder without crawling or climbing over or under obstacles such as piping, duct work, motors, transformers, pumps, etc.
- G. Firestopping System – Firestopping products that have been specifically tested and rated by a Nationally Recognized Testing Laboratory (NRTL), such as UL, to provide the required flame (F), fire and temperature (T), air and smoke (L), and water (W) containment for a given partition/penetration.
- H. Floor Box Assembly (Floor Box) – An on-grade solution or above grade (with a native fire classification or in combination with an approved Firestopping System) solution for in-floor terminations. The Assembly consists of pour pan (as applicable), Firestopping System (as applicable), floor box (compartment), plate mounting brackets, line voltage divider plates, termination plates, termination connectors, electrical receptacle(s), gang plates (termination cover plates), and access door / cover / lid.
- I. FM – Factory Mutual
- J. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.
- K. IMC – Intermediate Metal Conduit
- L. NEMA – National Electrical Manufacturers Association
- M. Plenum – A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
- N. Plenum-rated – A product that is listed by a NRTL as being suitable for installation into a plenum space.
- O. Point of Entrance (Building Entrance) – The point within a building where the Outside Plant (OSP) communications cabling emerges from an external wall, a concrete floor slab, or IMC/RMC. If Communications Point of Entrance isn't identified on the drawings, assume the Main Communications (MDF) also acts as the Point of Entrance.
- P. Poke Through Assembly (Poke-Thru) – An above grade solution with a native fire classification for in-floor terminations. The Assembly consists of pre-pour sleeve (as applicable), Firestopping System, fire resistant conduit stub, poke thru (compartment), plate mounting brackets, line

voltage divider plates, termination plates, termination connectors, electrical receptacle(s), gang plates (termination cover plates, as applicable), and access door / cover / lid.

Q. Quality Control Specialist – as it pertains to Work within this section, Quality Control Specialist is either the Project RCDD, as defined in Division 27 Section “Structured Cabling System”, for Common Work for Telecommunications or the Project AVIXA CTS-I, as defined in Division 27 Section “Audio Video Systems”, for Common Work for AV.

R. RMC – Rigid Metal Conduit

S. Surface Metal Raceway – A metallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.

T. Surface Nonmetallic Raceway – A nonmetallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.

U. UL – Underwriters Laboratory

1.4 REFERENCE STANDARDS

A. Follow all applicable codes, references, guidelines, and standards listed in Division 27 Section “General Communications Requirements”.

B. Follow the additional codes, references, standards and guidelines:

1. NEMA VE 1-2017 – “Metallic Cable Tray Systems”
2. NEMA VE 2-2013 with 2016 Corrections – “Cable Tray Installation Guidelines”
3. ASTM E 814 and ANSI/UL1479 – “Fire Tests Through Penetration Firestops”
4. ASTM E 84 and ANSI/UL 723 “Surface Burning Characteristics of Building Materials”
5. ASTM E 119 and ANSI/UL 263 “Fire Tests of Building Construction Materials”

1.5 ADMINISTRATIVE REQUIREMENTS

A. Adjust location of conduits, terminal blocks, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication:

1. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
2. Provide offsets, transitions and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.

3. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.
 - B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
 - C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed.
- 1.6 SUBMITTALS
- A. Follow the requirements for submittals in Division 27 Section "General Communications Requirements".
 - B. Bid Submittal
 1. Contractor Qualifications for Firestopping Systems: Provide copies of training/certification as required in the Quality Assurance portion of this specification section.
 - C. Pre-construction Submittal
 1. Manufacturers' cut sheets or catalog cut sheets of each of the pathways not specifically identified by its exact part number:
 - a. In addition to Division 27 Section "General Communications Requirements", include the following:
 - 1) Size – including physical and loading dimensions
 - 2) Maximum span length
 - 3) Weight supported
 - 4) Type
 - 5) Fittings to be used
 - 6) Method of attachment to structure
 - 7) Firestop system assembly information for each system to be installed:
 - a) Documentation from UL catalog for each system proposed. This documentation shall include the following information:
 - i) Firestop manufacturer
 - ii) UL system number
 - iii) F, T, and L Ratings
 - iv) The complete description of the firestop system; To include what specific construction the system is intended to pass through such

as a wall or floor assembly, the penetrating items allowed to pass through the opening in the wall or floor assembly, and the materials designed to prevent the spread of fire through the openings.

- 8) As well as any additional information required by individual sections of this Division

2. Shop Drawings

- a. Submit for review scaled layout drawings showing the size/routing of all pathways and the size/information/locations of all boxes, pullboxes, firestopping systems, and access panels.
 - 1) Each pathway shall be identified by type and size on the drawings.
 - a) Example #1: 4" EMT
 - b) Example #2: 4" x 12" Cable Tray
 - 2) Each grounding conductor shall be identified by size (and insulation):
 - a) Example: #3/0 insulated ground
 - 3) Each firestop system shall be identified by Manufacturer and Product, as well as UL system number for that particular location.
 - a) Example #1 – Firestopping Sleeve:
EZ-Path Series 22, UL System W-L-3255
 - b) Example #2 – Backbox in Fire-Rated Wall:
Specseal Power Shield, UL System QCSN/CLIV.R14288
 - 4) Each pullbox and access panel shall be identified by size and height above finished floor.
 - a) Pullbox Example: Pullbox 8" x 24" x 40" approximately 12' AFF.
- b. Unless otherwise required by these specifications, it is permissible to show pathways systems (conduit, cable tray, auxiliary supports, etc.) on the same shop drawing along with the cabling and system work to be installed through those pathways.
 - 1) Division 271000 "Structured Cabling System" and Division 274100 "Audio Video Systems" and their individual pathways shall be separate shop drawings; shared pathways such as cable tray shall be shown on both shop drawings.

D. Project Completion Submittal

1. Record Drawings:

- a. The Quality Control Specialist shall review the installation and Record Drawings for the Common Work Results required for their scope of work and shall stamp the final Record Drawings with their RCDD or CTS-I stamp before submission. By stamping the Record Drawings, the Quality Control Specialist indicates that the Common Work Results have been installed per the Contract Documents and all associated codes, standards, and guidelines, and all changes to the drawings have been incorporated into the Record Drawings.
 2. Pictures of each Firestopping System (with visible label).
- 1.7 QUALITY ASSURANCE
- A. Submittals and Shop Drawings for all Common Work Results specified in this section shall, if not created by, be reviewed by the Quality Control Specialist.
 1. The Quality Control Specialist shall stamp all relevant submittals for their associated Division 27 sections, which indicates that at a minimum the proposed work has been reviewed by them and found to be in compliance in regards to:
 - a. All applicable codes and industry standards and guidelines referenced in Division 27.
 - b. Being fully-coordinated with all other trades and to be installed per the Construction Documents.
 - c. And installed per manufacturer's direction.
 - B. The Quality Control Specialist shall also make weekly inspections during construction to ensure all work installed per this section is correct.
 1. Any deficiencies encountered prior to and during installation shall be corrected by the installing contractor under the direction of the Quality Control Specialist and/or the Design Consultant.
 - C. Firestopping Systems
 1. Firestopping material and systems shall be tested and listed by UL. All firestopping products shall bear this classification marking.
 2. Installation technicians shall be by qualified and trained personnel. Acceptable installer qualifications are as follows:
 - a. FM Research, approved in accordance with FM AS 4991.
 - b. Individuals who are trained and certified by the firestopping manufacturer. For Specified Technologies, all installers shall have current FIT Level 1 certification.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING FOR COMMUNICATIONS

- A. Refer to drawings and Division 27 Sections for exact grounding and bonding requirements.

2.2 PATHWAYS FOR COMMUNICATIONS SYSTEMS

A. General

1. All non-continuous cable supports shall be designed to prevent degradation of cable performance and pinch points that could damage cable
2. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
3. Telecommunications pathways shall be routed back to serving Communications Room. Refer to Drawings for additional information.

B. Cable Supports

1. The following manufacturers are Conditionally Approved.
 - a. Cooper/B-Line
 - b. Hilti
 - c. Monosystems
 - d. nVent Caddy
 - e. Panduit
 - f. Snake Tray
 - g. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)
2. Metal Hook Supports ("J-hooks")
 - a. Specifications
 - 1) Have a flat bottom and sufficient width to comply with the minimum bend radius of all cabling as required by the referenced standards and manufacturers recommendations.
 - 2) Be open for easy lay-in and removal of cabling
 - 3) Be designed so the mounting hardware is recessed to prevent cable damage
 - 4) Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3
 - 5) Cable hooks for corrosive areas shall be stainless steel, AISI Type 304
 - 6) Be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet job conditions

- 7) Be factory assembled multi-tiered cable hooks shall be used where required to provide separate cabling compartments, or where additional capacity is needed
 - b. Cable hooks for installation above ceilings shall be
 - 1) B-Line series BCH21, BCH32, BCH64
 - 2) Caddy CABLE-CAT 21 or 32 series hangers
 - 3) Or equivalent from Conditionally Approved manufacturer
- 3. Fabric Saddle Supports
 - a. Specifications
 - 1) Suitable for air handling spaces (plenum)
 - 2) Adjustable strap allows for multiple support sizes to reduce inventory.
 - b. Cable supports for installation above ceilings shall be
 - 1) nVent CADDY CAT 425, 425A6
 - 2) Arlington Fittings TL20P, TL25P, TL50P

C. Conduit

- 1. Specifications
 - a. Refer to Electrical Division 26 for specific product and material information.
 - 1) Sizes, methods, and more stringent requirements shall be adhered to when specified in this Division.
 - b. Conduits provided as connection to incoming services, utilities, including private services to other buildings or outside connection points shall be rigid metal or intermediate metal conduit at the point it enters the building, emerges from an exterior wall or ground floor slab to the final termination/transition point.
 - c. If services enter a room or space such as a mechanical room, electrical room or other intermediate room due to convenience or proximity to the exterior and adequate space has not been provided within 50 feet (15.3 m) for the equipment needed for transitioning these and future cables/services to an appropriately rated indoor cable then those conduits shall be continued uninterrupted (except for necessary pull boxes) to the final connection point or location where the transition point has been designated. Generally this connection point will be a designated Entrance Room for Communications or the Main Telecommunication space. If space has not been identified the contractor shall request information prior to bid.
 - d. Follow Electrical Division 26 for conduits underground, in slab or anywhere not within the building.

- e. Provide conduit as indicated on the Drawings or required by this Specification. Minimum conduit size shall be 1 inch (25.4 mm) for structured cabling. Provide a polypropylene or monofilament plastic line with not less than 200-lb (90.7 kg) tensile strength in each empty conduit. Permanently mark or tag each conduit or pull box, identifying it as communications (Telecom), AV, TV, Broadcast, Intercom, etc.), at intervals of not more than 75 feet (22.9 m). Each conduit that is stubbed into the ceiling space from an outlet box shall be permanently marked or tagged; refer to Labeling requirements in Section 3 – Execution.
- f. Route an empty conduit from each outlet box into the ceiling space above and terminate with a nylon bushing. In rooms with a non-accessible ceiling, route conduits to the nearest accessible corridor ceiling or communications space.

<u>Number of Structured Cabling Outlets/Connectors</u>	<u>Conduit Size</u>
Up to 4	1 inch (25.4 mm)
Up to 9	1-1/4 inch (31.8 mm)

D. Acoustical Pathway

1. Specifications

- a. For use in non-rated walls only.
- b. For use in place of conduit sleeves through walls of noise critical spaces.
- c. Plenum Rated (to UL2043)
- d. Sound Transmission Classification (STC) as tested per ASTM E90 shall be greater than 60.

2. Manufacturer shall be:

- a. Hilti CS-SL SA
- b. Specified Technologies, Inc. - NEZ33

E. Surface Raceways

1. The following manufacturers are Conditionally Approved.

- a. Surface Metal Raceways
 - 1) Hubbell
 - 2) Legrand/Wiremold
 - 3) Mono-Systems Inc.
 - 4) Panduit

- 5) Or Approved Substitution (submitted and accepted in the “pre-bid” phase)
- b. Surface Nonmetallic Raceways
 - 1) Hubbell
 - 2) Legrand/Wiremold
 - 3) Mono-Systems Inc.
 - 4) Panduit
 - 5) Or Approved Substitution (submitted and accepted in the “pre-bid” phase)
- 2. Specifications
 - a. Refer to Electrical Division 26 for specific product and material information.
 - 1) Where a conflict exists between Division 26 and Division 27 the more stringent requirements shall apply.
 - b. Raceways shall be sized per the quantity and size of the installed cables, plus 50% spare capacity. Minimum cross-sectional area shall be 1 inch.
 - c. Single gang and double gang surface boxes shall be a minimum of 2-1/2 inches deep.
 - d. Color shall be as directed by the Architect.
- 3. Manufacturer shall be:
 - a. Submit product cutsheet(s) from Conditionally Approved manufacturer listed above.

F. Outlet Boxes

- 1. Specifications
 - a. Boxes shall either be square or rectangular, as noted on the drawings. Dimensions indicate minimum size.
 - b. Telecommunications – for outlets shown on T or TN series drawings:
 - 1) For stud walls: dual-gang outlet box shall be a minimum size of 4-11/16 inches (119.1 mm) width by 4-11/16 inches (119.1 mm) height by 2-1/8 inches (54 mm) depth, with a dual-gang or single-gang raised cover/extension ring (as indicated on the drawings) a minimum of 3/8” deep. Depth shall match that of wall gypsum board(s).
 - a) Double gang – RACO 258/259 (Coordinate knock-out size with conduit size indicated on drawings); or
 - b) RANDL T-55017; or

- c) Or equivalent from
 - i) Emerson/Appleton
 - ii) Thomas & Betts/Steel City
 - iii) Approved Substitution
- 2) For ceilings (flush or above accessible ceiling): plenum-rated, dual-gang outlet box shall be a minimum size of 4 inches (101.6 mm) width by 4 inches (101.6 mm) height by 2-1/8 inches (54 mm) depth, with a dual-gang or single-gang raised cover/extension ring (as indicated on the drawings) a minimum of 3/8" deep. Depth shall match thickness of gypsum ceiling board(s) or accessible ceiling panel (if applicable).
 - a) Double gang – RACO 239 or equivalent, with ceiling grid framing where installed in accessible ceiling.
 - b) Or equivalent from
 - i) Emerson/Appleton
 - ii) Thomas & Betts/Steel City
 - iii) Approved Substitution
- 3) For 6" or 8" deep masonry walls: where single-gang faceplates are shown on the drawings, provide single-gang backbox a minimum of 3-1/2 inches deep; where double-gang faceplates are shown on the drawings, provide double-gang backbox a minimum of 3-1/2 inches deep.
 - a) Single gang – RACO 695
 - b) Double gang – RACO 696
- 4) Weatherproof: Aluminum die cast, weatherproof box with 1" conduit connection. Where single-gang faceplates are shown on the drawings, provide single-gang backbox a minimum of 2-1/2 inches deep; where double-gang faceplates are shown on the drawings, provide double-gang backbox a minimum of 2-1/2 inches deep.
 - a) Single gang – Thomas and Betts – IHD3-3 or equivalent
 - i) Or equivalent from
 - (1) Emerson/Appleton
 - (2) Hubbell/RACO
 - (3) Approved Substitution

- b) Double gang – Thomas and Betts – 2IHD5-3 or equivalent
 - i) Or equivalent from
 - (1) Emerson/Appleton
 - (2) Hubbell/RACO
 - (3) Approved Substitution
- c. Audio Video – for outlets and boxes shown on TA series drawings:
 - 1) Refer to box schedule on TA series drawings for size requirements.
 - 2) Boxes specifically identified on drawings by manufacturer and model number form the basis of design. Other equivalent manufacturers will be considered, but fully-coordinate proposed alternative with Division 274100 contractor and submit substitution request.

G. Floor Boxes

1. General

- a. Basis-of-Design Product: The specified floor box is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the schedule.
- b. Floor Box Schedule on drawings: Where titles in this section are column or row headings that introduce lists, the requirements listed for that title apply to product selection.
- c. Provide a complete Floor Box Assembly.
- d. UL514A listed for scrub water exclusion for all floor types.
- e. The following items are not provided per this specification section:
 - 1) Electrical receptacle(s) shall be provided per Division 26 Section “Wiring Devices” or as indicated on the Drawings. Refer to Electrical Drawings and Division 26 Specifications for receptacle types, quantities and colors. Unless otherwise noted, all floor boxes shall contain electrical power receptacles. If no requirements are listed elsewhere, provide a minimum of one normal 20A, 125V NEMA 5-20R duplex receptacle.
 - 2) Include provisions for mounting communications faceplate and connectors in accordance with the requirements of the communications systems provider. Telecommunications outlet termination plate and termination connectors shall be provided per Division 27 Section “Communications Horizontal Cabling”. Coordinate all other Assembly components to ensure compatibility.

- 3) Audio Video custom termination plates and connectors shall be provided per Division 27 Section "Audio Video Systems" and/or "Audio Video Systems Equipment". Coordinate all other assembly components to ensure compatibility.

H. Pull Boxes – for interior use only

1. Specifications

- a. NEMA 1
- b. Refer to Execution section for sizing requirements.
- c. Shall be keyed

2. The following manufacturers are Conditionally Approved.

- a. NEMA Enclosures
- b. Wiegmann
- c. Or Equivalent

I. Handholes – for exterior, in-grade applications only; refer to "Underground Conduit Requirements" in Part 3 for more information.

1. For use with one or two conduits, 2" diameter and smaller are installed, manufacturer shall be:

- a. Quazite PG 11"x18"
- b. Or Approved Equivalent

2. For all other conduit sizes and quantities, manufacturer shall be:

- a. Quazite – submit part number
- b. Or Approved Equivalent

J. Basket cable tray

1. The following manufacturers are Conditionally Approved.

- a. Atkore/Cope
- b. Bettermann Group/Chalfant
- c. Chatsworth
- d. Eaton/Cooper B-Line

- e. Hubbell
 - f. Legrand/Cablofil
 - g. MonoSystems
 - h. MPHusky
 - i. nVent/Hoffman
 - j. Schneider Electric/WIBE
 - k. Snake Tray
 - l. Thomas & Betts
 - m. WBT LLC
 - n. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)
2. Specifications
- a. *Cable Tray Size: Size identified on drawings indicate minimum width and depth size. Provide cable tray of sufficient size to accommodate a maximum calculated fill ratio of 50% for all Division 27 and 28 cabling, to include all cables installed plus 25% growth.*
 - b. Cable tray systems shall be pre-fabricated structures for supporting and routing cables or conductors that are pulled or laid in place after the pathway has been installed as a complete system
 - c. Basket cable tray systems shall consist of straight sections, fittings, and accessories as necessary for a complete, continuously grounded system.
 - 1) Cable tray and accessories shall be UL Classified as an equipment ground conductor.
 - d. Wire basket shall be made of high strength steel wires and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. All wire ends along wire basket sides (flanges) shall be rounded during manufacturing for safety of cables and installers.
 - e. Cable Tray Materials: Steel rod and/or wire; corrosion resistant to the degree suitable for the environment where it is to be installed; field-bendable.
 - f. Cable Tray Types:
 - 1) Basket cable tray: a cable tray manufactured from metal wire welded at all intersections and is formed to provide a channel for the cables.
 - g. Color: Cable tray shall be powder coated color as selected by Architect

K. Rigid Cable Tray

1. The following manufacturers are Conditionally Approved.
 - a. Atkore/Cope
 - b. Chalfant
 - c. Eaton/Cooper B-Line
 - d. Legrand/Cablofil
 - e. MonoSystems
 - f. MPHusky
 - g. Schneider Electric/WIBE
 - h. Snake Tray
 - i. Thomas & Betts
 - j. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)
2. Specifications
 - a. Refer to Electrical Division 26 for specific product and material information.
 - 1) Where a conflict exists between Division 26 and Division 27 the more stringent requirements shall apply.
 - b. Cable Tray Size: Provide cable tray with the loading depth and loading width as shown on the drawings. Size indicated on drawings is a minimum size; cable trays shall be designed to accommodate a maximum calculated fill ratio of 50%, to include all cables installed for Division 27 and 28 with 25% growth.
 - c. Cable tray systems shall be pre-fabricated structures for supporting and routing cables or conductors that are pulled or laid in place after the pathway has been installed as a complete system
 - d. Overhead Supports:
 - 1) The support span for cable support systems shall be determined in accordance with the manufacturer's maximum recommended load capacity for a given span. These systems may be supported by three basic methods: cantilever brackets from a wall, trapeze or individual rod supports from the ceiling, or directly from the floor
 - 2) Cable tray supports shall be located where practicable so that connections between sections of the tray fall between the support point and $\frac{1}{4}$ the distance

of the span. A support should be placed within 24 inches (609.6 mm) on each side of any connection to a bend, tee, or cross. See the NEMA-VE2 Metal Cable Tray Installation Guidelines for additional cable tray support and installation recommendations

- e. Cable tray systems shall consist of straight sections, fittings, and accessories as defined in NEMA VE-1 and UL classified as equipment grounding conductors. Provide radiused elbows, tees, crosses, splice plates, wall and overhead supports, and other fittings necessary for a complete, continuously grounded system
 - 1) Fittings and connectors shall be used to connect straight sections and change direction or size. Fittings include horizontal bends, vertical bends, reducers, crosses and tees. Connectors may include splice plates, splice clamps, and tee clamps. Accessories may include such items as covers, conduit adapters and barriers
- f. Cable Tray Materials and Finishes:
 - 1) Hot Dipped Galvanized After Fabrication Steel: Straight sections, fitting side rails and rungs shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 for 14 gauge and heavier, ASTM A1008, Grade 33, Type 2 for 16 gauge and lighter, and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. All covers and splice plates Shall also be hot-dip galvanized after fabrication; mill galvanized covers are not acceptable for hot-dipped galvanized cable tray. All hot-dip galvanized after fabrication steel cable trays Shall be returned to point of manufacture after coating for inspection and removal of all icicles and excess zinc. Failure to do so can cause damage to cables and/or injury to installers
- g. Rigid Cable Tray Types:
 - 1) Ladder: Ladder type tray shall be a pre-fabricated structure consisting of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails, for supporting and routing cables or conductors within the structure. Rungs shall be spaced on <6 inches, 9 inches, 12 inches, 18 inches> on center. Rung spacing in radiused fittings shall be 9 inches measured at the center of the trays width. Rungs shall have a minimum cable bearing surface of 3/4 inch (19.1 mm) with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails

L. Firestopping systems

- 1. General
 - a. All firestopping systems for Division 27 conduit, sleeves, cabling, boxes, etc. shall be from a single manufacturer, unless otherwise noted.
- 2. The following manufacturers are Conditionally Approved.

- a. 3M
 - b. Hilti
 - c. Specified Technologies, Inc
 - 3. Communications ladder rack and cable tray shall not continue through a fire-rated wall. Stop the tray, install multiple fire-rated pathway devices, and continue tray on the other side. Ensure grounding of the tray is continuous through the wall.
- M. Fire-Rated Pathway Device – for sleeves through a single penetration (wall or floor)
- 1. Specifications
 - a. Minimum performance requirements: Shall meet testing requirements of ASTM E-814 or U.L. 1479; Shall be installed in accordance with the NRTL. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.
 - b. Shall meet or exceed the ratings of the wall or floor that it penetrates.
 - c. Shall be a pre-fabricated and zero-maintenance solution which requires no action to activate the fire and smoke protective characteristics of the device.
 - d. Allows the installation and removal of cables without the need to remove or add any materials.
 - e. Used to seal penetrations of cables through fire rated partitions
 - f. Not subject to the single manufacturer requirement
 - 2. Manufacturer shall be:
 - a. EZ-Path family of products by Specified Technologies Inc.
 - b. Hilti Firestop Speed Sleeve CP 653 Series
 - c. Wiremold Flamestopper
- N. Firestopping for Backboxes in Fire-Rated Walls
- 1. Specifications
 - a. Used to seal backboxes in fire rated partitions.
 - b. Minimum performance requirements: Shall meet UL testing requirements of UL 263 and classified as Wall Opening Protective Material (QCSN or CLIV); Shall be installed in accordance with the NRTL. Shall meet or exceed the ratings of the wall or floor that it is located in.

- c. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.
 - 2. Manufacturer shall be:
 - a. Hilti CP 617 or CFS-P PA
 - b. Specified Technologies Inc., SpecSeal Power Shield
 - c. Or equivalent from Conditionally Approved manufacturer.
 - O. Firestopping for Thru-Wall (or Floor) Conduit Penetrations and Other Applications
 - 1. For fire-rated penetrations where the conduit pathway extends beyond a single fire-rated partition/floor, and other required firestopping applications not previously addressed in this specification.
 - 2. Specifications:
 - a. Shall be UL listed for the specific application; Shall meet or exceed the ratings of the wall or floor that it penetrates.
 - 3. Manufacturer shall be:
 - a. Hilti – submit UL System documentation for each floor/wall type and product cutsheets for all Hilti materials to be utilized
 - b. Specified Technologies Inc. – submit UL System documentation for each floor/wall type and product cutsheets for all STI materials to be utilized
 - c. Or equivalent from Conditionally Approved manufacturer.
- 2.3 ACCESS PANELS
- A. Access Panels
 - 1. Where pullboxes are required above inaccessible ceiling spaces, or for other required conditions, provide an appropriately-sized access panel. The following manufacturers are Conditionally Approved.
 - a. Activar/J.L Industries
 - b. Acudor Products
 - c. Alfab/Barco
 - d. Elmdor Products
 - e. Karp Associates, Inc.
 - f. Milcor

- g. Nystrom Building Products
 - h. Williams Brothers
 - i. Wind-lock
 - j. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)
2. Specifications:
- a. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation.
 - b. Joints and seams: continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
 - c. Frames: 16-gauge steel, with a 1 inch (25.4 mm) wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling:
 - 1) For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
 - 2) For gypsum wallboard or plaster: perforated flanges with wallboard bead.
 - 3) For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.
 - d. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
 - e. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
3. Locking Devices: Where indicated, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.
4. Indicate proposed size and locations on pre-construction shop drawings. No access panels shall be installed without Architect and Design Consultant approval.

2.4 IDENTIFICATION FOR COMMON WORK FOR COMMUNICATIONS SYSTEMS

A. Labels

- 1. The following manufacturers are Conditionally Approved for generic labeling requirements for conduits, pullboxes, and equipment racks.
 - a. Brady
 - b. Brother

- c. Dymo
 - d. HellermannTyton
 - e. Panduit
 - f. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)
2. Specifications:
- a. Refer to additional requirements in Part 3 – Execution.
 - b. Refer to individual sections for additional identification requirements for specific work.

2.5 KEYS

- A. Supply two copies of every key as required for pullboxes, junction boxes, and access panels.

PART 3 - EXECUTION

3.1 PATHWAYS FOR COMMUNICATIONS

A. General

- 1. Refer to Electrical Division 26 for additional installation requirements.
 - a. Where a conflict exists between Division 26 and Division 27 the more stringent requirements shall apply.
- 2. All supports shall be specifically designed to support the required cable weight and volume. Field manufactured supports will not be accepted.
- 3. Install a pull cord in each pathway (empty or not) for installation of new wires or cables. Use polypropylene or monofilament plastic line with not less than 200 lb (90.7 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.
- 4. Unless otherwise noted, pathway routing shown on the Drawings is illustrative only and meant to indicate the general configuration of the work. Install pathways so that adequate clearances and offsets between pathways and other trades are provided. Coordinate all pathways with other trades prior to installation.
- 5. All pathways shall include empty space for a minimum of 25% growth beyond initial installation of cabling when contractor performs conduit sizing calculations, otherwise follow conduit sizes indicated on drawings.
- 6. Cables shall be rigidly supported by cable pathways as indicated on the drawings. Cables shall be physically supported at intervals not to exceed 5 feet (1.52 m).
- 7. Store and keep dry all products in original container in a climate controlled environment until installation is to occur

8. Install all communications pathways:
 - a. So that cables are allowed to be pulled in accordance with referenced standards and guidelines.
 - b. So that cables are allowed to be pulled without damage to conductors, shield, armor, or jacket.
 - c. So that cables are not forced or allowed to exceed minimum allowed bend radius by manufacturer or referenced standards and guidelines.
 - d. So that the maximum allowable pulling tension is not exceeded.
 - e. To meet the requirements of the structure and the requirements of all other Work on the Project
 - f. To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.
 - g. Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Architect.
 - h. Parallel or perpendicular to building lines or column lines.
 - i. When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
9. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or other methods shall **not** be used to attach cables to cable supports; UON.
 - a. Except when supported by ladder racking within each Telecommunications room, UON.
10. Provide adequate communications pathways so that cabling is not forced to attach, be supported, or use other pathways not specifically designed and provided for communications cabling purposes. Any deviation from this will not be accepted.
 - a. At no point shall cables come in contact with, be supported by, or attach to other trades equipment or supports. UON
 - b. At no point shall cables come in contact with, be supported by, or attach to building structures or supports; UON
11. Provide appropriately sized sleeves where cables are required to pass through non-rated full-height partitions. Where allowed, sleeves shall extend a minimum of 3 inches (76.2 mm) beyond the partition surface on both sides, and shall be rigidly supported to support the weight of cables. Sleeves shall be sized so that no more than 50% of the cross-sectional

area is utilized by the cabling to be installed. The minimum inside diameter of each sleeve shall be nominal 2 inches (50.8 mm).

12. Suspended cables shall be installed with at least 3 inches (76.2 mm) of clear vertical space above the ceiling tiles and support channels (T-bars).
13. Waterproofing
 - a. Avoid, if possible, the penetration of any waterproof membranes such as roofs, machine room floors, basement walls, and the like. If such penetration is necessary, make penetration prior to the waterproofing and furnish all sleeves or pitch-pockets required. Advise the Architect and obtain written permission before penetrating any waterproof membrane, even where such penetration is shown on the Drawings.
 - b. Restore waterproofing integrity of walls or surfaces after they have been penetrated without additional cost to the Owner.
14. Cutting and Patching
 - a. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finished plaster, woodwork, metalwork, etc. using skilled tradespeople of the trades required at no additional cost to the Owner.
 - b. Do not cut, channel, chase or drill masonry, tile, etc., unless permission from the Architect is obtained. If permission is granted, perform this work in a manner acceptable to the Architect.
 - c. Patch around all openings to match adjacent construction.
 - d. Where conduit or equipment is mounted on a painted finished surface, or a surface to be painted, paint to match the surface. Cold galvanize bare metal whenever support channels are cut.
 - e. Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Owner.
 - f. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.
15. Mounting Heights
 - a. Mounting heights for equipment and devices requiring operational access shall conform to ADA requirements.
 - 1) Wall mounted devices requiring operational access shall be mounted a minimum of 15 inches above finished floor to bottom of device and a maximum of 48 inches above finished floor to top of device.

- b. Mounting heights shall be from floor to center of device, unless otherwise noted. Verify exact locations and mounting heights with the Architect before installation.
- c. Typical mounting heights shall match nearest adjacent typical electrical outlet mounting height UON or as directed by the Architect.

16. Painting

- a. Refer to Division 9 Section "Painting" for painting requirements.
- b. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under [individual Sections] [Division 9 of the Specifications]; colors shall be as selected by the Architect.
- c. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.
- d. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.
- e. Where factory finishes are provided and no additional field painting is specified, touch-up or refinish, as required by, and to the acceptance of, the Architect and Design Consultant, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Architect or Design Consultant, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.
- f. Provide touch-up paint as required by Specification Sections in this Division.

17. Fastenings

- a. Fasten equipment to building structure in accordance with the best industry practice.
- b. Where weight applied to the attachment points is 100 pounds or less, conform to the following as a minimum:
 - 1) Wood: Wood screws.
 - 2) Concrete and solid masonry: Bolts and expansion shields.
 - 3) Hollow construction: Toggle bolts.
 - 4) Solid metal: Machine screws in tapped holes or with welded studs.
 - 5) Steel decking or sub-floor: Fastenings as specified below for applied weights in excess of 100 pounds.

- c. Where weight applied to building attachment points exceeds 100 pounds, but is 300 pounds or less, conform to the following as a minimum:
 - 1) At concrete slabs provide 24 inch x 24 inch x ½ inch steel fishplates on top with through bolts. Fishplate assemblies shall be chased in and grouted flush with the top of slab screed line, where no fill is to be applied.
 - 2) At steel decking or sub-floor for all fastenings, provide through bolts or threaded rods. The tops of bolts or rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the decking or sub-floor manufacturer produces specialty hangers to work with his decking or sub-floor such hangers shall be provided.
 - d. Where weight applied to building attachment points exceeds 300 pounds, coordinate with and obtain the approval of Architect and conform to the following as a minimum:
 - 1) Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.
 - e. For items, which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.
 - f. Wall mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars. Prefabricated steel channels as manufactured by Kindorf or Unistrut are acceptable.
 - g. Bridle rings are prohibited for Division 27 cables, unless otherwise noted on drawings.
18. For large quantities of cables (greater than 50) that converge upon a common run such as at a rack, in corridors, and other areas, provide cable trays or other special supports that are specifically designed to support the required cable weight and volume.
19. Areas identified as noise critical spaces shall have all penetrations sealed to minimize sound transmission between adjacent spaces. Install Acoustical Pathway(s) through walls of noise critical spaces
- B. Access to pathways and associated equipment
- 1. Locate all cable trays, open hanger cable supports, j-hooks, pull boxes, junction boxes and fire stopping systems so as to provide easy access for operation, service inspection and maintenance.

2. Provide an Access Panel where equipment or devices are located above inaccessible ceilings. Where access doors are necessary but not shown on the plans, coordination type and location with Architect and Design Consultant through an RFI.
 - a. Pathways requiring access such as open hanger cable supports, j-hooks, and cable trays shall have an access door or other means of direct access at a minimum of 10 feet (3 m) intervals.
 - b. Cables or cable pathways requiring access such as open hanger cable supports, j-hooks, and cable trays may not change directions above an inaccessible ceiling unless complete access to the change of direction in pathway or cable route is within arms reach 3 feet (0.9 m) from adjacent accessible point.
3. Maintain all code required clearances and clearances required by manufacturers.

C. Cable distribution

1. Provide pathways for Telecommunications (Structured Cabling System) to allow cabling to be installed in the following manner:
 - a. For typical new walls:
 - 1) Homerun method: Conduit from outlet location all the way back to the Telecommunications Room/Space.
 - b. For existing walls:
 - 1) For stud walls - "Ring and String": Mud ring for faceplate, cabling run in hollow cavity of the wall and then j-hooks are utilized back to the nearest cable tray or serving Telecommunications Room/Space
 - 2) For masonry or inaccessible walls – Surface-mounted raceway to accessible ceiling space.
 - c. For phone and data lines to all Elevator Equipment Rooms and Fire Alarm panels:
 - 1) Homerun method: Conduit from outlet location all the way back to the Telecommunications Room/Space.
 - d. See drawings for clarification
2. Provide pathways for Audio Video Systems to allow cabling to be installed in the following manner:
 - a. For typical new walls:
 - 1) Homerun method: Conduit from outlet/box location all the way back to the AV Rack identified on the drawings.
 - b. For existing walls:

- 1) For stud walls - "Ring and String": Mud ring for faceplate, cabling run in hollow cavity of the wall and then j-hooks are utilized back to the nearest cable tray or serving Telecommunications Room/Space
- 2) For masonry or inaccessible walls – Surface-mounted raceway.

c. See drawings for clarification.

D. Conduits

1. Conduit shall be of the appropriate type required by code and as required by Electrical Division 26.
2. Adequate access shall be available where cables enter conduits
3. Bond and ground all metallic conduits and boxes in accordance with national or local requirements and with TIA-607 – "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
4. Install conduits in the most direct route possible, running parallel to building lines
5. Ream all conduit ends and fit them with an insulated bushing to eliminate sharp edges that can damage cables during installation or service.
6. Conduits which enter Telecommunications rooms shall extend 3 inches (76.2 mm) AFF or through the wall.
7. Conduits which enter Entrance Facilities shall extend 4 inches (101.6 mm) AFF or below the finished ceiling (if exists).
8. Flexible conduits may only be used where specifically allowed by these contract documents.
 - a. Flexible conduit sections shall be less than 20 feet (6.1 m) in length.
9. No continuous section of a conduit may exceed 100 feet (30.5 m) without a pullbox.
10. For structured cabling, no more than (2) 90° bends, or equivalent will be allowed between pullboxes.
 - a. Each and any offset shall be considered a 90° bend.
 - b. A pullbox is required wherever a reverse bend is installed.
11. The minimum bend radius for conduits is
 - a. (6) times the inside diameter for 2 inches (50.8 mm) conduits or less.
 - b. (10) times the inside diameter for conduits greater than 2 inches (50.8 mm).
12. Any single conduit run may not serve more than (1) outlet location unless expressly indicated on the drawings.

13. Where building entrance conduits (for service provider and owner's WAN cabling) do not enter the building directly into the Communications Entrance Room/Facility, extend those entrance conduits via RMC or IMC into the Communications Entrance Room/Facility.
 - a. Coordinate with Contractor for Division 27 Sections "Communications Backbone Cabling" and "Communications Horizontal Cabling" for potential other pathways where IMC/RMC are required.
14. Conduits shall contain no electrical condulets (also known as LBs).
 - a. Exception: Pre-approved (by the Design Consultant) condulets specifically manufactured for communications cabling and will maintain minimum bend radius for cabling to be installed. These locations are to be called out on the shop drawings.
15. Underground Conduit Requirements
 - a. For Structured Cabling System horizontal cabling and pathways within the footprint of the building and serving voice and data outlets exterior to the building, such as emergency phones/towers, security cameras and wireless access points attached to exterior light poles, etc
 - b. For Audio Video System cabling serving pole-mounted loudspeakers, broadcast boxes, etc.
 - c. Requirements
 - 1) Refer to applicable details on drawings for illustrative requirements.
 - 2) Wherever practical, slab-on-grade floorboxes shall have conduit extended underground or in-slab from box to serving communications room or equipment cabinet.
 - a) Only one horizontal bend is allowed, 90 degrees or less.
 - b) Indicate proposed routing and stub-up locations on shop drawings.
 - 3) Route all underground conduit so there is no more than (3) 90 degree bends, including stub-up bend at communications room/equipment cabinet.
 - a) For underground conduit serving outlets/boxes outside the footprint of the building that require more than (3) 90 degree bends, provide appropriately-sized handhole(s). Coordinate location with Architect and Owner, indicate proposed location(s) on shop drawings, and include product information in pre-construction submittals. In general, handholes are not to be located in roadways, parking lots, sidewalks, or any location that may be subject to vehicular traffic.
 - 4) Approved conduit types:
 - a) When routed in slab-on-grade:

- i) Horizontal conduit shall be RMC or Schedule 40 PVC, including horizontal bends. If PVC is installed, also install tracer wire.
 - ii) Vertical bends shall be RMC.
 - b) When routed below slab-on-grade or outside the footprint of the building:
 - i) Horizontal conduit shall be RMC or Schedule 40 PVC a minimum of 12" below grade. If PVC is installed, also install tracer wire.
 - ii) All vertical and horizontal bends shall be RMC.
- 16. Install approved expansion/deflection fittings where raceways pass through or over building expansion joints.
- 17. Route raceway through roof openings for piping and ductwork or through roof seals approved by the Architect, the roofing contractor, or both. Obtain approval for all roof penetrations and seal types from the Architect, Owner, roofing contractor, or all three as required to maintain new or existing roofing warranties.

E. Outlet boxes

- 1. No outlet boxes shall be located back-to-back in a wall cavity.
 - a. Where possible offset to next stud cavity, with a minimum of 6 inch (152.4 mm) separation.
- 2. Outlet boxes shall be within 3 feet (0.9 m) of nearest electrical outlet.
- 3. Outlet boxes located in fire-rated walls are to have the appropriate firestopping for backboxes. These locations are to be identified on shop drawings.
- 4. Where cabling enters a backbox directly (not via conduit), provide black rubber grommet on knockout.

F. PullBoxes

- 1. Pullboxes shall be placed in Conveniently Accessible locations.
- 2. Coordinate the location and installation of all pullboxes to ensure adequate access is provided.
- 3. Pullboxes above an accessible ceiling shall:
 - a. Be aligned directly over the ceiling grid to allow access
 - b. Be installed with a minimum of 3 inches (76.2 mm) clearance to ceiling grid and tiles

4. No directional changes shall be allowed in pullboxes. Conduit Shall continue in the same direction as it enters and then change direction via an appropriately sized bend in the conduit.
5. Size pullboxes according to the following chart (all sizes are minimums):

Conduit Trade Size	Width	Length	Depth	Width Increase for Additional Conduit (of same size)
1" or smaller	4"	4"	2-1/8"	Not applicable
1-1/4"	6"	20"	3"	3"
1-1/2"	8"	27"	4"	4"
2"	8"	36"	4"	5"
2-1/2"	10"	42"	5"	6"
3"	12"	48"	5"	6"
4"	16"	60"	8"	8"

G. Cable Tray

1. Cable trays shall be installed in accordance with the applicable electrical code and standards.
2. The inside of the cable support system shall be free of burrs, sharp edges or projections that can damage cable insulation. Abrasive supports (e.g., threaded rod) installed within the cable fill area shall have that portion within the tray rigidly protected with a smooth, non-scratching covering so that cable can be pulled without physical damage such as appropriately rated (plenum) plastic tubing.
3. Cables shall remain unattached to its pathway and shall simply lay at rest on the supports provided by its pathway. Wire ties, velcro straps, electrical tape or other methods shall **not** be used to attach cables to cable supports; UON.
4. Installation of cables shall not exceed the fill requirements stated above.
5. Cable trays shall not extend through fire-rated walls and walls for noise critical spaces.
6. Cable trays shall not extend over 6' lengths (or greater) of inaccessible ceilings. Stop cable trays just before the inaccessible ceiling and provide overhead conduits of quantity and size bridging the two sections of cable tray so that conduit cable capacity (square inches per fill ratio) is equal to that of the cable tray.
 - a. The cable fill ratio for cable tray shall be 50%.
 - b. The cable fill ratio for conduits shall be 40%.
 - c. Example: a 4" x 12" cable tray has 48 square inches of total capacity, and 24 square inches of cable capacity. Per the NEC, a 4" trade size EMT conduit has a 40% cable capacity of 4.62 inches. 24 divided by 4.62, rounding up to the next whole number equals (6) 4" conduits shall be provided for a 4" x 12" cable tray.
7. Cable trays and cable runways shall not be used as walkways or ladders.

8. A minimum of 12 inches (300 mm) access headroom shall be provided and maintained above a cable tray system or cable runway.
9. Care shall be taken to ensure that other building components (e.g., air conditioning ducts, pipes, conduits) do not restrict access.
10. Basket cable trays shall be supported according to manufacturer's instruction via one of the following:
 - a. Trapeze/Unistrut under the cable connected to the cable tray and to (2) 3/8" (or greater) rods to structure above.
 - 1) Center-hung, single-rod supports are not allowed.
 - b. Shelf or L-brackets attached to wood or metal studs.
11. Test cable tray systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with maximum grounding resistance.

3.2 LABELING

A. Labeling Installation

1. Labels that are to be secured by adhesive. They shall have a type of adhesive that is appropriate for the particular surface upon which the label is to be installed. The mounting surface shall be free of dust, dirt, oil, etc. that would impede the adhesion of the labels.

B. Labeling Requirements

1. Labels are to be installed on:
 - a. All firestopping systems. For wall and floor penetrations, label on both sides. See Firestopping later in this section. Take picture of each firestopping system (with label visible) to include with Project Completion submittal.
 - b. All pathways (e.g., conduit, innerduct, etc.) installed under this work.
 - 1) Label all conduit and innerduct with "TELECOM" or "AV" according to the intended system/use of the installed (or future) cabling. Conduit labels shall utilize text readable from a standing position on the finished floor. Conduit sleeves which pass through a single wall or floor need not be labeled.
 - a) For wall stub-up locations, label overhead only.
 - b) For conduits greater than 10', label both ends of conduit with far end location and Room/Number.
 - i) Example – "AV to AV Rack R01".
 - c) For conduits that stub directly up or into a Communications Room, label both ends of conduit.

- i) Example: underslab conduit from Telecom Room 1A to the Floor Box in Conference Room 101A shall be labeled as follows:
 - (1) Conduit stub-up location in Telecom Room 1A – “Telecom to Conf. Rm 101A Floorbox”
 - (2) Bottom of floorbox, immediately adjacent to serving Telecom conduit – “Telecom to Telecom Room 1A”
- 2) All pullboxes and junction boxes for Communications shall be labeled such as “TELECOM PULLBOX”, “AV JUNCTION BOX”, “TV”, etc. on the cover, such that the text is of sufficient size to be readable from a standing position on the finished floor.
 - a) Conduits entering and exiting all pullboxes and junction boxes shall be labeled with their destination/room number – ie “To AV Box Q:212:01 in Control Rm 212”.
- c. In general, the label is to be provided and installed by whomever installed the item that is being labeled.
- d. Refer to individual Division 27 Communications sections and to the drawings for additional information on labeling requirements.

3.3 FIRESTOPPING

A. General

- 1. Provide fire-resistant materials of a type and composition necessary to restore fire ratings to all wall, floor or ceiling penetrations; including membrane penetrations. All materials shall be classified or listed as a complete system by UL (or an approved NRTL by the Design Consultant and AHJ) and meet NEC and local codes. The use of partial systems or components of systems is not allowed unless specifically identified in the documents.
- 2. All penetrations through fire rated floors and walls shall be sealed to prevent the passage of smoke, flame, toxic gas or water through the penetration before, during or after a fire. The fire rating (F and T) of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or wall is maintained as required by referenced building codes.
 - a. Assume all floors are fire-rated, unless otherwise noted.
 - b. Also install fire stops at any other locations indicated in the Specifications or Drawings.
- 3. Provide a label on both sides of fire rated assembly at all fire stop locations indicating:
 - a. Fire stop Manufacturer
 - b. Installer and company

- c. Date installed
 - d. UL system number with all relevant ratings indicated
 - 4. Include labels in each telecom room in which one or more fire rated walls is installed. Provide a 2" block letter stencil label on the inside of the telecom room to indicate rating for each barrier.
 - 5. Provide systems as identified on the drawings and specified herein. At locations where the cabling routing encounters a fire-rated barrier provide an adequately sized fire stop device for the quantities and types for all cables to be installed plus 25% growth.
- B. Penetration Sealant – Conduits
- 1. Provide listed system to seal around openings between wall, floor or partition around conduits in accordance with system listing and manufacturer's instructions.
- C. Penetration Sealant – Voids, Cavities, and Openings
- 1. Install fire stop materials in the framed openings through fire rated partitions per the Architect's drawings and in accordance with the NRTL listed system instructions.
 - 2. Fire stop all voids, cavities, and openings left by the removal of cabling, conduits, conduit sleeves, cable trays or other equipment related to the communications systems not to be reused.
 - 3. Install the fire stop system in accordance with the manufacturer's instructions and local codes.
- D. Fire-Rated Pathway Device
- 1. Provide fire-rated pathway device anywhere cables are required to pass through fire-rated walls, floors or partitions.
 - 2. Devices shall be installed in locations where required by the Contract Drawings, arranged individually or appropriately ganged.
 - 3. Install the devices in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations.
 - 4. Apply the factory supplied gasketing material (where required) prior to the installation of the wall plates.
 - 5. Secure wall plates (where required) to devices per the equipment manufacturer's recommendations.

END OF DOCUMENT 270500

DOCUMENT 270543 - UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes:

1. Raceways, fittings, boxes, handholes, and manholes for direct buried and concrete-encased communications distribution pathways.

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING:

- A. Division 26 Sections "General Electrical Requirements" and "Common Work Results for Electrical" for general requirements and related documents that apply to this Section.
- B. Division 27 Section "General Communications Requirements" for general requirements and related documents that apply to this Section.
- C. Division 27 Section "Common Work Results for Communications" for limited scope general construction materials and methods.
- D. Division 31 Sections, including "Earth Moving".
- E. Division 32 Sections, including "Turf and Grasses and "Plants".

1.3 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 27 Section "General Communications Requirements":

1. Product data for the following products:

- a. Raceways, Raceway fittings, separators, and accessories, duct-bank materials, manholes/handholes, solvent cement, sealants, tracer wire, warning tape / warning planks.

2. Shop drawings for:

- a. Detailing fabrication and installation for custom manholes or handholes including duct entry provisions, reinforcing details, frame and cover design, manhole frame support rings, ladder details, grounding details, sump details, joint details, and cable racks, pulling irons, lifting irons.
- b. Detailing of pathway and placement of manhole/handhole devices for underground duct bank pathways.

B. Record Drawings: Submit Record Drawings as required by Division 01 and Division 27 Section "General Communications Requirements":

1. Accurately record actual routing of all exterior buried raceway including coordination with other surrounding utilities and underground structures. Provide scaled plans and sections that indicate dimensions from finished grade or other fixed structural elements for all components of the pathway (duct bank sizing and location, conduit quantities and placement within the duct bank, tracer wire locations and sizing, warning plank location and sizing, manhole/handhole placement as well as sizing of each manhole/handhole installed).

1.4 DEFINITIONS

- A. Terminology used in this specification is as defined below:

1. GRS: Galvanized Rigid Steel Conduit
2. RMC: Rigid Metal Conduit
3. RNC: Rigid Nonmetallic Conduit

- B. Refer to Division 27 Section "General Communications Requirements" for additional abbreviations / definitions.

1.5 CODE, STANDARDS, AND GUIDELINES

- A. The following codes and standards contain provisions that, through reference in this text, constitute provisions of document. At the time of publication the editions indicated were valid. All equipment, construction practices, design principles, and installation shall conform to the latest version of any or all of the following standards and codes published by the following organizations, where applicable

1. Federal Communications Commission (FCC)
2. Institute of Electrical and Electronics Engineers, Inc (IEEE)
3. National Fire Protection Association (NFPA)
4. National Electrical Code (NEC)
5. American National Standards Institute (ANSI)
6. Telecommunications Industry Association (TIA)
7. Electronics Components Industries Association (ECIA)
8. Building Industry Consulting Service International (BICSI)
9. National Electrical Contractors Association (NECA)
10. International Building Code (IBC)
11. FCC Regulations Part 68
12. NPFA-70 National Electrical Code Chapter 8 – Communications Systems

13. NFPA-71 Central Signaling Systems
 14. NFPA-780 Protection of Electronic and Computer Data Processing Equipment
 15. NFPA-780 Lightning Protection Code
 16. NFPA-101 Life Safety Code
 17. ANSI/TIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces
 18. TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
 19. TIA-STD-J-607 Commercial Building Bonding and Grounding requirements for Telecommunications
 20. ANSI/NESC – National Electrical Safety Code
- B. All equipment, construction practices, design principles, and installation shall conform to the latest version of any or all of the following guidelines published by the following organizations, where applicable
1. BICSI Methodologies
 - a. BICSI Telecommunications Distribution Methods Manual
 - b. BICSI ITS Installation Methods Manual
 - c. Customer Owned Outside Plant Design Manual
- C. Additional requirements for Manholes and Handholes:
1. Manholes shall be designed in compliance with the following ASTM standards:
 - a. ASTM C857-87 “Standard Practice for Minimum Structural Design Loading for Underground Pre-cast Concrete Utility Structures”,
 - b. ASTM C478 “Standard Specification for Pre-cast Reinforced Concrete Manhole Sections”,
 - c. ASTM C858-83 “Standard Specifications for Underground Pre-Cast Concrete Utility Structures”
 - d. All reinforcing steel shall conform to ASATM 432 “Standard Guide for Selection of a Leak Testing Method” and
 - e. ASTM 305 “Standard Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency”.

- f. ASTM C990, "Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants"
 - g. ASTM 432, "Standard Guide for Selection of a Leak Testing Method:
 - h. Test and inspect pre-cast concrete utility structures according to ASTM C 1037
- 2. Manholes to be designed per ACI 318-02 "Building Code Requirements for Structural Concrete".
 - 3. Test and inspect pre-cast concrete utility structures according to ASTM C 1037
 - 4. 4.Non-concrete Handholes and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77.

1.6 QUALITY ASSURANCE

- A. Pre-cast concrete manholes to be manufactured at a plant that holds a current NPCA certification
Pre-cast concrete manholes to be manufactured at a plant that holds a current NPCA certification.
- B. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 5 years.
- C. Communications and Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.
 - 2. Marked for intended use.
- D. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by an independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards
- E. Refer to Division 27 Section "General Communications Requirements" for additional Quality Assurance requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to project site with ends capped and store nonmetallic ducts with supports to prevent bending, warping, and deformation.
- B. Store pre-cast and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings, if present, are visible.

- C. Lift and support pre-cast concrete units only at designated lifting or supporting points.

1.8 PROJECT CONDITIONS

- A. Interruption of existing communications services to occupied facilities shall not occur unless permitted under the following conditions and then only after arranging to provide temporary electrical and communications services according to requirements indicated.
 - 1. Notify Architect no fewer than two weeks in advance of proposed interruption of the electrical or communications services.
 - 2. Coordinate all service interruptions with the other trades, customer AHJ and architectural team.
 - a. Confirmation of the interruption shall be confirmed with a signed notice from the above-mentioned parties.

1.9 COORDINATION

- A. Coordinate layout and installation of ducts, manholes, handholes, tracer wires, warning planks, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into manhole, handholes, tracer wires, warning planks, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by the Architect.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- B. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference.

2.2 RACEWAYS AND FITTINGS

- A. Metal Conduit
 - 1. Manufacturers:
 - a. AFC Cable Systems, Inc.

- b. Alfex Corporation, a Southwire Company
 - c. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - d. Electri-Flex Co.
 - e. Indalex
 - f. Manhattan/CDT/Cole-Flex
 - g. O-Z/Gedney; Unit of General Signal (Fittings)
 - h. Republic Raceway
 - i. Tyco International; Allied Tube & Conduit Div.
 - j. Wheatland Tube Co.
 - k. Or approved equivalent
2. RMC:
- a. GRS: Hot-dip galvanized steel (including threads): ANSI C80.1, UL 6
 - b. Plastic-Coated GRS and Fittings: NEMA RN 1, UL-listed. Coating thickness of 0.40 inches (1 mm), minimum.
 - c. Fittings: NEMA FB 1; compatible with raceway and tubing materials.
- B. Nonmetallic Raceway
1. Manufacturers:
- a. AFC Cable Systems, Inc.
 - b. American International.
 - c. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - d. Arnco Corp.
 - e. Cantex Inc.
 - f. Certainteed Corp.; Pipe & Plastics Group.
 - g. Condux International.
 - h. ElecSYS, Inc.
 - i. Electri-Flex Co.

- j. Lamson & Sessions; Carlon Electrical Products.
- k. Manhattan/CDT/Cole-Flex.
- l. RACO; Division of Hubbell, Inc.
- m. Spiralduct, Inc./AFC Cable Systems, Inc.
- n. Superflex Ltd.
- o. Thomas & Betts Corporation.
- 2. RNC: Extra-heavy Schedule 80 conduit type EPC-80-PVC, PVC: NEMA TC 2, UL 651.
 - a. Fittings: match to raceway type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable and UL listed for direct burial as well as above ground use.
- 3. RNC: Heavy Schedule 40 conduit type EPC-40-PVC, PVC: NEMA TC 2, UL 651.
 - a. Fittings: match to raceway type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable and UL listed for direct burial as well as above ground use.

C. Duct Accessories

- 1. Innerduct
 - a. Install size and quantity of innerduct within conduits as identified on the drawings.
 - b. Requirements:
 - 1) Suitable for installation within the installed conduits
 - 2) Sequential foot markings
 - 3) Material shall be corrugated High Density Polyethylene (HDPE)
- 2. Duct Separators shall be factory-fabricated rigid interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
- 3. Underground-line warning tape / tracer wire:
 - a. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
 - 1) Not less than 6 inches (150 mm) wide by 4 mils (0.102 mm) thick.
 - 2) Compounded for permanent direct-burial service.
 - 3) Embedded continuous metallic strip or core.
 - 4) Printed legend shall indicate type of underground line.

4. Concrete warning planks (to be installed over direct-buried duct-banks) shall be nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.
 - a. Color: Red dye added to concrete during batching.
 - b. Labeling: Mark each plank with "COMMUNICATIONS" in 2-inch high, 3/8-inch deep letters.
5. Refer to details on drawings for additional accessories.

2.3 PRE-CAST CONCRETE HANDHOLES AND BOXES

A. General

1. Product(s) identified on drawings forms Basis-of-Design. Equivalent product(s) that meet or exceed the specifications of the Basis-of-Design product and the specifications listed below will be considered from the following manufacturers:
2. Manufacturers:
 - a. Carder Concrete Products.
 - b. Christy Concrete Products
 - c. Elmhurst-Chicago Stone Co.
 - d. Oldcastle Pre-cast Group
 - e. Riverton Concrete Products; a division of Cretex Companies, Inc.
 - f. Utility Concrete Products, LLC
 - g. Utility Vault Co.
 - h. Wausau Title, Inc.
 - i. Or Approved Equivalent

B. Comply with ASTM C858 for design and manufacturing process.

C. Pre-cast concrete handholes and boxes shall be factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of the handhole or box.

1. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
 - a. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - b. Cover Handle: Recessed.

2. The cover finish shall be a nonskid finish with a minimum coefficient of friction of 0.50.
3. The cover shall have the following legend lettering molded into the cover:
 - a. "COMMUNICATIONS" for Telecommunications spaces
4. Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
5. Extensions and slabs shall be designed to mate with bottom of enclosure and shall be same material as enclosure.
 - a. Extension shall provide increased depth of 12 inches.
 - b. Slab shall be same dimensions as bottom of enclosure, and arranged to provide closure.
6. Windows shall be included as pre-cast openings in walls arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Window openings shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
 - c. Window openings shall be framed with at least two additional No.4 steel reinforcing bars in concrete around each opening.
7. Duct entrances into handhole walls shall have cast end-bell or duct-terminating fittings in the wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable
 - c. Rigid steel conduits shall be hot-dipped galvanized malleable iron or steel threaded to the end if the conduit is cast in place in the wall of the manhole. .
8. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
9. A clamped bonding ribbon shall be attached to rebar prior to encasement by concrete. Bonding ribbon shall exit manhole/handhole wall within 12" of top and between wall-mounted cable racks. Length shall be sufficient to attach to Ground Rod that stubs up 4" through manhole/handhole floor. Refer to detail on drawings and Chapter 6 of BICSI Outside Plant Manual for more information.

2.4 PRE-CAST MANHOLES

- A. Pre-cast-concrete manholes shall be furnished in sizes as indicated on the plans and as specified herein. Pre-cast manholes shall be constructed of reinforced concrete with a minimum 28-day concrete compressive strength for concrete at 4,000PSI (min). All concrete used in the construction of the manhole shall contain steel reinforcing bars to conform to all applicable building codes. All reinforcing steel shall conform to ASTM432 "Standard Guide for Selection of a Leak testing Method" and ASTM 305 "Standard Practice for Mechanical mixing of Hydraulic Cement pastes and Mortars of Plastic Consistency".
- B. Manholes shall be provided complete with all appurtenances and accessories required.
 - 1. Product(s) identified on drawings forms Basis-of-Design. Equivalent product(s) that meet or exceed the specifications of the Basis-of-Design product and the specifications listed below will be considered from the following manufacturers:
 - 2. Manufacturers: Subject to compliance with requirements and hold a current NPCA certification, provide products by one of the following:
 - a. Barbour Concretes.
 - b. PreTech Corp.
 - c. Precision Precast Co.
 - d. Oldcastle Pre-cast Group.
 - e. Utility Concrete Products, LLC.
 - 3. Substitution of Other Manufacturers: Subject to compliance with requirements; pre-caster shall hold a current NPCA certification. Requests to utilize an alternate pre-cast manufacturer shall be provided in writing and approved by Engineer prior to procurement and implementation.
- C. Comply with ASTM C478, "Standard Specification for Precast Reinforced Concrete Manhole Sections", as specified in Part 3 "Underground Enclosure Application" and with interlocking mating sections, complete with accessories, hardware, and features.
- D. Windows: Pre-cast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - 1. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to facilitate racking of cables on walls.
 - 2. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
 - 3. Window openings shall be framed with at least two additional No.4 steel reinforcing bars in concrete around each opening.

4. Installer to coordinate location of openings with the design as depicted on the Telecommunications sheet/s for additional details.
- E. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 1. Type and size shall match fittings to duct or conduit to be terminated
 2. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable
 3. Installer to coordinate location of openings with the design as depicted on the Telecommunications sheet/s for additional details.
- F. Concrete Knockout Panels: 1-1/2 to 32 inches thick, for future conduit entrance and sleeve for ground rod.
- G. Each manhole shall provide a sump drywell of at least 8" in diameter
- H. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
- I. Bonding Ribbon
 1. A clamped bonding ribbon shall be attached to rebar prior to encasement by concrete. Bonding ribbon shall exit manhole/handhole wall within 12" of top and between wall-mounted cable racks. Length shall be sufficient to attach to Ground Rod that stubs up 4" through manhole/handhole floor. Refer to detail on drawings and Chapter 6 of BICSI Outside Plant Manual for more information.

2.5 UTILITY STRUCTURE ACCESSORIES

- A. Utility structures shall be installed complete including accessories as listed below.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - a. Elmhurst-Chicago Stone Co.
 - b. McKinley Iron Works, Inc.
 - c. Neenah Foundry Company.
 - d. NewBasis
 - e. Oldcastle Precast Group
 - f. Osburn Associates, Inc.
 - g. Pennsylvania Insert Corporation.

- h. Precision Precast
 - i. PreTech Corp
 - j. Riverton concrete Products; a division of Cretex Companies, Inc.
 - k. Strongwell Corporation; Lenoir City Division.
 - l. Underground Devices, Inc.
 - m. Utility Vault Co.
 - n. Wausau Tile, Inc
 - o. Or Approved Equivalent
 - 2. Contractor shall provide cut sheets and engineered shop drawings for the manhole for review and approval prior to procurement and installation.
- B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
- 1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 32 inches; cover to be rated for heavy traffic H-20, UON.
 - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - b. Special Covers: recess in face of cover designed to accept finish material in paved areas
 - c. For any MV 12' to 20' in length two (2) covers shall be provided; for MV over 20' three (3) covers shall be provided.
 - 2. Cover Legend: Cast in. Selected to suit system.
 - a. "COMMUNICATIONS"
 - 3. Manhole Chimney Components: Pre-cast concrete rings with dimensions matching to those of roof opening.
 - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C387, Type M, may be used. Manhole Sump Frame and Grate: ASTM A48/A 48M, Class 30B, gray cast iron.
 - 4. Pulling Irons in Concrete Walls:
 - a. Locate centrally over conduit ingress/egress locations: manufactured by Cooper Power Systems, Joslyn Manufacturing and Supply, Hubbell / Chance, or pre-approved equal. Devices shall be 7/8" in diameter with a length of 12" and a width

of 10-7/8"; irons shall be embedded within the walls with a max tension of 13,000 LBF.

- C. Pulling-In and Lifting Irons in Concrete Floors: 7/8 inch diameter, hot-dip galvanized, bent rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
 - 1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension
- D. Bolting Inserts for concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of non-corrosive, chemical-resistant, non-conductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.
 - 1. Tested Ultimate Pullout Strength: 12,000-lbf minimum.
- E. Expansion Anchors for Installation after Concrete is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
- F. Cable Rack Assembly: Stainless Steel stanchions and Non-metallic arms. Components fabricated from nonconductive, fiberglass-reinforced polymer.
- G. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- H. Fixed Manhole Ladders: Arranged for attachment to wall of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.
- I. Cover Hooks: Heavy duty, design for lifts 60-lbf and greater; two required, to be delivered to the Owner prior to Substantial Completion.

2.6 GROUNDING

- A. Ground Rods: UL-listed:
 - 1. Copper-clad steel; bonded copper electrolytically applied to minimum thickness of 10 mils
 - 2. 3/4" thick, by 10' long
 - 3. Manufacturer shall be:
 - a. Copperweld Steel Company
 - b. ITT Weaver
 - c. Thomas & Betts
 - d. Pre-Approved equal.

B. Grounding Conductors and Connectors

1. Manufacturers:

- a. Apache Grounding/Erco Inc.
- b. Boggs, Inc.
- c. Chance/Hubbell.
- d. Copperweld Corp.
- e. Dossert Corp.
- f. Erco Inc.; Electrical Products Group.
- g. FCI/Burndy Electrical.
- h. Galvan Industries, Inc.
- i. Harger Lightning Protection, Inc.
- j. Hastings Fiber Glass Products, Inc.
- k. Heary Brothers Lightning Protection Co.
- l. Ideal Industries, Inc.
- m. ILSCO.
- n. Kearney/Cooper Power Systems.
- o. Korns: C. C. Korns Co.; Division of Robroy Industries.
- p. Lightning Master Corp.
- q. Lyncole XIT Grounding.
- r. O-Z/Gedney Co.; a business of the EGS Electrical Group.
- s. Panduit, Inc
- t. Raco, Inc.; Division of Hubbell.
- u. Robbins Lightning, Inc.
- v. Salisbury: W. H. Salisbury & Co.
- w. Superior Grounding Systems, Inc.
- x. Thomas & Betts, Electrical.

- y. Or approved equivalent
- 2. Grounding Conductors
 - a. Grounding Electrode Conductors: Bare, stranded, unless otherwise indicated.
 - b. Underground Conductors: Tinned-copper conductor, No. 2/0 AWG minimum stranded unless otherwise indicated.
 - c. Bare Copper Conductors: Comply with the following:
 - 1) Solid Conductors: ASTM B 3.
 - 2) Assembly of Stranded Conductors: ASTM B 8.
 - 3) Tinned Conductors: ASTM B 33.
 - d. Copper Bonding Conductors: As follows:
 - 1) Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
 - 2) Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
 - 3) Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- 3. Connector Products
 - a. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
 - b. Bolted Connectors: Bolted-pressure-type connectors
 - 1) Compression Connectors: Burndy Hyground, or equal, permanent, pure, wrought copper, meeting ASTM 8 1 87, essentially the same as the conductors being connected; clearly and permanently marked with the information listed below:
 - a) Company symbol and/or logo.
 - b) Catalog number.
 - c) Conductors accommodated.
 - d) Installation die index number or die catalog number is required.
 - e) Underwriters Laboratories "Listing Mark:".

- f) The words "Suitable for Direct Burial" or, where space is limited, "Direct Burial" or "Burial" per UL Standard ANSI/UL467 (latest revision).
- 2) Cast connectors: copper base alloy according to ASTM B 30 (latest revision).
- c. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 UNDERGROUND DUCT APPLICATION

- A. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40 PVC, in concrete-encased or direct-buried duct bank, unless otherwise indicated
 - 1. For all changes in elevation or direction, conduit shall be RMC or concrete-encased PVC.
- B. Underground Ducts Crossing Paved Paths, Walks, and Driveways, Roadways, and Railroads: RNC, NEMA Type EPC-80 PVC, encased in reinforced concrete.

3.3 UNDERGROUND ENCLOSURE INSTALLATION

- A. Handholes and boxes Telephone, Communications, and Data Wiring:
 - 1. Units in roadways and Other Deliberate Traffic Paths: Pre-cast concrete. AASHTO HB H-20 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Pre-cast Concrete, AASHTO HB 17, H-20 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate loading by Vehicles: Pre-cast Concrete, AASHTO HB 17, H-10 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced Polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading
 - 5. Handholes shall be used as pull-through points only. Handholes shall not be used as splice points, unless authorized in writing by the design team.
 - 6. Handholes shall not be used in conduit runs that have more than (3) three 4" conduits.
 - 7. Joint use of handholes by other trades is not allowed.
- B. Manholes: Pre-cast concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.4 EARTHWORK

- A. Excavation and Backfilling: Comply with Division 31 Section "Earth Moving" but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling and compaction is complete.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants".
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching".

3.5 DUCT INSTALLATION

- A. Maintain a minimum trench depth to allow for the top row of conduits in the duct bank to be 36" below grade
- B. Contractor shall remove all rock and debris from backfill material. Contractor shall remove all excess material from the site and compact the excavation. Unpaved areas shall be finished flush with the surrounding natural ground. Contractor shall restore damaged grassed areas.
- C. Contractor shall tamp backfill material in 6" lifts with a mechanical tamp until compact density is at least equal to surrounding density
- D. For concrete and driveway approaches, contractor shall replace the entire joint of the approach unless otherwise directed by the Engineer. In areas with brick sidewalks, remove only the existing brick pavers necessary to install the conduit. Replace the brick pavers within seven (7) days of their removal. Furnish new bricks of similar type necessary to restore sidewalk area to its original appearance. Any new bricks shall identically match the existing brick pavers.
- E. Contractor shall backfill the trench at locations along the trench path where non-movable objects, such as rocks and boulders, cannot be avoided causing a deviation in the elevation height of the multi-duct conduit system. The purpose of the backfill is to provide a gradual change in elevation of the trench, from the bottom to the highest point of the obstruction such that excessive bending and stress will not be transferred to the conduits once the conduit system is installed.
- F. Slope: Pitch ducts a minimum slope of 1/2 % down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions
- G. All underground conduits shall be slurry capped sealed.

- H. Conduit lengths shall contain no continuous sections longer than 300 feet. If conduit lengths total more than 300 feet, pull points (manholes / handholes) shall be provided. The use of pull boxes to changes directions is prohibited, unless expressly detailed or indicated on the drawings.
- I. Conduits shall have no more than 180 degrees of cumulative bends between pull points or more than 90 degrees of bends at any one point. All bends must be long, sweeping bends with a radius of not less than six times the internal diameter of conduits 50mm (2 inches) or smaller, or ten times the internal diameter of conduits larger than 50mm (2 inches). 48" sweeps are preferred.
 - 1. For all changes in elevation or direction conduit shall change to RMC from PVC.
- J. Required separation from other utilities.
 - 1. Power up to 1KVA:
 - a. 12" of well-packed earth
 - b. 4" of masonry
 - c. 3" of concrete
 - 2. Gas, Oil, Water, etc.:
 - a. 12" when parallel
 - b. 6" when crossing
- K. All conduits shall be mandrelled prior to installation of cable or (for spare conduits) prior to substantial completion; the OD of the test mandrel shall be no smaller than 80% of the conduit internal diameter.
- L. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
- M. Duct Entrances to Manholes and Handholes: Use end bells, spaced approximately 10-inches OC for 4-inch ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell with out reducing duct line slope and without forming a trap in the line.
 - 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances
 - 4. All ends of conduits must be reamed.
 - 5. All conduits in the Telecommunications duct bank shall enter one end of the manhole / handhole and exit the opposite end, UON.

- N. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical".
- O. All conduits entering a building must be pitched to drain away from the building to avert water intrusion. To prevent conduit shearing, conduits entering through walls shall be RMC and extend to undisturbed earth, particularly where such backfill is susceptible to load bearing tension.
- P. Sealing: Provide temporary closure at termination of ducts that enter buildings. After cables have been installed, seal ducts (including spare) at termination.
- Q. Pulling Cord: Install 1250-lbf ½-inch (min) wide mule tape in all conduits and in all innerducts installed, including spares; all mule tape shall provide footage markers and be indexed to facilitate future identification.
- R. Concrete-Encased Ducts: Support ducts on duct separators.
 - 1. Separator installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Spacers shall be installed / utilized per the manufacturer's standard specifications. Couplings for conduits shall be staggered at least six (6) inches. Secure separators to earth and ducts to prevent floating during concreting. Stagger separators approximately 6-inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around the ducts or duct group.
 - 2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to the manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install ¾-inch reinforcing rod dowels 18-inches into concrete on both sides of joint near corners of envelope.
 - 3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct bank application.
 - 4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts: 3-inches between ducts and exterior envelope wall, 2-inches between ducts for like services, and 4-inches between power and signal ducts.
7. Depth: Install top of duct bank at least 24-inches below finished grade in areas not subject to deliberate traffic, and at least 30-inches below finished grade in deliberate traffic paths of vehicles, unless otherwise indicated.
8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3-inches of concrete.
 - b. Stub-ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60-inches from edge of base. Install insulated grounding bushings on terminations at equipment.
9. Warning Tape: Bury warning tape approximately 18 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3-inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18-inches. Space additional tapes 12-inches apart, horizontally
10. Tracer Wire: Provide an orange #6 AWG high strength copper clad steel with a high density polyethylene coated tracer wire' install by strapping it to the top row center conduit every 8-feet with a polyethylene-based tape; only (1) one tracer wire is required within the duct bank regardless of the number of conduits present. Tracer wire to terminate within every manhole / handhole to facilitate the application of an electrical current to the wire to aid in locating the duct bank in the future once the duct bank is buried.

S. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6-inches between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6-inches in nominal diameter.
4. Install backfill as specified in Division 31 Section "Earth Moving".
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and

contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4-inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving".

6. Install ducts with a minimum of 3-inches between ducts for like services and 6-inches between power and signal ducts, unless more restrictive separation is specified elsewhere in this section or on the drawings.
7. Depth: Install top of duct bank at least 36-inches below finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3-inches of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60-inches from edge of base. Install insulated grounding bushings on terminations at equipment.
10. Warning Planks: Bury warning planks approximately 18 inches above all direct-buried ducts and duct banks placing them 24-inches OC. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18-inches. Space additional planks 12-inches apart, horizontally.
11. Tracer Wire: Provide an orange #6 AWG high strength copper clad steel with a high density polyethylene coated tracer wire' install by strapping it to the top row center conduit every 8-feet with a polyethylene-based tape; only (1) one tracer wire is required within the duct bank regardless of the number of conduits present. Tracer wire to terminate within every manhole / handhole to facilitate the application of an electrical current to the wire to aid in locating the duct bank in the future once the duct bank is buried.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C891, unless otherwise indicated.
2. Install each unit level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.

B. Elevations:

1. Install manholes / handholes per manufacturer's instructions; lid to manhole / handhole to be flush with the surrounding terrain so that no earth, roadway or sidewalk removal is required to access the manhole / handhole interior. Contractor to provide chimney/ extensions / collars to facilitate the placement of the manholes / handholes so as to maintain the minimum distance to the surface above the highest row of conduits in the duct bank given the location of the manhole / handhole at the point of installation.
 2. Manhole Roof: Install with rooftop at least 15-inches below finished grade.
 3. Install handholes with bottom below the frost line, 15'' of frost line below grade at Project site.
 4. Handhole Covers: Set surface flush with finished grade.
- C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
- D. Manhole Access: Circular opening in manhole roof; sized to match cover size.
1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
 2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
- E. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section "Elastomeric Sheet Waterproofing." After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days
- F. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07 Section "Bituminous Dampproofing". After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
- G. Hardware: Install removable hardware, including pulling eye, cable stanchions, cable arms, and insulators, as required for installation and support of cable and conductors and as indicated.
- H. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- I. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8-inches for manholes and 2-inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- J. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover

3.7 GROUNDING

- A. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- B. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 6 AWG minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- C. Equipment Grounding Conductors
 - 1. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
 - 2. Underground Grounding Conductors: Bury at least 24 inches below grade, or 6 inches below the official frost line, whichever is greater, or when crossing a duct bank, bury 12 inches above duct bank.
- D. Connections
 - 1. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible. Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by the manufacturers for indicated applications. Provide electrical insulating tape, heat shrinkable insulating tubing, welding materials, and bonding straps as recommended by the manufacturers for types of service indicated.
 - a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - b. Make connections with clean, bare metal at points of contact.
 - c. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - d. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 - e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
 - 2. Compression Fittings: Permanent compression-type fittings may be used for the following:

- a. Connecting conductors together.
- b. Connecting conductors to ground rods
3. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A/B.
4. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
5. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

E. Field Quality Control

1. Testing: Perform the following field quality-control testing:
 - a. Test completed grounding system at each location. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.
 - b. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
 - c. Perform point-to-point megohmmeter tests between the ground rod and all cable shields, splice cases, locate wires, and racking hardware to determine the resistance.
 - d. Investigate point-to-point resistance values that exceed 0.5 ohms.
 - 1) Check for loose connections.
 - 2) Check for absent or broken connections.
 - 3) Check for poor quality welds.
 - 4) Consider other reasons.
 - e. Excessive Grounding Electrode Resistance: If measured resistance to earth ground value exceeds specified values, add grounding electrodes and additional conductors as required to obtain the specified value.

3.8 GRADING AND PLANTING

- A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 31 and 32. Maintain restored surfaces. Restore disturbed paving as indicated.

3.9 INSTALLATION ACCEPTANCE

- A. Prior to final acceptance of the duct bank and associated structures, pull an aluminum or wooden test mandrel through the duct to prove joint integrity and to verify ducts have not been deformed. Provide mandrel equal to 80 percent fill of the duct internal diameter.
- B. Test duct bank, manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified above. Correct any deficiencies and retest as specified above.
- C. Clean internal surfaces of manholes (including sumps) and handholes and remove foreign materials.
- D. Acquire written approval from the Owner prior to backfilling any duct banks or covering manholes / hand holes
 - 1. Provide Record Drawings indicating the exact pathway of the Telecommunications Duct bank include elevation changes and the location of all manholes/handholes. Label all manholes MH-xx and handholes HH-xx, where xx starts with the number 01 and increments by 1, coordinating exact labeling scheme with Owner.

END OF DOCUMENT 270543

DOCUMENT 271000 - STRUCTURED CABLING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide a complete functioning telecommunications structured cabling system, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.
- B. Specification sections 271000 through 271999, and Drawings numbered with prefixes TN, generally describe these systems, but the scope of the Structured Cabling System Work includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical, Communications, and Electronic Safety and Security Drawings and Specifications; and Addenda.
- C. This section includes additional requirements for the Structured Cabling (Telecommunications) System, which include the following:
 - 1. Quality Assurance requirements, including Contractor qualifications and advanced warranties

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Owner Requirements : City of Lee's Summit Telecommunications cabling system standards
- C. Division 27 Section "General Communications".
- D. Division 27 Section "Common Work Results for Communications".
- E. Requirements of this Section apply to all Sections 271000 through 271999.

1.3 STANDARDS

- A. The references to the following standards represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts and their addenda. The Contractor is responsible for following the correct revision or printing (UON):
 - 1. ANSI/TIA-568 – "Commercial Building Telecommunications Cabling Standard Set"
 - 2. ANSI/TIA-569 – "Commercial Building Standard for Telecommunications Pathways and Spaces"
 - 3. TIA-526 – "Standard Test Procedures for Fiber Optic Systems"

- TIA/EIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant – OFSTP-7
 - TIA/EIA-526-14 Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant – OFSTP-14
4. TIA/EIA-568-1 Commercial Building Telecommunications Cabling Standard Part 1: General Requirements
 5. TIA/EIA-568-2 Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components
 6. TIA/EIA-568-3 Optical Fiber Cabling Components Standard
 7. TIA/EIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces
 8. TIA/EIA-598 Optical Fiber Cable Color Coding
 9. TIA/EIA-606 Administration Standard for Commercial Telecommunications Infrastructure
 10. J-STD-607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 11. TIA/EIA-758 Customer-Owned Outside Plant Telecommunications Cabling Standard
 12. NFPA 70 National Electric Code
 13. BICSI Telecommunications Distribution Methods Manual, 14th Edition
 14. TIA TSB 140 – “Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems”
 15. ANSI/TIA-606 – “Administration Standard for Commercial Telecommunications Infrastructure
 16. ANSI/TIA-607 – “Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises”
 17. ANSI/BICSI/NECA 568 – “Standard for Installing Commercial Building Telecommunications Cabling”
 18. ANSI/TIA-758 – “Customer-Owned Outside Plant Telecommunications Cabling Standard”

1.4 GUIDELINES

- A. The references to the following guidelines represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts and their addenda. The Contractor is responsible for following the correct revision or printing (UON)

1. BICSI Information Technology Systems Installation Methods Manual (ITSIMM)
2. BICSI Telecommunications Distribution Methods Manual (TDMM)
3. BICSI Outside Plant Design Reference Manual (OSPDRM)

1.5 DEFINITIONS

- A. BICSI - Building Industry Consulting Service International
- B. Structured Cabling System – the physical infrastructure installed to support information technology/transport for voice and data applications, commonly referred to as a Telecommunications System. This includes, but is not limited to: Category 3/5e/6/6A copper cabling, terminations/blocks, modules, faceplates, etc., and optical fiber cabling, terminations, modules, etc.
- C. Wet Location - as defined in the NEC, installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

1.6 QUALITY ASSURANCE

- A. Personnel Qualifications:
 1. Provide and maintain a BICSI Registered RCDD in good standing on staff as a full-time employee at all times. This RCDD shall be familiar with the project and available to attend all scheduled project meetings when required by the Owner/Design Consultant. Weekly inspections and approval of all work performed shall be conducted by this RCDD.
 2. Provide and maintain a Project Manager whom is a BICSI Registered Certified Technician Level 2 Installer in good standing on site at all times. This project manager shall attend all scheduled project meetings and be responsible for all submittals.
 3. The person(s) conducting the testing for all Telecommunications cabling shall be a current BICSI Certified Level II Commercial Installer or higher.
 4. Any additional personnel that will be physically installing any part of the Telecommunications Infrastructure covered by this Division shall, at a minimum, be a BICSI Certified Level 1 Commercial Installer in good standing or have equivalent manufacturer training certificate (of those identified as approved for this project) and approved by the Design Consultant.
 5. These requirements are provided as a minimum level of qualification. Any additional or more stringent requirements by the specific manufacturer chosen to provide the proper level or term of warranty as specified in this division shall be met.
 6. Alternate qualifications may be considered if requested alternates are provided in accordance with the substitution section herein prior to bid.
- B. Contractor qualifications:

1. Provide a list of projects (no less than 2) of similar size, scope and type in which the Bidder has performed in a capacity comparable to the size, scope and type outlined in these Construction Documents. Provide the project name, relevant project information for comparison evaluation, and contact names with telephone numbers of each such project.

1.7 ADVANCED STRUCTURED CABLING SYSTEM WARRANTY

- A. All components, including but not limited to, connectors, terminal blocks, cabling and all other components considered to be a part of what is commonly referred to as an end-to-end solution for all backbone and horizontal cabling systems, shall be warranted for a minimum period of 20 years from the date of installation against defects in materials, equipment and workmanship. This warranty shall also include the performance of these systems. This warranty shall include transmission requirements as specified in applicable ANSI/TIA/IEC/ISO standards for each cable system specified. This warranty shall also include all current and future applications designed for and becomes available under warranty for each cable system.
 1. Warranty shall be guaranteed by reputable manufacturer from below:
 - a. Belden Incorporated (For Horizontal Cabling portion)
 - b. CommScope Inc. (For Horizontal Cabling and Fiber optic Cabling portion)
 - c. Mohawk (For Horizontal Cabling and Fiber optic Cabling portion)
 - d. Corning Cable Systems (for Fiber portion only)
 - e. Legrand/Ortronics (for Data connectivity and Fiber optic connectivity portion only)
 - f. Leviton/Berk-Tek
 - g. Mohawk Cable
 - h. Panduit (Data connectivity portion only)
 - i. Siemon (Data connectivity portion only)
 - j. Krone (For Data connectivity, Horizontal Cabling and Fiber optic Cabling portion)
 - k. SignalMax(for Fiber optic connectivity portion only)
 - l. Or Approved Substitution (submitted and accepted in the pre-bid submittal by City of LEE's summit)
- B. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.
- C. Perform the remedial work promptly, upon written notice from the Architect or Owner.
- D. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.8 WORK INCLUDED

- A. Provide labor, materials, and accessories required to provide complete, operating Telecommunications Infrastructure systems as called for in the Contract Documents and in accordance with applicable codes and regulations. Labor, materials or accessories not specifically called for in the Contract Documents, but required to provide complete, operating infrastructure systems shall be provided without additional cost to the Owner. The work includes, but is not necessarily limited to, the following:
1. All horizontal cabling between the Telecommunications rooms and the outlets.
 2. All backbone cabling, including cabling between the Telecommunications Entrance Facility Room and the Telecommunications rooms and designated Telecommunications equipment rooms.
 3. All termination blocks, outlets/jacks, patch panels, patch cords and station cables, cabinets, equipment racks, etc., required to support, terminate and/or cross connect cabling at the main cross-connect, Telecommunication rooms and/or other designated equipment locations.
 4. All physical cable management hardware including, but not limited to: "J-hooks" in accessible ceiling areas, cable trays, conduits, ladder-type cable racks within telecommunication rooms and "D-rings" on backboards and equipment racks/cabinets/frames.
 5. A Grounding/Bonding System, as described in these construction documents.
 6. Termination, cross connect and patching of all cable pairs as indicated herein or on schedules or on drawings.
 7. Testing, labeling and documentation of all cables and hardware installed under this contract.
 8. Preparation and submission of shop drawings, testing reports, as-built drawings, and cabling documentation as described below.

1.9 COORDINATION

- A. The locations of cable termination fields, outlets, patch panels, equipment racks and other equipment indicated on the Drawings are approximately correct, but they are understood to be subject to such revision as may be found necessary or desirable at the time the work is installed in consequence of increase or reduction of the number of outlets, or in order to meet field conditions, or to coordinate with modular requirements of ceilings, or to simplify the work, or for other legitimate causes.
- B. Exercise particular caution with reference to the location of outlets, patch panels, control panels, switches, etc., and have precise and definite locations accepted by the Architect before proceeding with the installation.
- C. The Drawings show only the general run of raceways and approximate locations of outlets. Any significant changes in location of outlets, cabinets, etc., necessary in order to meet field conditions shall be brought to the immediate attention of the Architect for review before such alterations are made. Modifications shall be made at no additional cost to the Owner.

- D. Verify with the Architect the exact location and mounting height of outlets and equipment not dimensionally located on the Drawings.
- E. Outlet/cable tags in the form of alpha/numeric characters are used where shown to indicate the outlet and cable designation numbers in cable termination fields (terminal blocks and/or patch panels). Show the actual outlet/cable numbers on the as-built drawings, on the associated typed termination field labels and in the printed and computer readable cabling schedules. Where sample outlet/cable-numbering information is not indicated, request clarification from the Architect.
- F. The drawings generally do not indicate the number of cables in conduit, or the actual identity of cables in specific conduits, cable tray or other cabling pathways. Provide the correct cable type and quantity as required by the indicated outlets, cable schedules, the design intent of any example drawings or schedules, referenced wiring diagrams (if any), the maximum distance limitations, and the applicable requirements of the NEC and ANSI/TIA-568.
- G. Adjust location of conduits, terminal blocks, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication.
 - 1. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
 - 2. Provide offsets, transitions and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.

1.10 SUBMITTALS

- A. Refer to requirements in Division 27 Section "General Communications Requirements". At a minimum, include the following items:
 - 1. Pre-bid submittal
 - a. Product substitutions, approved alternate or equivalent requests to be reviewed for approval (Prior to Bid)
 - b. Alternate personnel credentials to be reviewed for approval
 - 2. Bid submittal
 - a. Bid Response Forms
 - b. Personnel Qualifications / Credentials - Supplemental to Division 1 requirements submit the following documents to indicate the required personnel qualifications per the quality assurance section of this section:
 - 1) Member of staff required to be RCDD

- a) A copy of their valid RCDD certificate, RCDD number, and BICSI member number shall be provided with bidding documents.
 - 2) On-site project manager
 - a) A copy of their valid BICSI Certified Technician certificate and BICSI member number shall be provided with bidding documents.
 - 3) Other personnel physically installing any portion of the Communications infrastructure
 - a) A copy of their valid BICSI Commercial Installer certificate and BICSI member number shall be provided with bidding documents
 - b) An alternate certification may be considered by the Design Consultant for approval, which shall be completely at the Design Consultant's discretion.
 - c) If the contractor chooses to submit an alternate certification from one of the conditionally approved vendor list as an acceptable alternate for a BICSI Commercial Installer, the following shall be included:
 - i) A valid copy of each certification with the person's name and member number including the manufacturer's logo
 - ii) A document provided by the manufacturer describing what specific subjects the certification covers, period of time spent doing course work required to gain certification, exam topics, and the requirements needed to maintain the certification.
 - 4) Contractor Qualifications (Previous project references)
 - 5) Voluntary Bid Alternates
3. Pre-construction submittal
- a. Warranty information
 - 1) Sample warranty certificate for the Advanced System Warranty, indicating manufacturer and terms/conditions
 - 2) Proof that Contractor is certified with the Advanced System Warranty manufacturer
 - b. Resubmit Contractor and Personnel Qualification, update if necessary
 - c. A typed list, indexed by Specification section, of products specifically identified by part number (no wild card characters) within each specification section in this Division. Order shall match that as in these specifications.
 - d. Manufacturers' cut-sheets, in same order as typed list and in these specifications.

- 1) At a minimum all cut-sheets shall contain the following:
 - a) Cross-reference to the specification section and/or drawings for which the product is to be reviewed for compliance and acceptance
 - b) Every product cut-sheet submitted for review shall contain the manufacturers' name and logo
 - c) All parts, pieces, and equipment submitted for review shall be identified specifically by stamp, or highlighted in such a manner that the product(s) being considered are clearly identifiable and distinguished from all other materials, parts or equipment that may be on the submittal.
 - d) For cut-sheets with accessories, additional parts, or derivations of the product being submitted all shall be clearly identified for the reviewer and acceptance.
 - e) Sufficient detail for reviewer to identify all required information, such as size, weight, color, NRTL listings, approval or certification information, and other necessary identifying information to confirm product meets specifications.
- e. Shop Drawings
- f. And as required by individual sections in this Division
4. Project completion submittal
 - a. Preliminary Project Completion submittal requirements:
 - 1) To be submitted:
 - a) After all horizontal and backbone cabling has been installed, terminated, labeled, tested, and corrected so that all cables and strands pass the Testing Requirements.
 - b) In conjunction with the Substantial Completion Review request.
 - i) Design Consultant requires a minimum of 2 weeks notice to schedule the on-site Substantial Completion Review.
 - ii) Substantial Completion Review shall be a minimum of 2 weeks before Substantial Completion, or earlier if the Project Schedule requires it, to allow for major Punch List items to be address by Contractor.
 - 2) Submittal shall include:
 - a) Scanned Work Site Prints that include horizontal and backbone cable/outlet labels that correspond to the Test Results.

- b) Passing Test Results for all cables and strands, in the following formats:
 - i) Abbreviated Test Results in Excel or CVS file format, shown in numerical/alphabetical order, with the following information:
 - (1) Project Name
 - (2) Date of Preparation
 - (3) ID of Work Area Outlet / connector being tested
 - (4) Date of test
 - (5) Contractor's Name
 - (6) Media Type
 - (7) Make, Model, and Serial Number of test equipment used
 - (8) Date of last calibration
 - (9) Names of test crew
 - (10) Serving Telecommunications Room Number (all tests shall be submitted in numerical / alphabetical order by Telecommunications Room)
 - (11) Category or type of cable being tested
 - (12) Pass or Fail status
 - ii) Full Test Results in the original file format of the tester (example: .mdb file), shown in numerical/alphabetical order, with the following information:
 - (1) Project Name
 - (2) Date of Preparation
 - (3) ID of Work Area Outlet / connector being tested
 - (4) Date of test
 - (5) Contractor's Name
 - (6) Media Type
 - (7) Make, Model, and Serial Number of test equipment used
 - (8) Date of last calibration

- (9) Names of test crew
 - (10) Serving Telecommunications Room Number (all tests shall be submitted in numerical / alphabetical order by Telecommunications Room)
 - (11) Category or type of cable being tested
 - (12) Full Test Result Data (per Part 3 of this specification)
- b. Final Project Completion submittal requirements:
- 1) Advanced Structured Cabling System Warranty Certificate. Warranty terms and conditions shall contain the following:
 - a) Length of warranty period
 - b) Applications covered (future and present)
 - c) Single manufacturer responsible for fulfilling warranty
 - d) Who is covered
 - e) What is covered
 - f) All disclaimers, limitations, etc.
 - g) What, if anything, is not covered
 - 2) Product Information
 - a) Product List (Bill of Materials) – a typed list of products (in order of these specifications), in Excel or CSV file format, indicating:
 - i) Product Type (as identified in these specifications)
 - ii) Manufacturer
 - iii) Model Number
 - iv) Quantity installed
 - v) Serial Number (if applicable)
 - vi) Manufacturer Warranty date (if longer than 1 year)
 - b) Manufacturer Cut Sheets / Specification Sheets
 - c) Operation and Maintenance Manuals – manufacturer's installation, service, and maintenance instructions.

- d) Warranty certificates (for products not covered by the Advanced System Warranty)
 - i) If products require registration, register on the Owner's behalf.
- 3) As Built Drawings
 - a) At the completion of the project, incorporate changes to the Structured Cabling System noted on the jobsite work prints onto a set of as built Drawings. These changes shall be done electronically and saved to PDF format.
 - b) Include date and installing contractor's logo and contact information in the title block.
 - c) Mark each sheet "As Built Drawing".
 - d) Drawings shall include:
 - i) Corrected items from Substantial Completion Review punch list.
 - ii) Cable ID (all characters) for each work area outlet jack (so that they are searchable in the PDF version)
 - iii) Routing of cable/conduit/cable tray and location of any firestopping systems and pull boxes.
 - iv) Project RCDD's stamp, which indicates that the project has been installed in compliance with industry standards and the contract documents.
- 4) Updated, complete Test Results in the following formats (to include the retesting data of any cables installed or modified after Preliminary Project Completion submittal):
 - a) Abbreviated Test Results in Excel or CVS file format, shown in numerical/alphabetical order, with the following information:
 - i) Project Name
 - ii) Date of Preparation
 - iii) ID of Work Area Outlet / connector being tested
 - iv) Date of test
 - v) Contractor's Name
 - vi) Media Type
 - vii) Make, Model, and Serial Number of test equipment used

- viii) Date of last calibration
 - ix) Names of test crew
 - x) Serving Telecommunications Room Number (all tests shall be submitted in numerical / alphabetical order by Telecommunications Room)
 - xi) Category or type of cable being tested
 - xii) Pass or Fail status
- b) Full Test Results in the original file format of the tester (example: .mdb file), shown in numerical/alphabetical order, with the following information:
- i) Project Name
 - ii) Date of Preparation
 - iii) ID of Work Area Outlet / connector being tested
 - iv) Date of test
 - v) Contractor's Name
 - vi) Media Type
 - vii) Make, Model, and Serial Number of test equipment used
 - viii) Date of last calibration
 - ix) Names of test crew
 - x) Serving Telecommunications Room Number (all tests shall be submitted in numerical / alphabetical order by Telecommunications Room)
 - xi) Category or type of cable being tested
 - xii) Full Test Result Data (per Part 3 of this specification)
- B. Each structured cabling section (271000-271999) shall be submitted individually. All structured cabling section submittals (271000-271999) shall be submitted on the same date. "Piecemeal" submissions will not be reviewed.
- C. For each room or area of the building containing Structured Cabling System infrastructure and equipment, submit the following as part of the shop-drawings and as-built drawings:
- 1. Floor plans, at not less than 1/8" scale, showing routing of Communications conduits, cable trays, and wireways, including surface-mounted raceways and pullboxes. Also show the

routing of bundles of cables supported by "J-hooks", or similar means, if and where such installation practices are allowed by the Contract Documents.

- a. Outlet locations shall be identified with jack/module type and label. Coordinate labeling scheme with Owner prior to submitting.
 2. Riser diagrams showing types, quantities and schematic routing of all Communications backbone pathways, cabling and the TBB and TBC.
 3. Enlarged plan views and elevation layout drawings for the Telecommunications Entrance Facility Room, Telecommunications Rooms and all other designated Telecommunications Equipment Rooms indicating the equipment in the exact location in which it is intended to be installed. These plans shall be of a scale not less than $\frac{1}{4}$ inch = 1'-0". They shall be prepared in the following manner:
 - a. Indicate the physical boundaries of the space including door swings and ceiling heights and ceiling types (as applicable).
 - b. Illustrate all Communications equipment proposed to be contained therein. The Drawings shall be prepared utilizing the dimensions contained in the individual equipment submittals. Indicate code and manufacturer's required clearances.
 - c. Illustrate all other equipment therein such as conduits, detectors, lighting fixtures, ducts, registers, pull boxes, wireways, structural elements, etc.
 - d. Indicate the operating weight of each piece of equipment.
 - e. Indicate dimensions to confirm compliance with code-required clearances.
 - f. Indicate maximum normal allowable operating temperature for each piece of equipment (as per each respective manufacturer's recommendation). (Note: This requirement applies to active Communications equipment such as LAN hubs, routers, amplifiers, radio transmitters/receivers, PBX or key telephone equipment, etc., if installed under this work.)
 - g. Equipment removal routes for individual equipment items with plan dimensions exceeding 24" by 36" or height exceeding 84".
 - D. The Communications Equipment room layout submittals and the related Structured Cabling System submittals shall be submitted concurrently. Failure to submit concurrently may result in the immediate return of the submittal marked REVISE AND RESUBMIT.
- 1.11 SPARE PARTS
- A. Furnish to the Owner the following spare parts as part of the complete Structured Cabling System:
 1. Any custom or proprietary copper Category cable termination tool.
 2. Furnish and install select Patch Cables and Station Cords in quantities, lengths, and colors as specified in Division 27 "Telecommunications Equipment Room Fittings".

3. Additional Special Tools, as defined in Part 3 of this specification.
- B. Have these spare parts in the Main Communications Room during Design Consultant's Site Observation Review visit; turn over to Owner before Substantial Completion.

PART 2 - PRODUCTS

2.1 110-STYLE PUNCHDOWN TOOL

- A. Manufacturer shall be Panduit PDT-110 or equivalent.

2.2 COPPER TESTING EQUIPMENT

- A. Category 3/5e Cable Tester

1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.

- a. Category 3/5e UTP cable Tester

- 1) Fluke
- 2) Ideal
- 3) Softing
- 4) Viavi

2. Requirements

- a. The field tester shall be a level II-E (IIe) or greater.
- b. The field tester shall meet the requirements of ANSI/TIA-568.

- B. Augmented Category 6 Cable Tester

1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.

- a. Augmented Category 6 Cable Tester

- 1) Fluke
- 2) Ideal
- 3) Softing
- 4) Viavi

2. Requirements

- a. The field tester shall be a level III-E (IIIe) or greater.

- b. The field tester shall meet the requirements of ANSI/TIA-568.

C. ISO/IEC Class F Cable Tester

- 1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.

- a. ISO/IEC Class F Cable Tester

- 1) Fluke
- 2) Ideal
- 3) Softing
- 4) Viavi

- 2. Requirements

- a. The field tester shall be a level III-E (IIIe) or greater.
- b. The field tester shall meet the requirements of ISO/IEC 11801.

2.3 OPTICAL FIBER TESTING EQUIPMENT

A. OPTICAL TIME DOMAIN REFLECTOMETER (OTDR)

- 1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.

- a. Optical Time Domain Reflectometer (OTDR)

- 1) Fluke
- 2) Ideal
- 3) Softing
- 4) Viavi

- 2. Requirements

- a. An OTDR shall be used to provide Tier Two testing, which shall provide information regarding attenuation, connector location and insertion loss, splice location and splice loss, and any other power loss events that may have been created during installation.
- b. The OTDR shall be utilized from both ends of the fiber strand to better isolate any potential problems.
- c. For unterminated fiber, a "bare fiber adapter" shall be utilized.

B. OPTICAL POWER MEASUREMENT METER

- a. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.

- 1) Optical Power Measurement Meter

- a) Fluke
- b) Ideal
- c) Softing
- d) Viavi

2. Requirements

- a. An Optical Loss Test Set (OLTS) shall be used to provide Tier One testing, which shall provide information regarding link attenuation, continuity, and polarity of the installed fiber optic cable.
- b. The OLTS shall be used with the appropriate adapters to allow connectivity to the optical fiber link.
- c. The OLTS shall meet the launch requirements of ANSI/TIA-455-78B.

C. OPTICAL FIBER INSPECTION SCOPE (or FIBER VIEWERS)

1. Available Manufacturers. Contractor may submit other cable testers that meet specification requirements.

- a. Optical Fiber Inspection Scope

- 1) AFL
- 2) EXFO
- 3) Fluke
- 4) Softing
- 5) Viavi

2. Requirements

- a. An Optical Fiber Inspection Scope shall be utilized to examine all ends of fiber optic strands prior to splicing or termination.
- b. The Optical Fiber Inspection Scope shall have a minimum of 400x magnification. If the cable and/or connectivity manufacturer requires greater magnification to meet their installation requirements, the more restrictive standard shall apply.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 IDENTIFICATION / LABELING

A. General

1. Labels or tags containing a unique cable ID designator as specified on the drawings or herein shall be placed on both ends of all cables, 6 inches (152.4 mm) from the connector and/or terminal block.
2. Label or tag all cables passing through Telecommunications rooms.
3. Subsequent to placing and terminating cables, place the appropriate cable label.
4. The administration of the Telecommunications infrastructure includes:
 - a. Labels (plates, tags, etc.) to identify individual components.
 - b. Schedules (or other records (printed and/or in computer data base form) to document information about the individual components and the relationships between them.
 - c. Plans or drawings to assist with visualizing the physical and/or logical locations of the components.
5. Provide labels on all applicable items installed under this work and to provide all related records and drawings so that the Owner will be able to administer the Telecommunications infrastructure.

B. Labeling Installation

1. Labels that are to be secured by adhesive shall have a type of adhesive that is appropriate for the particular surface upon which the label is to be installed. The mounting surface shall be free of dust, dirt, oil, etc. that would impede the adhesion of the labels.
2. Labels, plates and tags are to be installed in such a manner that they will be accessible, both physically and visually, after completion of the work. (Exception: It is understood that labels on the outlet end of station cables are generally not visible unless the face plates, bezel, module, etc., is removed or opened.)
3. Any temporary labels used during installation, cable pulling, etc. are to be removed and replaced by the permanent labels identified in Part 2 of this specification before the work will be accepted.
4. If at any time during the job the cable tag becomes illegible or removed for whatever reason during the construction period, immediately replace it with a duplicate pre-printed cable tag at the Contractor's expense before the work will be accepted.

C. Labeling Requirements

1. Labels, plates and tags are to be installed on:
 - a. All Telecommunications rooms (spaces).
 - b. All horizontal links and their components, including:
 - 1) Attaching a label no more than 6 inches (152.4 mm) from both ends of all horizontal cables installed under this work.
 - 2) Labeling/Color Coding of cable termination hardware (terminal blocks, outlets, patch panel jacks, etc.) installed under this work.
 - 3) Labeling/Color Coding of major termination assemblies (such as termination fields or frames, racks, etc.) installed under this work.
 - 4) Labeling the Telecommunications outlet housing individual connectors in the work area.
 - a) Labeling each connector terminating horizontal cables in these outlets.
 - b) Label identification within a given space (work area) shall begin at the entrance to the space and proceed in a clockwise manner around the space.
 - 5) Any additional components required by ANSI/TIA-606
 - c. All components of the commercial grounding and bonding system for Telecommunications; to include but not limited to all bonding conductors, PBB and SBB's.
 - d. All building backbone cables and their components, including:
 - 1) Attaching a label no more than 6 inches (152.4 mm) from both ends of all backbone cables installed under this work.
 - 2) Labeling of backbone cables as they transit through other Telecommunications rooms (spaces)
 - 3) Labeling/Color Coding of cable termination hardware (terminal blocks, outlets, patch panel jacks, etc.) installed under this work.
 - 4) Labeling/Color Coding of major termination assemblies (such as termination fields or frames, racks, etc.) installed under this work
 - 5) Any additional components required by ANSI/TIA-606.
 - e. All required fire stopping systems.
 - f. All campus backbone cables and their components, including:

- 1) Attaching a label no more than 6 inches (152.4 mm) from both ends of all backbone cables installed under this work.
 - 2) Labeling of backbone cables as they transit through other Telecommunications rooms (spaces)
 - 3) Labeling/Color Coding of cable termination hardware (terminal blocks, outlets, patch panel jacks, etc.) installed under this work.
 - 4) Labeling/Color Coding of major termination assemblies (such as termination fields or frames, racks, etc.) installed under this work
 - 5) Any additional components required by ANSI/TIA-606.
- g. All pathways (e.g., inner duct, cable racking, conduit, etc.) installed under this work.
- 1) All interior pathways including cable trays and conduits shall be striped, traced, colored, or marked.
- h. Provision of a database that records appropriate information regarding all cabling, terminations, frames, racks, etc. installed under this work.
- i. In general, the label, plate or tag is to be provided and installed by whoever installed the item that is being labeled.
- j. Refer to individual Telecommunications specification sections (Division 27) and to the Telecommunications drawings for additional information on labeling requirements.

3.3 TEST REPORTS FOR THE STRUCTURED CABLING SYSTEM

A. General cable testing

1. Pre-installation testing:

- a. Visually inspect all cables, cable reels/boxes, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
- b. Where post-manufacturer test data has been provided by the manufacturer on the reel, box or shipping carton: submit copies to the Owner prior to installing cables.
- c. Mark reels or boxes as tested/inspected and submit associated test results to Owner/Design Consultant.
- d. Do not install any cable with less than the manufacturer's guaranteed number of serviceable conductors.

2. Post-installation testing:

- a. Calibrate all testers prior to use in accordance with manufacturers' printed instructions.
 - b. Conduct cable testing as described below upon completion of installation. Test fully completed systems only. Piecemeal testing is not acceptable.
 - c. Remove all defective cables from pathway systems. Do not abandon cables in place.
3. All test results and corrective procedures are to be documented and submitted to the Owner within five (5) working days of test completion.
 - a. Prior to testing, submit for review and approval copies of test report forms proposed for use.
 - b. Each test report shall contain the following general information: Date of Preparation, Date of Test, Project Name, Contractor's Name, Media Type, Make, Model and Serial Number of test equipment used, Date of Last Calibration and Names of Test Crew.

B. Copper cable testing

1. Perform all manufacturer recommended and required test calibration procedures prior to testing any cables.
2. Paired and multi-conductor riser metallic cables:
 - a. After terminating and splicing the cables. Test all cable pairs for continuity, ground fault, proper cross-connection, shorts and crossed pairs.
 - b. After installing cross-connects, perform end-to-end testing of each cross-connected cable pair for continuity, ground fault, proper cross-connection, shorts and crossed pairs.
 - c. Cable test reports: As a minimum, also provide: cable number, cable type, pair or conductor count, individual pair or conductor numbers, number of cross-connects and/or patches in each pair, results of each test for each pair or conductor, total number of serviceable pairs or conductors in cable.
3. Four-Pair Cables:
 - a. After terminating both ends of all 4-pair cables, but before any cross-connects are installed, test these cables for the following:
 - 1) Category 3 Cables and high pair count cables (25, 50, 100, 200-pairs, etc.).
 - a) Wire map
 - b) Length
 - c) Insertion loss

- d) Near-end crosstalk (NEXT) loss
 - e) Propagation delay
 - f) Delay skew
- 2) Augmented Category 6 F/UTP Cables
- a) Wire map
 - b) Length
 - c) Insertion loss
 - d) Near-end crosstalk (NEXT) loss.
 - e) Power sum near-end crosstalk (PSNEXT)
 - f) Equal-level far-end crosstalk (ELFEXT)
 - g) Power sum equal-level far-end crosstalk (PSELFEXT)
 - h) Return loss
 - i) Propagation delay
 - j) Delay skew
 - k) Alien Crosstalk (AXTalk) – Follow manufacturer's instructions for method
4. After installing cross-connects, perform end-to-end testing of each cross-connected cable for continuity, ground fault, proper cross-connection, shorts and crossed pairs. For 100 pair or smaller cables, replace entire cable if bad pair is found. For larger pair-count cables, replace if more than 1% of pairs are bad.
5. Submit the following information regarding the cable testing: cable number, cable type, pair or conductor count, individual pair or conductor numbers, number of cross-connects and/or patches in each pair (if applicable), results of each test for each pair and total number of serviceable pairs in cable.
6. In addition to the tests specified above, provide a minimum of two suitably qualified cabling technicians and copper test equipment to be present on-site for a period of 2 hours during the Design Consultant's Substantial Completion Review. Be prepared to conduct on-the-spot cable tests as requested. Successful equipment performance tests do not relieve the Contractor from the specified testing, repair, and documentation requirements.
- C. Optical Fiber cable testing
1. Post-installation testing:

- a. After installation of connectors, visually inspect each fiber end-face at 50X magnification. Refinish fibers with visible defects and/or striations in the core area.
 - b. Perform end-to-end, bi-directional attenuation (loss) test for each multimode fiber strand at 850nm and 1300nm. Conduct tests in accordance with TIA-526-14, Method B and with test instrument manufacturer's printed instructions.
 - c. Perform end-to-end, bi-directional attenuation (loss) test for each singlemode fiber strand at 1310 and 1550 wavelengths. Conduct tests in accordance with TIA-526-7, Method A.1 and with test instrument manufacturer's printed instructions.
 - d. Demonstrate that measured link loss does not exceed the "worst case" allowable loss which is defined as the sum of: the connector losses (based on the number of mated connector pairs at the ANSI/TIA-568 maximum allowable loss of 0.75dB per mated pair) and the optical fiber loss (based on length and the ANSI/TIA-568 maximum allowable loss (3.5dB/km @ 850nm and 1.5dB/km @ 1300nm for multi-mode and 1.0dB/km @ 1300 and 1550nm for single-mode) by more than 1.0dB.
 - e. Strands whose measured attenuation fall outside the acceptable range shall be subject to further inspection and testing to determine the nature of the fault. At a minimum, at OTDR shall be used to: determine the true loss for each connector pair, the exact length of the fiber and to identify the presence of any core damage.
 - f. Faults related to fiber being connectorized shall be corrected, and the fiber re-tested as described above, until acceptable attenuation measurements are recorded.
 - g. Where defects are found to be inherent in the fiber itself: replace any cable having fewer than the manufacturer's guaranteed number of serviceable fibers.
 - h. Provide testing in accordance with manufacturer's requirements for a fully-warranted cabling system(s) as required by these Contract Documents.
2. Testing jumpers used shall remain connected at the test equipment for the entire duration of testing. If at any time the jumper becomes loose or removed, for any reason, the jumper shall be reinstalled and re-referenced. This procedure shall be documented each time it is performed to indicate date, time and who performed the procedure. This log shall accompany test reports submitted.
3. All test results and corrective procedures are to be documented and submitted to the Owner within five (5) working days of test completion.
 - a. Prior to testing, submit for review and approval copies of test report forms proposed for use.
 - b. Each test report shall contain the following general information: Date of Preparation, Date of Test, Project Name, Contractor's Name, Media Type, Make, Model and Serial Number of test equipment used, Date of Last Calibration and Names of Test Crew.

- c. Cable number, fiber count, individual fiber numbers, connector types, number of connectors/patches, calculated maximum link loss, length or run, measured link loss for each fiber.
4. In addition to the tests specified above, provide a minimum of two suitably qualified cabling technicians and fiber test equipment to be present on-site for a period of 2 hours during the Design Consultant's Substantial Completion Review. Be prepared to conduct on-the-spot cable tests as requested. Successful equipment performance tests do not relieve the Contractor from the specified testing, repair, and documentation requirements.

D. Acceptance

1. The Owner and Design Consultant reserve the right to observe the conduct of any or all portions of the testing process.
 - a. The Owner and Design Consultant further reserves the right to request the Contractor conduct a random re-test of up to ten percent (10%) of the cable plant to confirm documented test results during the Substantial Completion Review. If more than one of these randomly tested cables do not pass, the Owner and Design Consultant reserves the right to require a re-testing of 100% of the cable plant, all without additional costs to the project.
2. For 100 pair or smaller replace entire cable if a bad pair or conductor is found. For larger pair count cables, replace if more than 1% of pairs are bad.
3. All test results are to be documented and submitted to the Architect in a timely manner, in accordance with the Submittal instructions in Part 1 of this section.
 - a. Corrective procedures following the Substantial Completion Review shall be properly documented, and affected and new cables shall be retested prior to Substantial Completion.
 - b. Updated complete Test Results, including retested, new and unaffected cables, shall be included in the Final Project Completion submittal.

3.4 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:
 1. The complete build-out of all Communications Rooms, cleaned of dust and debris.
 2. Installation, termination, final labeling, and testing of all backbone and horizontal cabling.
 3. The installation and labeling of all firestopping systems required for Telecommunications cabling and outlets. If firestopping was provided by a separate contractor (per Division 27 "Common Work Results for Communications"), ensure all firestopping systems are installed and labeled.
 4. The installation, labeling, and testing of the Telecommunications Grounding and Bonding System.

5. Ensure faceplates are level, free of dust and paint, match color/style of adjacent electrical receptacle, and have blue protective film removed.
 6. Update jobsite Work Prints with all individual port / cable IDs, which shall correspond to the cable IDs in the Test Results.
 - a. These shall then be scanned to PDF (minimum resolution of 150 dpi) to be included in the Preliminary Project Completion documentation outlined in the Part 1 Submittal requirements earlier in this section.
 - B. Request in writing a review for Substantial Completion. Refer to Part 1 Submittal requirements earlier in this section for required notice and Preliminary Project Completion documentation that shall be included with this request.
 - C. State in the written request that the Contractor has complied with the requirements for Substantial Completion for the (Telecommunications) Structured Cabling System.
 - D. Upon receipt of a request for review, the Architect will either proceed with the review or advise the Contractor of unfilled requirements.
 - E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, then provide reimbursement to the Architect and Design Consultant for time and expenses incurred for the visit.
 - F. Upon completion of the review, the Architect and Design Consultant will prepare a "final list" of outstanding items to be completed or corrected for final acceptance. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.
- 3.5 SPECIAL TOOLS
- A. Delivery to Owner's representative 2 complete sets (UON) of all special tools and small equipment items needed for proper operation, adjustment and maintenance of cabling and equipment installed under this work. All tools to be new and still in manufacturers packaging. The cost for these tools is to be included within the bid price for this work.
 - B. The terms "special tools" and "small equipment items" is meant to include such items as punch down tools, connector assembly tools, etc. with each individual item having a retail replacement cost not exceeding five hundred dollars (\$500.00). It is NOT meant to include common hand tools such as standard screwdrivers, pliers, wrenches, etc.

END OF DOCUMENT 271000

DOCUMENT 271100 - TELECOMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes fittings that are within the physical walls of the communications equipment rooms to support the Telecommunications System. Fittings include but are not limited to:
 - 1. Bonding and Grounding (Earthing)
 - 2. Plywood Backboard
 - 3. Entrance Protection
 - 4. Cabinets, Racks, Frames, and Enclosures
 - 5. Termination Blocks and Patch Panels
 - 6. Patch Cables and Station Cords
 - 7. Cable Management and Ladder Rack
 - 8. Rack-mounted Power Equipment
- B. Section does not specify fittings such as cables, cable terminations, or faceplates for structured cable system (SCS). These components are specified in the Division 27 Section "Communications Backbone Cabling" and Division 27 Section "Communications Horizontal Cabling".
- C. Section does not specify fittings for audio video system(s). These components are specified in the Division 27 Section "Audio Video Systems" and "Broadcast Audio Video Systems".

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING

- A. Follow all applicable codes, references, and standards listed in Division 27 Sections "General Communications Requirements" and "Structured Cabling System".
- B. Division 26 Section "Grounding and Bonding for Electrical Systems".

1.3 DEFINITIONS

- A. Backbone Bonding Conductor (BBC) – The conductor that interconnects elements of the telecommunications grounding infrastructure.
- B. Communications Equipment Room – This term shall apply to spaces specifically designed to maintain communications equipment. This definition shall encompass ANSI/TIA-569 terms for Entrance Room, Common Equipment Room (CER), and Common Telecommunications Room (CTR). This definition also shall encompass BICSI Telecommunications Distribution Methods Manual terms for Telecommunications Room (TR), Telecommunications Enclosure (TE), Equipment Room (ER), and Entrance Facility (EF).

- C. Communications Entrance Protection – Fittings that reduce risk to life, limb, or property by protecting against power surges. This definition shall encompass protection devices and fittings described in Article 770 “Optical Fiber Cables and Raceways” and Article 800 “Communications Circuits” of NFPA 70 “National Electrical Code”.
- D. Communications Cabinet – A floor or wall mount unit enclosed with side panels. Communications equipment is supported by mounting rails separated at 19” or 23” inches.
- E. Communications Rack – A floor or wall mount unit without side panels. Racks can be 2-post or 4-post. Communications equipment is supported by mounting rails separated at 19” or 23” inches.
- F. Communications Frame - A floor or wall mount unit without side panels. Communications termination blocks are the only communications devices mounted to the unit.
- G. Communications Enclosure – A floor or wall mount unit enclosed with side panels. Communications equipment is not supported by mounting rails separated by 19” or 23” inches. This definition shall encompass BICSI Telecommunications Distribution Methods Manual term for Telecommunications Enclosure (TE).
- H. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.
- I. Primary Bonding Busbar (PBB) – A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.
- J. Secondary Bonding Busbar (SBB) – A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.
- K. Telecommunications Bonding Backbone (TBB) – A conductor that interconnects the Primary Bonding Busbar (PBB) to the Secondary Bonding Busbar (SBB).
- L. Telecommunications Bonding Conductor (TBC) – A conductor that interconnects the telecommunications bonding infrastructure to the building’s service equipment (power) ground.

1.4 SUBMITTALS

- A. Follow the requirements for submittals in Division 27 Section “General Communications Requirements”, as well as the detailed Submittal requirements in Section “Structured Cabling System”. The following additional items shall be submitted:
- B. Pre-Bid Phase:
 - 1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution provide submittals with sufficient detail for review by the Engineer. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.
- C. “Pre-construction” submittal:

1. Shop Drawings:

- a. Submit for review scaled layout drawings showing the layout of equipment racks, ground bars, wall mounted equipment and termination blocks, conduits, and ladder rack within telecom rooms. Ideally, this information would be indicated on scaled overall plans for each floor; however, it is permissible to combine with other Structured Cabling System shop drawings for individual areas.

2. Provide a typed list indicating part name, manufacturer, part number, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters).

3. Submit manufacturers' cut sheets or catalog cut sheets for each product specified.

D. "Project Completion" submittal:

1. As-built Drawings:

- a. Submit scaled layout drawings showing the layout of all equipment and pathways in telecom rooms with final identifiers if applicable. Ideally, this information would be indicated on scaled overall plans for each floor; however, it is permissible to combine with other Structured Cabling System Record Drawings for individual areas.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of device from a single manufacturer and through one source. Where practical and possible, obtain all devices from a single manufacturer and one source.

- B. Communications equipment room fittings shall be listed by a NRTL.

1.6 WARRANTIES

- A. Provide manufacturer warranties as required in Division 27 Section "Structured Cabling System".

PART 2 - PARTS

2.1 BONDING AND GROUNDING (EARTHING)

A. General

1. Provide a complete functioning telecommunications grounding and bonding system, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary for the system to be in compliance with the ANSI/TIA-607 Standard "Generic Telecommunications Bonding and Grounding for Customer Premises". Major components include:
 - a. PBB in the Entrance Facility and SBBs in all remaining Telecommunication Rooms and Spaces.

- b. TBC connecting the PBB to the main Electrical Service Ground.
 - c. TBB connecting the PBB to all SBBs.
 - d. All equipment and pathway grounding and bonding connections as identified on the drawings, recommended by manufacturers of equipment installed under this section, and stipulated in the referenced standard.
- 2. Available Component Manufacturers:
 - a. Chatsworth
 - b. Cooper B-Line
 - c. Erico
 - d. Harger
 - e. Hoffman
 - f. Panduit
- 3. Conductor Manufacturers
 - a. Shall be from the list of Component Manufacturers; or
 - b. Shall be from the list of Manufacturers in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".

B. Primary Bonding Busbar (PBB)

- 1. Specifications
 - a. All busbars shall have a clear cover installed to protect connections
 - b. Cover shall be:
 - 1) Plexiglass or plastic
 - 2) Cover shall be printed with 3/8" lettering "PBB" using appropriate labels.
 - 3) Of the same manufacturer as the ground bar
 - c. A predrilled Electrotin plated copper busbar provided with holes for use with standard sized lugs; hole patterns shall be in TIA/BICSI style.
 - d. Have minimum dimensions of 1/4 inch thick x 4 inches wide x 20 inches long.
 - e. Provide enough length for all connections with 25% growth.
 - f. Provided with insulators to electrically isolate busbar from mounting surface.

- g. Provided with a minimum of 2-inches clearance from wall or other mounting surfaces for access.
 - 2. Manufacturer shall be
 - a. Harger TGBIP14420TMGB
 - b. Chatsworth 40153-020
 - c. Or equivalent from Component Manufacturer
- C. Secondary Bonding Busbar (SBB)
 - 1. Specifications
 - a. Be a predrilled Electroplated copper busbar provided with holes for use with standard sized lugs
 - b. Have minimum dimensions of 1/4 inch thick x 2 inches wide x 12 inches long
 - c. Provided with insulators to electrically isolate busbar from mounting surface
 - d. Provided with a minimum of 2-inches clearance from wall or other mounting surfaces for access.
 - 2. Manufacturer shall be
 - a. Harger TGBI14212TGB
 - b. Chatsworth # 13622-012
 - c. Or equivalent from Component Manufacturer
- D. Ground Wire for TBB
 - 1. Specifications
 - a. All grounding and bonding connectors shall be listed by a Nationally Recognized Testing Laboratory (NRTL) as required by the NEC.
 - b. All grounding and bonding conductors shall be copper and may be insulated UON. When conductors are insulated, they shall be listed for the application (i.e. Plenum, riser, outside plant, etc.)
 - c. Ground Wire for TBB: Non-Insulated grounding wire with a minimum conductor size as indicated on drawings. Wire shall be UL listed.
 - d. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name.

- 2) Copper Conductor Gauge.
 - 3) UL listing.
 - e. Cable jacket shall be green with black lettering.
 - f. Sizing shall be per Part 3 of this section. All sections of TBB longer than 300 feet shall be 750 kcmil.
- E. Bonding Conductor (To main Electrical service ground) for Telecommunications (TBC): Insulated grounding wire with a minimum copper conductor size equal to that of the TBB, with PVC insulation. Shall be UL listed.
 1. Specifications
 - a. Shall be copper.
 - b. Insulated grounding wire with PVC insulation
 - c. A minimum copper conductor size equal to that of the largest TBB or other bonding conductor connected to the PBB, UON.
 - d. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name
 - 2) Copper Conductor Gauge
 - 3) NRTL listing information
 - e. Cable jacket shall be green with black lettering
 - f. A minimum conductor size as indicated on drawings
- F. Ground Wire (for connections within each Telecommunications Room and to Cable Tray)
 1. Specifications
 - a. Shall be copper.
 - b. When not routed through plenum or other air-handling space: Insulated grounding wire with a minimum copper conductor size of number 6 AWG, with PVC insulation. Shall be UL listed.
 - c. When routed through plenum or other air-handling space: Non-Insulated grounding wire with a minimum copper conductor size of number 6 AWG. Shall be UL listed.
 - d. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name.

2) Copper Conductor Gauge.

3) UL listing.

e. Cable jacket shall be green with black lettering.

G. Connectors / Connections

1. Specifications

a. All connectors and connections shall utilize products that are Listed by a NRTL such as UL.

b. All connectors shall have twin clamping elements for cable; two holes for attachment to grounding bar, etc.

2. Compression Lugs

a. Specifications

1) Shall be manufactured from electro-plated tinned copper for use with copper conductors.

2) Shall include inspection port.

3) On center dimension between holes (O.C. Dim. B/T Holes) shall be 0.625" ("A" Pattern) or 1" ("C" Pattern)

b. Manufacturer shall be:

1) Harger GECLB Series

2) Or Approved Equivalent

3. Conductor to conductor connection

a. Specifications

1) All connections between conductor and the joining or mating of cables to connectors shall be done by exothermic weld or irreversible compression connector.

b. Manufacturer – Exothermic Weld

1) Erico CADWELD

2) Harger Ultraweld

3) Or Approved Equivalent

c. Manufacturer – Irreversible Compression connector

- 1) Burndy HYGROUND
 - 2) Or Approved Equivalent
 4. Connector for conduit to cable
 - a. Specifications
 - 1) All continuous conduits (except entrance conduits) which extend into the Telecommunications Room shall be fitted with a pipe clamp or conduit bonding clamp connected to the PBB/SBB.
 - b. Manufacturer shall be:
 - 1) For 1" diameter and larger conduits – Harger series CPC electro tin-plated pipe clamp
 - 2) For less than 1" diameter conduits – Harger TBGC4SCS electro tin-plated conduit bonding clamps
 - 3) Or Approved Equivalent
 5. Connector for conductor to cable tray
 - a. Specifications
 - 1) For metallic cable trays that extend to the Telecommunications Room.
 - b. Manufacturer shall be:
 - 1) Harger electro tin-plated cable tray bonding clamps – TBCTC
 - 2) Or Approved Equivalent

H. Insulated Grounding Bushings

1. Specifications
 - a. All communications entrance conduits that extend into the Telecommunications Room shall be fitted with an Insulated Grounding Bushing.
 - b. Shall be UL Listed for copper conductors.
 - c. Shall include lug for easy connection of conductor to PBB/SBB.
2. Manufacturer shall be:
 - a. O-Z/Gedney IBC-L
 - b. Or Approved Equivalent

2.2 PLYWOOD BACKBOARD

- A. 4' x 8' sheets of 3/4" thick (minimum) A-C grade plywood be securely fastened to the supporting walls as indicated on the plans.
 - 1. Plywood shall be installed with "A" side facing the interior of the room.
 - 2. Plywood shall be fire-retardant with stamp visible when installed, painted white with a minimum of two coats of fire-retardant paint with two coats of white paint with the exception of the stamped area indicating that it is fire-retardant].
 - 3. Plywood shall be mounted at 6" AFF and extend to 8'6" AFF.

2.3 TELECOMMUNICATIONS ENTRANCE PROTECTION

- A. Surge Protection
 - 1. The following manufacturers are Conditionally Approved:
 - a. Circa Telecom
 - b. Emerson Network Power
 - c. ITWLinX
 - d. TII Network Technologies
 - e. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)
 - 2. Horizontal Cable Surge Protectors – for 4-pair, Category 6A horizontal cables that serve outlets exterior the footprint of the building, including, but not limited to, cables serving outlets that are mounted on roofs, exterior walls, light poles, and emergency phones/towers.
 - a. Requirements
 - 1) Shall meet UL 497
 - 2) Shall exceed TIA 568 Category 6A performance standards
 - 3) Shall be capable of being used with POE+ applications
 - b. Wall-mount Protectors – for single cables, where quantity of cables in Equipment Room needing protection is 6 or less
 - 1) Manufacturer shall be:
 - a) Emerson Edco CAT6A-POE
 - b) ITWLinX SurgeGate Series CAT6A-LAN

- c. Rack-mount Protectors – where more than 6 cables in an Equipment Room require surge protection
 - 1) Shall be rack-mountable in 19” wide equipment rack
 - 2) Provide quantity of Category 6 protectors/modules required for install, plus 25% spare
 - 3) Manufacturer shall be:
 - a) APC ProtectNet Chassis (PRM24) with Cat 6 Surge Modules (PNETR6)
 - b) Emerson Edco RM-CAT6-**POE
- d. Far-end Protection: Wherever connected devices (such as cameras) do not have integral protection, provide the following at the far-end of the cable:
 - 1) Blackbox CAT6 In-Line Surge Protector
 - 2) Emerson CAT6-5POE-FF

2.4 TELECOMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES

A. Two-Post Floor Rack

- 1. The following manufacturers are Conditionally Approved:
 - a. Eaton Bline Series , model SB556084XUFB.
 - b. Or Approved Substitution (submitted and accepted in the “pre-bid” phase by City of Lee’s Summit)
- 2. Requirements
 - a. Approximately 7’-0” in height with 45U available to mount panels/equipment.
 - b. Mounting rails shall be spaced 19” wide per ECA EIA/ECA-310-E. Mounting rails shall contain 0.375” square holes of universal server mounting. Mounting rails shall contain front and rear flange mounting holes for panels/equipment.
 - c. Two-post rack shall be aluminum construction, 11 gauge and have a self-supporting base.
 - d. Finish shall be black.
 - e. Minimum static load capacity: 1,000 lb
 - f. UL Listed

- g. Secure rack to floor. Provide rack manufacturer's rack installation kit matching floor type of rack installation for a complete system meeting drawings and manufacturer instructions. Raised floor racks shall be mounted to sub or base floor with 5/8" threaded rods and steel brackets.
- h. Provide 6" stand-off bracket accessory on top of rack to mount ladder rack.
- i. Provide free standing relay rack accessories: rack base insulator kit, rack line-up spacer kit, rack base dust cover, equipment support bracket, equipment guard rail, and RMU Label Kit for a complete system meeting drawings and manufacturer instructions.
- j. Mount Grounding Isolation pad between equipment rack and concrete slab, prior to bolting equipment rack to slab. Isolation pad by B-Line SB-2545-01 or equivalent.

B. Swing Wall Rack

1. The following manufacturers are Conditionally Approved:

- a. APC
- b. B-Line
- c. Chatsworth Products
- d. Great Lakes
- e. Hoffman
- f. Middle Atlantic
- g. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

2. Requirements

- a. Approximately 2'-11" in height with 16U available to mount panels/equipment.
- b. Mounting rails shall be spaced 19" wide per ECA-310-E. Mounting rails shall contain 0.375" square holes of universal server mounting. Mounting rails shall contain front and rear flange mounting holes for panels/equipment.
- c. Swing wall rack shall be minimum 14-gauge carbon steel construction and have a self-supporting base.
- d. Finish shall be durable powder coat in black .
- e. Minimum static load capacity: 200 lb.
- f. UL Listed
- g. Secure rack to wall. Install rack per manufacturer's hardware requirements and installation instructions for wall type.

- h. Provide rack accessories such as fan kits with (2) 4-1/2" exhaust fans, fan guards and vent blockers (Model # DWR-FK17+ VBK-D17) and bonding kit PET-K-D/EWR for a complete system meeting drawings and manufacturer instructions.
 - i. Wall rack depth shall be 17.3"
 - 3. Product shall be :
 - a. Middle Atlantic, DWR series , model DWR-16-17.

2.5 TELECOMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

A. General

- 1. All telecommunications termination blocks and patch panels shall be by the same manufacturer and covered under the same Advanced Structured Cabling System Warranty.
 - a. The following manufacturers are Conditionally Approved:
 - b. Owner's standard manufacturer : Mohawk, Leviton/Berk-Tek, CommScope, Belden, Krone
 - c. Or Approved Substitution (submitted and accepted in the "pre-bid" phase by City Lee Summit)

B. Rack-mount Modular - Copper Patch Panels

- 1. General Requirements for Patch Panels: Comply with referenced standards. Cables shall be terminated with connecting hardware of same category or higher.
- 2. Patch panels shall be provided complete with all mounting hardware, jacks, retainers, wire guides, designation strips, etc.
- 3. Patch panels shall accept modular jacks of exactly one port, and this modular jack shall be the same type as being installed at the far-end faceplates.
- 4. Provide enough ports for the number of cables terminated on the patch panel, plus 25 percent spare. Provide all connector blocks', including plugs and jacks where required to fill each panel completely. Do not leave any blank openings.
- 5. Modular Patch Panels shall be of a metal design with snap in module frames for each individual jack.
- 6. Ports and panels shall be easy to identify with label holders for machine-printed and color-coded labels. Rack mountable patch panels shall mount to standard EIA 19" racks.
- 7. Patch panel shall be 19" rack-mount, 48-port, 2 rack spaces (3.5")
- 8. Horizontal Cabling

- a. Four-pair Augmented Category 6 UTP cabling shall be terminated onto a four-pair Augmented Category 6 jack module. All jack modules shall be terminated using the T568B wiring scheme. The eight-position jack module shall exceed the connector requirements of the TIA Augmented Category 6 standard.
 9. Submit Manufacturer and part number as part of pre-construction submittals.
 - C. Rack-mount Optical Fiber Panels
 1. Fully enclosed cable management type patch panel. Rack mountable in equipment cabinets/racks. Front and rear access (front access only for wall mounted). Complete with all necessary cable clamps, couplings and connector bulkheads.
 - a. Optical fiber cables shall be terminated in cable management trays/modules.
 - b. Cable management module/tray can accommodate optical fiber patch cable. Tray/module shall provide a means to avoid exceeding the cable manufacturer's minimum bending radius to protect against crimping or over bending.
 - c. Cable management tray shall have labeling on the front of the tray.
 - d. Optical fiber patch panels shall have a plexiglass latching front panel. Labeling and connectors shall be clearly visible with front panel open or closed.
 - e. Optical fiber patch panels shall accept a variety of inter-changeable bulkheads including ST, SC, LC, FDDI as well as attenuators.
 - f. Optical fiber patch panels shall provide a splice tray option.
 - g. Fiber optic enclosures shall be 19" rack-mount and 2 rack units (3.5") in height. The enclosure shall be equipped for pigtail connector splicing and installation, and provide a crossover pathway for optical fiber jumpers using LC connectors for single mode fiber.
 2. Optical fiber termination method(s)
 - a. Factory-terminated pigtail and with fusion splice
 - b. Single-mode connectors:
 - 1) Simplex single mode LC connectors and adapters. Color shall be blue. Suitable for use with specified single-mode optical fiber. Maximum insertion loss across mated pair: less than 0.75dB.
 3. Submit Manufacturer and part number as part of pre-construction submittals.
- 2.6 TELECOMMUNICATIONS PATCH CABLES & CROSS-CONNECT WIRES
- A. General

1. Supply all necessary patch cables and cross-connect wires as part of a complete and functioning telecommunications system to support voice, data, audio-video, security, and other miscellaneous systems.
2. The manufacturer of patch cables shall be the same as the telecommunications connectivity, unless otherwise specified.
3. All patch cables shall be factory-terminated and tested.

B. Copper Cross-Connect Wires

1. Provide cross-connect wires as indicated on the drawings and as required to form a complete and functioning telecommunications system. This includes extension of analog voice lines from the service provider demarcation point to the following connections:
 - a. Fire Alarm Control Panels
 - b. Emergency analog phone locations
 - c. Security Panels
2. Manufacturer shall be:
 - a. Same as copper connectivity or backbone cabling manufacturer
 - b. Submit product cutsheet for review

C. Copper Patch Cords

1. Category performance shall be the same as copper patch panels.
2. Cable shall be 4-pair, twisted pair with factory-terminated RJ-45 modules on each end.
3. Provide (furnish and install) all patch cords required for the following connections and systems (coordinate color, length, and quantity with sub-contractors of those systems):
 - a. Fire Alarm Control Panels
 - b. Emergency analog phone locations
 - c. LAN connections for Audio-Video Systems equipment
 - d. LAN connections Security Systems equipment and cameras
4. Furnish patch cords to the Owner prior to substantial completion in the following lengths and quantities:
 - a. Total quantity shall be 100% of the terminated ports, in the following colors and lengths:
 - 1) One-fourth shall be 3' and yellow

- 2) One-fourth shall be 3' and blue
 - 3) One-fourth shall be 3' and Grey
 - 4) One-fourth shall be 10' and blue
 5. Manufacturer shall be:
 - a. Same as copper connectivity manufacturer
 - b. Submit product cutsheet for review
- D. Copper Station Cables
1. For use at Telecommunications Work Area Outlets
 2. Same specification as Copper Patch Cords
 3. Cable shall be 4-pair, twisted pair with factory-terminated RJ-45 modules on each end.
 4. Furnish patch cords to the Owner prior to substantial completion in the following lengths and quantities:
 - a. Total quantity shall be 100% of the terminated ports, in the following colors and lengths:
 - 1) One-fourth shall be 25' and black
 - 2) Half shall be 10' and white
 - 3) One-fourth shall be 3' and yellow
 5. Manufacturer shall be:
 - a. Same as copper connectivity manufacturer
 - b. Submit product cutsheet for review
- E. Fiber Optic Patch Cords
1. Singlemode
 - a. Connectors shall be LC on both ends.
 - b. Furnish patch cords to the Owner prior to substantial completion in the following lengths and quantities:
 - 1) Total quantity shall be 50% of the terminated ports, in the following lengths:
 - a) All shall be 7'-0"

c. Manufacturer shall be:

- 1) Same as fiber connectivity manufacturer
- 2) Submit product cutsheet for review

2.7 TELECOMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

A. Ladder Rack (Cable Runway)

1. Color: black
2. Rung Spacing: 9"
3. Width: 18"
4. UL Listed as an equipment grounding conductor
5. Provide ladder rack components such as e-bend, outside radius bend, and corner bracket for a complete system meeting drawings and manufacturer instructions.
6. Provide ladder rack supports such as wall angle support kit, triangular support bracket, center support kit, threaded rod, I-beam clamp, threaded ceiling kit, cabinet elevation kit, foot kit, rack mounting plate, rack elevation kit for a complete system meeting drawings and manufacturer instructions.
7. Provide ladder rack accessories such as cross member radius drop, end caps, and dividers for a complete system meeting drawings and manufacturer instructions.
8. The following manufacturers are Conditionally Approved:
 - a. B-Line
 - b. Chatsworth Products
 - c. nVent/Hoffman
 - d. Middle Atlantic
 - e. Or connectivity manufacturer carrying structured cabling warranty
 - f. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

B. Vertical Cable Managers

1. Manufacturer shall be the same as equipment racks and cabinets, unless otherwise noted.
2. Color: black
3. Size: as specified on drawings, or a minimum of 6" wide by 6" deep, whichever is greater.

4. The following manufacturers are Conditionally Approved:

- a. B-Line
- b. Chatsworth Products
- c. Ortronics
- d. Panduit
- e. Or connectivity manufacturer carrying structured cabling warranty
- f. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)

C. Horizontal Cable Management

- 1. Manufacturer shall be .
- 2. Color: black
- 3. 2RU, above and below each flat 48-port patch panel, as shown on the drawings.
- 4. The following manufacturers are Conditionally Approved:
 - a. Panduit NCMH2
 - b. Or Approved Substitution (submitted and accepted in the "pre-bid" phase by City of Lee's Summit)

2.8 POWER EQUIPMENT FOR CABINETS, RACKS, AND ENCLOSURES

A. Horizontal Power Strip

- 1. Shall operate at 120V AC / 60Hz.
- 2. Shall include a minimum of 8 rear -facing NEMA 5-15R outlets.
- 3. Shall be 1RU high and mount into standard 19" wide equipment rack.
- 4. Shall have 15A capacity with surge suppression on all outlets.
- 5. Provide one per equipment rack
- 6. Manufacturer shall be:
 - a. APC AP9562
 - b. Chatsworth
 - c. Geist SP104-10
 - d. Middle Atlantic PD815RA-PL

B. Uninterruptible Power Supply

1. As per City of Lees Summit 'requirements

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 GROUNDING AND BONDING INSTALLATION

A. General:

1. Install all other ground conductors (wire) without splices or mechanical couplers installed between the wire points of origin and termination except as shown on the Drawings and/or specified herein. Where splices are necessary, the number of splices should be a minimum and they shall be accessible and located in Telecommunications rooms (spaces). Joined segments of a TBB shall be connected using exothermic welding, irreversible compression-type connectors, or equivalent. All joints shall be adequately supported and protected from damage. "Daisy chaining" of Telecommunications ground bus bars back to the PBB will not be accepted unless specifically indicated on the Telecommunications drawings or specified herein
2. Unless otherwise noted, all ground wires shall be routed through the Telecommunications cable management pathways so as to achieve a "coupled bonding conductor" effect
3. Where insulated conductors are necessary provide adequately rated insulation jackets or pathways to meet all required building codes. (I.e. Plenum, riser, outside plant, run entirely in conduit, etc.)
4. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 3 feet (1 meter) in length, the conductors shall be bonded to each end of the conduit using a grounding bushing or a No. 6 AWG conductor, minimum.
5. The Telecommunications Bonding Conductor (TBC), each Telecommunications bonding backbone (TBB) conductor, and each Backbone bonding conductor (BBC shall be green or marked with a distinctive green color
 - a. Marking with a distinctive green color Shall be done at a minimum of every 1 foot (0.3 meter) by appropriate methods
 - b. Indicate proposed and actual routing of these conductors on overall floor plans in both the pre-construction Shop Drawings and Record Drawings, respectively.
6. Follow additional installation requirements from NECA/BICSI 607-2011 "Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings".

B. Required Grounding Connections:

1. Provide and install one individual ground wire from each equipment rack/cabinet/frame (installed under this work) to the SBB in the room. Each conductor is to be "home run"; do not "daisy chain" the connections, except as may be indicated on the drawings.
2. Provide and install one individual ground wire from the raised floor system (if applicable) to the PBB. Conductor is to be "home run"; do not "daisy chain" the connections, except as may be indicated on the drawings.
3. Provide and install one individual ground wire from the overhead and vertical ladder racking (installed under this work) to the SBB in the room. All sections of ladder rack shall be securely connected together; otherwise, provide ground wire from each section of ladder rack.
4. Where structural steel is available for connection install one individual ground wire to the nearest structural steel for connection.
5. Provide and install all grounding connections as required by Telecommunications set of drawings.

C. Connector Installation:

1. Provide all ground wire connectors as shown on the Drawings or as indicated herein, unless otherwise noted.
2. Follow the connector manufacturer's instructions for installing the connector to the cable and the connector to the cabinet/rack, ground bar, etc. Use the appropriate tools for the job, tighten nuts/bolts to proper torque, remove paint, insulation, oxidation as needed to assure good metal to metal contact, etc. If the manufacturer does not provide tightening specifications, follow the recommendations of UL Standard 486.

D. Cable Identification:

1. Label both ends of each ground conductor within 6 inches (152.4 mm) of a connector terminal or splice. Label the grounding conductors as shown on the Drawings or specified herein. All labels shall include the following in addition to specific labeling requirements for each conductor.

**IF THIS CONNECTOR OR CABLE IS
LOOSE OR MUST BE REMOVED,
PLEASE CALL THE BUILDING
TELECOMMUNICATIONS
MANAGER**

E. Quantities of Ground Wires (Conductors)

1. Location and placement of grounding and bonding wires and components shall be as shown on the Drawings or defined herein.

2. Quantities of ground wires, bonding components, etc. shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. Provide the correct quantities of materials to construct a grounding and bonding system that meets the intent of these Specifications and the relevant codes.

F. Sizing of Ground Wires (Conductors)

Subject to the applicable electrical code and the reference standards and guidelines, the TBC, TBB, BBC conductors (if applicable), and conductors to serving electrical panels and building steel shall be sized per the following table (Table 1 from ANSI/TIA-607):

Linear Length (ft)	AWG Size
less than 13	6
14-20	4
21-26	3
27-33	2
34-41	1
42-52	1/0
53-66	2/0
67-84	3/0
85-105	4/0
106-125	250 kcmil
126-150	300 kcmil
151-175	350 kcmil
176-250	500 kcmil
251-300	600 kcmil
Greater than 301	750 kcmil

G. Testing

1. As a minimum test, as described below, all metallic wires and cables installed under these Specifications.
2. Test the grounding conductor and the terminal connectors for total resistance between the equipment item being grounded and the main telecommunications grounding point in the room. This resistance Shall be less than 0.10 Ohm.
3. Recommended test equipment (obtain approval of Owner/ Design Consultant prior to using substitute test equipment):
 - a. An ohmmeter capable of indicating resistance down to 10 milli-ohms or below.

H. Acceptance

1. Upon receipt of the Contractor's documentation of cable testing, the Owner/ Design Consultant will review/observe the installation and randomly request tests of the cables/wires installed. Once the testing has been completed and the Owner/ Design Consultant is satisfied that all work is in accordance with the Contract Documents, the Owner will notify the Contractor in writing.

I. Record Drawings

1. The Project Record Drawings shall show the types and locations of installed grounding and bonding conductors.

3.3 TELECOMMUNICATIONS ENTRANCE PROTECTION INSTALLATION

- A. Fully protect each end of all incoming conductors which are considered to have lightning exposure in accordance with NEC chapter 8.
 1. Exception: Service providers will provide and install primary protectors on service entrance cabling.
- B. Install grounding wire as straight as possible from terminal to Grounding Bar.
- C. UON, mount all protection devices on wall surface in a manner sufficient to support the weight, and to sustain incidental contact.
- D. Protector housings shall stack vertically.
- E. Grounding and Bonding of Entrance Conduits
 1. Bond all metallic shields and armored jacketing material for all incoming cables as close as practicable to the entry into the building.
 2. Bonding conductors shall be connected to the appropriate bus bars as specified in this Section and in accordance with NEC chapter 8.
 3. Connect the grounding conductor from the protection devices directly to the PBB/SBB as specified in this Section and in accordance with the NEC and the manufacturers' recommendations.
 4. Verify grounding means exist at each end of the circuit as required by the NEC. If no grounding means exists then provide all connections required by the NEC.

3.4 TELECOMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES INSTALLATION

- A. Wall cabinets, racks, frames, and enclosures shall be installed on a plywood backboard or attached to a masonry wall. The rack should not be attached to sheet rock (gypsum wall board).
- B. Tags/labels shall be placed on each equipment rack, cabinet and frame in accordance with specification Division 27 Section "Common Work Results for Communications"

3.5 CABLE LADDER RACKING

- A. Installation and configuration shall conform to the requirements of the ANSI/TIA Standards 568C & 569, NFPA 70 (National Electrical Code), NEMA VE2, and applicable local codes.
- B. Install cable ladder racking level and plumb according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.
- C. Install cable ladder racking where indicated in the drawings and as required by these Specifications

- D. Corner clamp brackets shall be used to join sections of cable ladder rack that are perpendicular to each other.
- E. Cable ladder rack stringers shall be attached to plywood backboards with angle brackets and "J" bolts.
- F. End supports and stringer junction brackets shall be used to attach vertical cable ladder segments to the floor.
- G. Stringer junction brackets shall be used to attach end to end horizontal cable ladder rack segments.
- H. Open ended stringer segments shall be closed with corner clamps and end bars.
- I. Mounting plates and "J" bolts shall be used to attach the cable ladder racking to the relay racks or equipment cabinets.
- J. Runway should be supported every 4 feet on center with 5/8 diameter threaded rod with slotted hanger clamps, or applicable support brackets or attachments [unless more strict seismic supports are required. All wall brackets shall be attached to plywood backboard.
- K. A support shall also be placed within 24 in. on each side of any connection to a fitting.

3.6 CABLE MANAGEMENT AT EQUIPMENT RACKS AND CABINETS

- A. Install cable organizers and/or cable channel on equipment racks and within cabinets at locations as described in the Specifications and/or indicated on the Drawings.

3.7 QUANTITIES OF RACK/CABINET AND DISTRIBUTION FRAME EQUIPMENT AND COMPONENTS

- A. Location and placement of communications equipment room fittings shall be as shown on the Drawings or defined in these specifications and schedules.
- B. Quantities and sizes of communications equipment room fittings shown on the Drawings are illustrative only and are meant to indicate the general configuration of the work. Provide the correct quantities of all materials necessary to accommodate the work described in these specifications and schedules and shown on the Drawings.
- C. Equipment racks, cabinets and distribution frames shall be assembled and installed as per the manufacturers' printed instructions.

END OF DOCUMENT 271100

DOCUMENT 271300 - COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide a complete intra-building (premises) backbone cabling system in accordance with these Contract Documents. Including but not limited to, the following:
 - 1. Optical Fiber Cables
 - 2. Splices (where required by these Contract Documents)
 - 3. Necessary installation and supporting hardware.

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions, requirements, and recommendations in Division 27 Section "General Communications Requirements"
- B. Division 27 "Common Work Results for Communications"
- C. Division 27 "Structured Cabling System"
- D. Division 27 Section "Telecommunications Equipment Room Fittings"

1.3 BACKBONE CABLING DESCRIPTION

- A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
- B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.4 PERFORMANCE REQUIREMENTS

- A. General Performance: Backbone cabling system shall comply with transmission standards in ANSI/TIA-568, when tested according to test procedures of this standard.

1.5 CODES, REFERENCES, AND STANDARDS

- A. Follow all applicable codes, references, and standards listed in Division 27 Sections "General Communications Requirements" and "Structured Cabling System".

1.6 GUIDELINES

- A. Follow all applicable guidelines listed in Division 27 Sections "General Communications Requirements" and "Structured Cabling System".

1.7 QUALITY ASSURANCE

- A. Refer to Division 27 Section "Structured Cabling System" for Quality Assurance requirements.

1.8 SUBMITTALS

- A. Follow the requirements for submittals in Division 27 Section "General Communications Requirements", as well as the detailed Submittal requirements in Section "Structured Cabling System". The following additional items shall be submitted:

- B. Pre-Bid Phase:

- 1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution provide submittals with sufficient detail for review by the Engineer. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.

- C. Bid phase:

- 1. Unit Pricing:

- a. Optical Fiber Backbone:

- 1) Supply unit pricing for the addition/deletion of individual indoor and outdoor strand, 12 strand, 24 strands and cable splices including connectors, closures, testing, etc.
 - 2) Supply unit pricing for the addition/deletion of individual multi-mode connectorization including connectors (pig-tails and splices, if used) and testing.
 - 3) Supply unit pricing for the addition/deletion of individual single-mode connectorization including connectors (pig-tails and splices, if used) and testing.

- D. "Pre-construction" submittal:

- 1. Shop Drawings:

- a. Submit for review scaled layout drawings showing the routing of all backbone cabling, with pair/strand counts, cable types, type of pathway (cable tray, j-hooks, conduit, firestopping device) and proposed cable identifiers indicated for each cable. Ideally, this information would be indicated on scaled overall plans for each floor; however, it is permissible to combine with other Structured Cabling System shop drawings for individual areas.
 - 2. Provide a typed list indicating part name, manufacturer, part number, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters).
 - 3. Submit manufacturers' cut sheets or catalog cut sheets for:

- a. Each of the cables specified:
 - 1) Cut sheets shall include the following information at a minimum:
 - a) Manufacturers name and logo
 - b) Cable outside diameter
 - c) Number of conductors/strands in each cable and binder group
 - d) Gauge or strand thickness
 - e) Minimum transmission performance rating
 - f) Cable jacket material and rating
 - g) Maximum pulling tension
 - h) Jacket/Sheath color
 - i) Individual conductor or strand insulation colors
 - j) Minimum bend radius
 - i) During installation and post installation.
 - ii) As well as any additional information required by individual sections of this Division.

E. "Project Completion" submittal:

1. As-built Drawings:

- a. Submit scaled layout drawings showing the routing of all backbone cabling, with pair/strand counts, cable types, type of pathway (cable tray, j-hooks, conduit, firestopping device) and final cable identifiers indicated for each cable. Ideally, this information would be indicated on scaled overall plans for each floor; however, it is permissible to combine with other Structured Cabling System Record Drawings for individual areas.

1.9 WARRANTIES

- A. Provide manufacturer warranties as required in Division 27 Section "Structured Cabling System".

PART 2 - PRODUCTS

2.1 MULTI-MODE OPTICAL FIBER CABLE

A. General

1. Requirements

- a. See Division 27 and backbone (riser) diagram(s) on the Drawings for required fiber counts.
 - b. Cable shall meet the transformation performance and physical specifications of ANSI/TIA-568.
 - c. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name and trade mark
 - 2) Fiber size
 - 3) Fiber Grade
 - 4) UL listing (Shall be suitable for the application)
 - 5) Sequential length markings
 - d. Type: OM4
 - e. Cable jacket color shall be:
 - 1) AQUA for laser optimized multi-mode fiber optic cable
 - f. Fiber Size – 50/125 μm
 - g. Maximum allowable attenuation (db/km) is 3.5 at 850nm and 1.5 at 1300nm.
- B. Intra-building; cables that remain within the envelope/footprint of the building that are not installed within pathways defined to be in “wet” locations
- 1. Requirements
 - a. Cable shall have an overall armor of steel or aluminum.
 - b. Cable jacket shall be plenum (OFNP | OFCP) rated.
 - c. Manufacturer shall be:
 - 1) Leviton /Berk-Tek PDPK024
 - 2) Commscope
 - 3) Belden
 - 4) Krone
 - 5) Mohawk
 - 6) Or equivalent from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

2.2 SINGLE MODE OPTICAL FIBER CABLE

A. Requirements

1. See Division 27 and backbone (riser) diagram(s) on the Drawings for required fiber counts.
2. Cable shall meet the transformation performance and physical specifications of ANSI/TIA-568.
3. Cable jacket marking: Shall be legible and shall contain the following information:
 - a. Manufacturer's name and trade mark
 - b. Fiber size
 - c. Fiber Grade
 - d. UL listing (Shall be suitable for the application)
 - e. Sequential length markings
4. Cable jacket color shall be:
 - a. YELLOW for single-mode fiber optic cables
5. Low water peak fiber construction
6. Dispersion shifted fiber optic construction
7. Maximum allowable attenuation (db/km) is 1.0 at 1310nm and 1.0 at 1550nm.
8. Intra-building; cables that remain within the envelope/footprint of the building that are not installed within pathways defined to be in "wet" locations

B. Intra-building; cables that remain within the envelope/footprint of the building that are installed within pathways defined to be in "wet" locations

1. Cable shall have an overall armor of steel or aluminum
 - a. Cable jacket shall be indoor/outdoor plenum cable and suitable for installation in such environments.
 - b. Cable jacket rating shall be consistent with manufacturer's requirements to be covered under warranty specified.
 - c. Manufacturer shall be:
 - 1) Leviton /Berk-Tek LTP012
 - 2) Commscope

- 3) Belden
- 4) Krone
- 5) Mohawk
- 6) Or equivalent from Conditionally Approved manufacturer listed above
(subject to Advanced System Warranty requirements)

2.3 SPLICES (SPlice CASES)

- A. In general, optical fiber cables are not to be spliced except where indicated otherwise in the Drawings and Specifications.
 1. Refer to Division 27 Section "Telecommunications Equipment Room Fittings" for splicing requirements integral to rack-mounted enclosures.
- B. Where splicing is indicated in the Drawings and Specifications, multi-mode and single-mode optical fiber cable splicing shall be fusion spliced. Provide splice case with trays to accommodate all fiber strands that enter case.
- C. Multi-mode and single-mode optical fiber cables shall be spliced at points indicated on the Drawings.
 1. End caps with hole configurations to meet cable sheath diameters without filters.
 2. Plugs for all unused end cap holes.
 3. Trays shall be used to hold all splices.
 4. Optical fiber cables shall be labeled between 6" and 12" from their entry to the splice case.
- D. Maximum allowable loss for splices is 0.3 db.
- E. Manufacturer shall be:
 1. Preformed Line Products – Coyote Fiber Optic Closures series
 2. Or approved equivalent

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 CABLE INSTALLATION

- A. General:
 1. Place all backbone cabling in accordance with these specifications, on the Drawings and as indicated on any cable schedules.

2. Install each cable as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the cable installation specifications.
 - a. There shall be no splices or mechanical couplers installed between the cable points of origin and termination except as shown on the Drawings and/or specified herein.
 - b. There shall be no Bridged taps (multiple appearances of the same cable pairs at several distribution points) installed.
3. Unless otherwise noted, all cables shall be routed through the building cable conduit/cable ladder system. Refer to the Telecommunications floor plan and detail drawings for the layout of the conduits, cable tray and cable ladder.
 - a. Backbone cables in which no portion of the cable jacket will be exposed when routed in a plenum or other air handling space, shall be riser rated (CMR, MPR, OFNR, or OFCR). Cables suitable for use in air plenums or other air handling spaces, and which meet the electrical/transmission specifications, are also acceptable for riser applications.
 - b. Backbone cables in which any portion of the cable jacket will be exposed when routed in an air plenum or other air handling space shall be plenum (CMP, MPP, OFNP, or OFCP) rated.
 - c. Backbone cables installed in "wet" locations as defined by the NEC or in these construction documents shall be suitable for installation in such environments and follow the installation requirements for outside plant cables as specified herein.
 - d. Backbone cables routed vertically within a Telecommunications Room shall be supported by velcro-attachment every 18" to vertically-mounted ladder rack or D-rings.
4. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.
 - a. Except when supported by ladder racking or D-rings within each Telecommunications room, UON.
5. All backbone cables running on ladder racking within all Telecommunications rooms throughout the building shall be neatly placed and secured to the horizontal and vertical ladder racking with cable lacing twine or nylon wire ties at intervals not to exceed every third rung plus all locations where the cable changes direction.
6. At the same time backbone cables are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull cord.

7. Do not install kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 8. Where distance allows all backbone cables shall be provided with slack/service loops at each end of the cable. Each slack/service loop shall be:
 - a. A minimum of (10) feet in length, UNO
 - b. Configured in a loosely formed figure eight configuration (ie. not coiled)
 9. Prior to using any cable pulling lubricants provide the Design Consultant with written documentation from the cable manufacturer supporting the cable manufacturers' acceptance of its use in compliance with all required warranties as part of these contract documents. The use of non-water based lubricants shall be provided when pulling PVC jacketed and all cables not suitable for contact with water.
 10. Comply with all referenced standards and guidelines
 11. Cables shall be masked, covered, or otherwise protected from being painted or coming in contact with any other substance that may degrade the performance or physical characteristics of the cable jacket or insulation over time.
 12. Where backbone cabling has a shield or metallic member, the shield or metallic member shall be bonded to the PBB/SBB in accordance with ANSI/TIA-607 and BICSI/NECA 607-2011.
- B. Outside plant cable installation: for cables placed in "wet locations". These locations include but are not limited to; pathways that extend outside the envelope of the building such as aerial entrances, direct buried cables, underground conduits, conduits embedded in, or routed below a ground floor slab, etc.
1. Unlisted cables shall transition to an indoor rated cable within 50' of the entrance point as required the NEC.
 - a. This 50' allowed by code is only to allow termination as close as practicable to the entrance point. Terminate all outdoor only (unlisted) cables at the closest point of entrance and transition to an indoor rated cable to extend to additional Telecommunications rooms (spaces)
 2. No portion of outdoor only (unlisted) cables may be installed with the cable jacket exposed in any plenum or other air handling spaces nor shall they be allowed to transition between different levels of the building.
 3. Where specifically allowed by these construction documents cable jackets rated for dual use by a NRTL, such as an indoor/outdoor rated cable may be used.
 - a. These cables may be installed in locations within the building in which the cable jacket is appropriately rated to meet all applicable building codes.

4. Rigid metallic conduit shall be used to route outdoor (unlisted) cabling to within 50' of the transition point to indoor rated cabling in accordance with the NEC.
5. Cables which extend beyond the envelope/footprint of the building shall be installed with entrance protectors in accordance with Division 27 Section "Communications Equipment Room Fittings".

3.3 OPTICAL FIBER CABLE INSTALLATION

A. General:

1. Place all optical fiber backbone cabling in accordance with these specifications, and as indicated on the cable schedules and the Drawings.
2. Splices between optical fiber cables are permitted only at those locations indicated on the Drawings.
3. Splices between riser rated optical fiber cables and factory connectorized pigtails are permitted, but not required at each fiber termination location indicated on the Drawings. Pre-terminated riser cables meeting the material specifications may be utilized.
4. Comply with all referenced standards and guidelines.

B. Pre-installation testing:

1. Optical fiber cables: Perform visible light continuity check on each fiber. If one end is not accessible: perform OTDR test to assure fiber continuity.

C. Optical Fiber Backbone Cables:

1. Place between the optical fiber Main Distribution Frame (MDF) and the Telecommunications rooms as noted in the cable schedules and the Drawings.
2. Optical fiber cable is to be installed within inner duct at all locations where it is within nominal 4-inch conduit (not including short conduit sleeves.)
3. Support optical fiber riser cables with suitable support grips. After being supported, the optical fiber cables will be routed over to the optical fiber patch panel in that particular Telecommunications room.

3.4 OPTICAL FIBER MAIN DISTRIBUTION FRAME

- A. Optical fiber cables shall be routed to the Fiber MDF from each of the Telecommunications Rooms via conduits, trays and riser sleeves. See the Drawings.
- B. Optical fiber cables shall enter the Fiber Distribution Frame from the top of the frame and then routed to the connector and splice modules/shelves.

3.5 CABLE IDENTIFICATION

- A. Label all backbone cabling with machine-printed labels according to the labeling scheme identified on the drawings. Where the drawings are silent, submit RFI through appropriate channels requesting labeling scheme.
- B. Cables shall be labeled within 6" at each end and within each pullbox.
- C. All cable labels shall be thermal-transfer type and utilize self-adhesive labels. The following are approved manufacturers:
 - 1. Brady, IDXPRT
 - 2. Hellermann Tyton, Spirit 2100
 - 3. Panduit LS9
 - 4. Or equivalent

3.6 CABLE TERMINATIONS

- A. Terminate all backbone cabling specified in accordance with Division 27 Section "Communications Equipment Room Fittings", No cables shall contain unterminated elements UON.

3.7 CABLE TESTING

- A. Refer to Division 27 Section "Structured Cabling System" for testing requirements.

3.8 ACCEPTANCE

- A. The Owner and Design Consultant reserves the right to observe the conduct of any or all portions of the testing process.
- B. All cables that fail testing are to be corrected prior to substantial completion and acceptance by owner. Replace entire cable if bad pair or strand is found.

END OF DOCUMENT 271300

DOCUMENT 271500 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide a complete Category 6A horizontal (work area) telecommunications cabling system as shown on the TN sheets and in accordance with these Contract Documents.
- B. This section specifies the following:
 - 1. Horizontal Copper Cable
 - 2. Copper Connectivity
 - a. Faceplates
 - b. Surface Box
 - c. Jacks/plugs/inserts
 - 3. Power Over Ethernet Extenders
 - 4. Horizontal Fiber Cable
 - 5. Fiber Connectivity
 - a. Modules/jacks/inserts

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions, requirements, and recommendations in Division 27 Section "General Communications Requirements"
- B. Refer to Division 27 Section "Common Work Results for Communications" for general pathway, firestopping, access panel, identification, and other requirements.
- C. Refer to Division 27 Section "Structured Cabling System" for Advanced System Warranty information and other requirements.
- D. Refer to Division 27 Section "Telecommunications Equipment Room Fittings" for telecommunications equipment racks, patch panels, wall-blocks, surge suppressors, and other equipment room requirements.
- E. Category 6 and fiber cabling and connectivity for Audio Video Systems (as required by the TA drawings) are specified in Division 27 Section "Telecommunications Requirements for Audio Video Systems".

1.3 CODES, STANDARDS, AND GUIDELINES

- A. In addition to all applicable codes, standards, and guidelines listed in Division 27 Sections "General Communications Requirements" and "Structured Cabling System", follow the most recent editions of the following:
1. NFPA 70 (NEC) – "National Electrical Code" (NEC)
 2. IEEE NESC - "National Electrical Safety Code"
 3. ANSI/BICSI 005 – "Electronic Safety and Security System Design and Implementation Best Practices"
 4. ANSI/NECA/BICSI-607 – "Standard for Telecommunications Bonding and Grounding Planning and Installation methods for Commercial Buildings"
 5. ANSI/TIA-568 – "Commercial Building Telecommunications Cabling Standard Set"
 6. ANSI/TIA-569 – "Commercial Building Standard for Telecommunications Pathways and Spaces"
 7. ANSI/TIA-607 – "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises"
 8. ANSI/TIA-606 – "Administration Standard for Commercial Telecommunications Infrastructure"
 9. BICSI – "Telecommunications Distribution Methods Manual"
 10. BICSI – "Information Technology Systems Installation Methods Manual"
 11. IEEE 142 – "Recommended Practice for Grounding of Industrial and Commercial Power Systems" (Green Book)
 12. IEEE 1100 – "Recommended Practice for Powering and Grounding Electronic Equipment" (Emerald Book)
 13. TIA-526 – "Standard Test Procedures for Fiber Optic Systems"
 14. TIA-TSB-140 – "Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems"

1.4 DEFINITIONS

- A. Advanced System Warranty – refer to Division 27 Section "Structured Cabling System".
- B. Communications Equipment Room - This CSI MasterFormat term shall apply to spaces specifically designed to maintain communications equipment. This definition shall encompass ANSI/TIA-569 terms for Entrance Room, Common Equipment Room (CER), and Common Telecommunications Room (CTR). This definition also shall encompass BICSI

Telecommunications Distribution Methods Manual terms for Telecommunications Room (TR), Telecommunications Enclosure (TE), Equipment Room (ER), and Entrance Facility (EF).

- C. Direct Attach Method – as defined in ANSI/BICSI 005-2013, the horizontal cabling on the remote device end directly attaching (or connecting) to the device through a connectorized cable or hard-wired termination, eliminating the workstation outlet, jack and equipment cord.
- D. Horizontal Cabling
 - 1. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
 - a. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector
 - b. Bridged taps and splices shall not be installed in the horizontal cabling
 - c. Splitters shall not be installed as part of the optical fiber cabling
 - 2. A work area is approximately 100 sqft (9.3 sqm), and includes the components that extend from the telecommunications outlet/connectors to the station equipment.
 - 3. The maximum allowable horizontal cable length for Category copper cable is 295 feet (90 meter). This maximum allowable length does not include an allowance for the length of 16 feet (4.88 meter) to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet (4.88 meter) in the horizontal cross-connect.
 - 4. Horizontal cables longer than 295 feet shall be hybrid optical fiber and power conductor cable with a Power Over Ethernet Extender transmitter/receiver on each end.
- E. Structured Cabling / Telecommunications System – a fully-functional passive telecommunications system (infrastructure), that includes permanently installed copper Category and fiber optic cable terminated onto a patch panel or outlet.

1.5 QUALITY ASSURANCE

- A. As a minimum, the person(s) conducting the testing for all Telecommunications cabling shall be a current BICSI Certified Level II Commercial Installer or higher.
- B. All testing equipment used shall have the latest version of software and/or firmware installed prior to testing any cabling. Testing equipment shall also undergo all manufacturers' required and recommended routine maintenance.

1.6 SUBMITTALS

- A. Follow the requirements for submittals in Division 27 Section "General Communications Requirements"
- B. Pre-bid submittal

1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution provide submittals with sufficient detail for review by the Engineer. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.

C. Bid submittal

1. Provide unit prices for the following:
 - a. The addition/deletion of individual horizontal cables. Include costs to furnish, install, terminate, test, label, etc, including backbox and conduit stubbed up to accessible ceiling space and j-hook supports every 5' to nearest cable tray or telecom room. Express costs on the basis of a run of up to 150 feet.

D. Pre-construction submittal

1. Provide a typed list indicating part name, manufacturer, part number, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters)
2. Submit manufacturers' cut sheets or catalog cut sheets for:
 - a. Each of the cables specified. Cut sheets shall include the following information at a minimum:
 - 1) Manufacturers name and logo
 - 2) Cable outside diameter
 - 3) Number of conductors/strands in each cable and binder group
 - 4) Gauge or strand thickness
 - 5) Minimum transmission performance rating
 - 6) Cable jacket material and rating
 - 7) Maximum pulling tension
 - 8) Jacket/Sheath color
 - 9) Individual conductor or strand insulation colors
 - 10) Minimum bend radius
 - a) During installation and post installation.
 - b) As well as any additional information required by individual sections of this Division.

- b. Faceplates and modules. Cut sheets shall include the following information at a minimum:
 - 1) Manufacturers name and logo
 - 2) Material type
 - 3) Performance rating
 - 4) Physical Dimensions
 - 5) Color
 - c. Product information of test equipment to be used for the testing of cabling.
 - d. Provide documentation indicating manufacturer required and recommended maintenance and calibration services and intervals at which these services shall be performed.
 - 1) Provide documentation indicating the dates at which all testing units have undergone these services. For services required on a daily or pre-test basis provide documentation on the procedures the contractor will undergo for performing such services.
- 3. Shop Drawings
 - a. Submit for review scaled layout drawings showing the routing of all cabling, and the locations where terminal blocks, patch panels, Telecommunications outlets, cable types, cable jacket listing information, firestop locations (with quantity and NRTL system number identified), furniture feed points, and fiber optic termination panels are to be installed.
 - b. Shall show the number of horizontal cables served by each room and the number of patch panels and termination blocks to be installed (including those to accommodate 25% growth).
 - c. Each individual outlet on the drawings shall have proposed outlet identification indicated.
 - d. Unless otherwise required by these specifications, it is permissible to show different cabling systems (voice, data, CATV, A/V) on the same shop drawing.
- 4. Testing
 - a. Qualifications: Identity and qualifications of the personnel who will perform the testing as required above in the Quality Assurance paragraph.
 - b. Submit all physical characteristics needed for appropriate testing setup and verification. I.e. Nominal velocity of propagation (NVP) for each and every cable type. This parameter shall be identified and submitted for review. Such submittals

for all parameters shall be from printed manufacturers' cut-sheets or other manufacturers' printed material.

- c. Submit the proposed schedule for performing testing at least 2 weeks prior to the start of testing.

5. Sample warranty information as indicated herein and elsewhere in this Division.

E. Project completion submittal

1. As-built Drawings

- a. Submit scaled layout drawings showing the routing of all cabling, and the locations where terminal blocks, patch panels, Telecommunications outlets, cable types, cable jacket listing information, firestop locations (with quantity and NRTL system number identified), furniture feed points, and fiber optic termination panels have been installed.
- b. Shall show the number of horizontal cables served by each room and the number of patch panels and termination blocks installed (including those to accommodate 25% growth).
- c. Unless otherwise required by these specifications, it is permissible to show different cabling systems (voice, data, CATV, A/V) on the same As-built drawing.

2. After approval by the Owner, submit the test results in two computer readable copy in CD, DVD or mutually acceptable format by the Contractor and Owner.

3. Advanced Structured Cabling System Warranty Certificate

1.7 WARRANTIES

- A. Provide manufacturer warranties as required in Division 27 Section "Structured Cabling System".

PART 2 - PRODUCTS

2.1 HORIZONTAL (WORK AREA) COPPER CABLE

- A. Horizontal cables for dry environments

1. Requirements

- a. Unshielded Twisted Pair (UTP)
- b. Minimum performance specifications: Cable shall meet requirements for Augmented Category 6 of ANSI/TIA-568.
- c. Four pairs of 22-24 AWG solid copper conductors
- d. Cable jacket color(s) shall be

- 1) Blue for data
 - 2) Yellow for Video
 - 3) Grey for Building access control
 - 4) Red for fire
 - 5) Orange for HVAC
- e. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name
 - 2) Copper Conductor Gauge
 - 3) Pair Count
 - 4) UL and CSA listing
 - 5) Manufacturer's trade mark
 - 6) Category rating
 - 7) Sequential distance markings, in one foot increments
- f. Individually insulated conductors under a common sheath
- g. Plenum (CMP) rated.
2. Manufacturer shall be:
 - a. <Berk-Tek 1108XXXX.

Or equivalent from Conditionally Approved manufacturer listed below (subject to comply with specification and advanced System Warranty requirements):

 - b. Commscope
 - c. Belden
 - d. Krone
 - e. Mohawk
- B. Horizontal cables for Wet Locations (as defined in Division 27 Section "Structured Cable System")
 1. Requirements
 - a. Suitable to be in contact with standing water

- b. Cable construction shall be consistent with manufacturer's requirements to be covered under warranty specified in Division 27 Section "General Communications Requirements".
 - c. Minimum performance specifications: Cable shall meet requirements for Augmented Category 6 of ANSI/TIA-568.
 - d. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name
 - 2) Copper Conductor Gauge
 - 3) Pair Count
 - 4) UL and CSA listing
 - 5) Manufacturer's trade mark
 - 6) Category rating
 - 7) Sequential distance markings, in one foot increments
2. Product shall be:
- a. Augmented Category 6 – Berk-Tek LANMARK-10G Cat 6A OSP
 - b. Or equivalent from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

2.2 FACEPLATES FOR COPPER CONNECTIVITY

A. Single-gang faceplate:

- 1. Requirements
 - a. High impact nylon with number of ports to allow all modular jacks to be installed as required, and as indicated on the drawings.
 - b. Color shall be match electrical U.O.N. by owner
 - c. Single gang, U.O.N
 - d. With ID window , fire retardant plastic rated UL 94V-0
- 2. Product shall be
 - a. Leviton 42080-1WS
 - b. Or equivalent from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

B. Double-gang faceplate:

1. Requirements

- a. High impact nylon with number of ports to allow all jacks to be installed as required, and as indicated on the drawings.
- b. Color shall be match electrical U.O.N. by owner
- c. Double gang, U.O.N
- d. With ID window , fire retardant plastic rated UL 94V-0

2. Product shall be

- a. Leviton 42-80-2WP
- b. Or equivalent from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)

C. Weatherproof faceplate:

1. Requirements

- a. Water resistant faceplate (to IP56 rating, or equivalent) with number of ports to allow all jacks to be installed as required, and as indicated on the drawings.
- b. With in-use cover

2. Product shall be:

- a. Panduit Mini-Com Water Resistant Faceplate with integral cover.
- b. Hubbell RW57300 (Or Approved Equivalent) with decora-insert and jacks from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements).

2.3 COPPER CONNECTIVITY

A. Modular jacks

1. Requirements

- a. Outlets shall meet requirements for Augmented Category 6 of ANSI/TIA-568.
- b. All 8-position modular jacks are to be wired according to the TIA T568B pin/pair assignments.
- c. Outlet hardware shall be UL listed.
- d. One port

- e. Color shall match faceplate , U.O.N. by owner
 - 2. Product shall be
 - a. Leviton 6110G-xx6 Or equivalent from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)
 - B. Field termination plugs
 - 1. Requirements
 - a. Outlets shall meet requirements for Augmented Category 6 of ANSI/TIA-568.
 - b. All 8-position modular jacks are to be wired according to the TIA T568 B pin/pair assignments.
 - c. UL Listed: UL 2043 (plenum)
 - 2. Product shall be
 - a. Leviton SBCPI-18W
 - b. Or equivalent from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)
 - C. Blank inserts
 - 1. Requirements
 - a. Provide blank modules to fill any unused openings in faceplates
 - b. Color shall match other jack colors
 - 2. Product shall be
 - a. Leviton 41084-BW
 - b. Or equivalent from Conditionally Approved manufacturer listed above (subject to Advanced System Warranty requirements)
- 2.4 POWER OVER ETHERNET EXTENDER
- A. General:
 - 1. Shall be utilized where noted on drawings and for any work area outlets that requires a Category 6 connection, where the cable distance exceeds 295 feet.
 - 2. The Power over Ethernet (PoE) extender system shall provide the capability to upgrade a channel of a standard Ethernet switch to deliver PoE (IEEE 802.3af), PoE+ (IEEE 802.3at), or HPoE (non-standard) over a composite fiber/power cable.

3. The system shall utilize an external power injector at the source end.
4. The system shall provide power that is compliant with the requirements of a Class 2 Power Source per NFPA 70 or CSA C22.1 and be listed as such.
5. The system shall be comprised of a power injector and converter that generates and injects DC power and converts electrical signals to optical signals in the head end room, a receiver that converts the optical signals back to electrical signals and acts as a power supply for Power Over Ethernet at the work area outlets, and a composite cable for both fiber optic and copper power elements.

B. Media Converters - Power Source Devices

1. Shall be capable of being mounted on a horizontal or vertical surface or rack-mount bracket or chassis. Chassis modules shall take power from a common power supply.
2. The operating temperature range shall be 0°C to 40°C (32°F to 104°F).
3. The Power over Ethernet capabilities shall be:
 - a. Input voltage range 100 – 240 VAC.
 - b. Complies with the universal IEEE 802.3at PoE endpoint standard, supplying PoE to class 0, 1, 2 and 3 devices or PoE+ to class 0, 1, 2, 3 and 4 devices.
4. Product shall be
 - a. Berk-Tek One Reach
 - b. Commscope Powered Fiber

C. Media Converters – Work Area Outlet Devices

1. Shall accept power from power source equipment at head end.
2. Shall be available in 1 and 2 port modules.
3. Remotes shall be placed in enclosures/boxes suitable for the environment such as NEMA Type 1 (indoors, typical) or NEMA Type 3R (outdoors, typical).
4. The operating temperature shall be -40°C to 50°C (-40°F to 122°F).
5. Product shall be
 - a. Berk-Tek One Reach
 - b. Commscope Powered Fiber

D. Hybrid Optical Fiber/Copper Cable

1. The cable shall be a composite, containing multimode fibers and solid copper conductors of size 12 AWG.
2. Plenum (CMP or MPP, Outdoor rated.
3. Product shall be
 - a. Berk-Tek One Reach
 - b. Commscope Powered Fiber

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 CABLE INSTALLATION

A. General

1. Place all horizontal cabling in accordance with these specifications, on the Drawings, and as indicated on any cable schedules
2. Install each cable as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the cable installation specifications.
 - a. There shall be no splices or mechanical couplers installed between the cable points of origin and termination except as shown on the Drawings and/or specified herein.
 - b. There shall be no Bridged taps (multiple appearances of the same cable pairs at several distribution points) installed.
 - 1) Horizontal cabling shall be terminated in a Telecommunications room that is on the same floor as the area (outlet) being served in accordance with ANSI/TIA-568.
 - 2) No horizontal Category cables shall exceed the allowed maximum distance of 295 feet (90 meters) by ANSI/TIA-568.
 - 3) Horizontal cables longer than 295 feet shall be hybrid optical fiber and power conductor cable with a Power Over Ethernet Extender transmitter/receiver on each end.
3. Unless otherwise noted, all cables shall be routed through the building cable tray/conduit/surface-mounted raceway system. Refer to the electrical drawings for the layout of the conduits. Refer to the Telecommunications drawings for layout of cable tray.
 - a. All horizontal cables shall be plenum (CMP, MPP, OFNP, or OFCP) rated. UON

- b. Horizontal cables installed in “wet” locations as defined by the NEC or in these construction documents (such as conduits embedded or routed below a ground floor slab) shall be suitable for installation in such environments and follow the installation requirements for outside plant cables as specified herein.
 - 4. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.
 - a. Except when supported by ladder racking within each Telecommunications room, UON.
 - 5. At the same time horizontal cables are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. Use polypropylene or monofilament plastic line with not less than 200 lb (90.72 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.
 - 6. Do not install kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable
 - 7. Comply with all referenced standards and guidelines.
 - 8. Cables shall be masked, covered, or otherwise protected from being painted or coming in contact with any other substance that may degrade the performance or physical characteristics of the cable jacket or insulation over time.
 - 9. Where distance allows all horizontal cables shall be provided with slack/service loops at each end of the cable, one at the work area outlet and one at the Telecommunications room/enclosure. Each slack/service loop shall be:
 - a. A minimum of 8 feet (2.44 meter) in length, UNO
 - b. Configured in a loosely formed figure eight configuration (i.e. not coiled)
 - 10. Prior to using any cable pulling lubricants provide the Engineer with written documentation from the cable manufacturer supporting the cable manufacturers' acceptance of its use in compliance with all required warranties as part of these contract documents. The use of non-water based lubricants shall be provided when pulling PVC jacketed and all cables not suitable for contact with water.
- B. Outside plant cable installation: for cables placed in “wet locations” or as required by these construction documents. (I.e. all cables which extend beyond the footprint/envelope of the building or pathways leading to floor-boxes embedded in a ground floor slab)
- 1. Unlisted cables shall transition to an indoor rated cable within 50 feet (15.24 meter) of the entrance point as required the NEC.
 - a. This 50 feet (15.24 meter) allowed by code is only to allow termination as close as practicable to the entrance point. Terminate all outdoor only (unlisted) cables at the

closest point of entrance and transition to an indoor rated cable to extend to additional Telecommunications rooms (spaces)

2. No portion of outdoor only (unlisted) cables may be installed with the cable jacket exposed in any plenum or other air handling space nor shall they be allowed to transition between different levels of the building.
3. Where specifically allowed by these construction documents cable jackets rated for dual use by a NRTL, such as an indoor/outdoor rated cable may be used.
 - a. These cables may be installed in locations within the building in which the cable jacket is appropriately rated to meet all applicable building codes.
4. Rigid metallic conduit shall be used to route outdoor (unlisted) cabling to within 50 feet (15.24 meter) of the transition point to indoor rated cabling in accordance with the NEC.
5. All cables which extend beyond the envelope/footprint of the building shall be installed with entrance protectors in accordance with Division 27 Section "Communications Equipment Room Fittings"

C. Horizontal (work area) Cables:

1. From the appropriate Telecommunications room, provide each work area outlet, the types and quantities of horizontal cables as described in the applicable system specification sections. Cables will leave the Telecommunications room via cable tray, conduit/sleeve or floor duct. Each cable will be terminated except for pay phone and elevator machine room junction box locations.
2. Install all horizontal cables in accordance with Division 27 Section "Common Work Results for Communications" and as indicated on the drawings.

3.3 CABLE & WIRE INSTALLATION

A. General:

1. Place all station cabling in accordance with these specifications, and as indicated on the cable schedules and the Drawings.

B. Station Cables:

1. Install station cabling, outlets and jacks as detailed in the horizontal cable placement schedules and the Drawings. The typical configuration for outlets shall be two unshielded twisted pair (UTP) cables of 4-pairs each, unless otherwise noted on the drawings or the Horizontal Cable Placement Schedules.

C. Cables located in "wet" locations

1. Provide all required entrance protection in accordance with Division 27 "Communications Equipment Room Fittings".

2. Follow the requirements for installing outside plant rated cable as specified in Division 27 Section "Communications Horizontal Cabling"
3. All cables routed to floor boxes in the slab shall route to a transition box within 50 feet (15.24 meter) of where the conduit emerges from the slab. Provide connecting hardware within an appropriately rated enclosure to allow a transition from outside plant cable to indoor rated cable. Indoor rated cable shall be rated as required by building code and as specified herein. Route indoor cables as indicated for horizontal cable distribution. Transition hardware shall meet or exceed the category performance of the highest rated cable being terminated.
 - a. Cables from multiple different floor boxes may be routed to a single, appropriately sized, transition enclosure.

3.4 CONNECTOR INSTALLATION

- A. Furnish and install all cable connectors as shown on the Drawings.
- B. Provide number of connectors as required by the Drawings and as required by these documents, where the number of connectors required does not fill the entire faceplate provide blank inserts so that no opening is left.
- C. The provision and termination of connectors from each cable shall be done as follows:
 1. Where connector types are identified on the applicable drawings or in the specifications, furnish and install the specified connectors on the specified cables. Installation of the connectors shall be in accordance with the manufacturer's printed instructions.
 2. All installed connectors, regardless of type, method of procurement or permanency, shall be adequately protected during and after installation.
- D. Copper Connector Installation
 1. Terminate all four pairs of each cable on one outlet jack.
 2. Furnish and install all cable connectors as shown on the Drawings or as indicated herein, unless otherwise noted.
 3. The provision and termination of connectors for each cable shall be done as follows:
 - a. Where connector types are identified on the applicable drawings or in the specifications, Furnish and install the specified connectors on the specified cables. Installation of the connectors shall be in accordance with the manufacturer's printed instructions.
 - b. All installed connectors, regardless of type, method of procurement or permanency, shall be adequately protected during and after installation.

3.5 FLOORBOX LOCATIONS

- A. Refer to Division 27 "Common Work Results for Communications" for size, type, and specifications.

1. Provide appropriate mounting brackets (as required), faceplates, modular jacks, inserts, mounting frames and cabling required to fully populate and provide a fully functional system.
- B. For slab-on-grade floorbox locations, coordinate with the Common Work contractor to extend underground or in-slab conduit all of the way to the serving Telecommunications Room. If that is not practical, coordinate with Common Work contractor on stub-up location and overhead enclosure size/location to transition OSP (wet-rated) cable to plenum-rated cable.
 1. Note underground conduit routing and overhead transition point locations on pre-construction shop drawings and Record Drawings.

3.6 FACEPLATE INSTALLATION

- A. Furnish and install all faceplates in locations as shown on the Drawings.

3.7 CABLE IDENTIFICATION

- A. Label all horizontal cabling with machine-printed labels according to the labeling scheme identified on the drawings. Where the drawings are silent, submit RFI through appropriate channels requesting labeling scheme.
 1. Shop drawings shall include floor plan that indicates proposed cable/outlet identification for each outlet.
- B. Cables shall be labeled within 6" at each end.
- C. All cable labels shall be thermal-transfer type and utilize self-adhesive labels. The following are approved manufacturers:
 1. Brady, IDXPART
 2. Hellermann Tyton, Spirit 2100
 3. Panduit LS9
 4. Or equivalent

3.8 CABLE TERMINATIONS

- A. Terminate all horizontal cables in accordance with Division 27 Section "Communications Equipment Room Fittings". No cables shall contain unterminated elements UON.

3.9 CABLE TESTING

- A. Refer to Division 27 Section "Structured Cabling System" for testing requirements.

3.10 ACCEPTANCE

- A. The Owner and Design Consultant reserves the right to observe the conduct of any or all portions of the testing process.

- B. All cables that fail testing are to be corrected prior to substantial completion and acceptance by owner. Replace entire cable if bad pair or conductor is found.

END OF DOCUMENT 271500

DOCUMENT 274100 - AUDIO VIDEO SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. These specifications and the associated TA series drawings describe the audio-video (AV) systems (hereafter referred to as the "Technical System") requirements to be furnished and installed as a portion of the project scope of work.
- B. System is intended for presentation, meetings, paging, and background music and not for performances.
- C. Work includes all such work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Communications, Fire Alarm and Electronic Safety and Security Drawings and Specifications; and Addenda.
- D. Work under this section of the specifications includes all labor, equipment, and installation as required to provide a complete technical system in compliance with the contract documents.
- E. Employ the services of a qualified structural engineer to review all overhead mounting and suspension details of the technical system equipment. All mounting and suspension schemes indicated on the drawings are shown for concept only. Submit shop drawings stamped by a structural engineer of all details and weights for review by the project's Architect, Structural Engineer, and Design Consultant.
- F. The work in this section shall be coordinated with other work to determine installation scope for conduit, outlet boxes, junction boxes, pull boxes, terminal cabinets, 120-volt AC power circuits, and insulated ground cables required for the technical system.
 - 1. Provide related low-voltage "on/off" AC power control system wiring, low-voltage "on/off" control switches, and certain AC power/ground requirements internal to the equipment racks as specifically noted herein and/or on the drawings.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section, as do the following:
 - 1. Division 27 Section "General Communications Requirements"
 - 2. Division 27 Section "Common Work Results for Communications"
- B. All Category and fiber optic cabling and terminations shall adhere to the Division 27 Section "Structured Cabling Systems".
- C. This section is a parent section to all sections numbered 274101 thru 274199. Requirements found in this section shall apply to all child sections unless otherwise noted.
 - 1. Exception: Division 27 "Television Distribution Systems" is a stand-alone section.

1.3 EXAMINATION OF SITE

- A. This project is a new facility.
- B. Prior to submitting a bid personally examine the site of the proposed work and verify the conditions which involve this work.
- C. By the act of submitting a bid, the contractor will be deemed to have made reasonable allowances for site examinations, site conditions, and included all costs in their proposal. Failure to verify these conditions will not be considered a basis for the granting of additional compensation.

1.4 MATERIAL AND WORKMANSHIP

- A. All equipment shall be new and in proper operating condition. All workmanship shall be of the finest quality by experienced installation technicians.
- B. Contact the Architect, in writing, regarding the selection of colors for all exposed equipment.
- C. In addition to a complete set of the system project drawings and specifications, maintain at the job site a complete set of manufacturer's original operation, instruction, installation, and service manuals for each equipment item, for reference.

1.5 ORDINANCE AND CODES

- A. Comply with all applicable national and local codes and ordinances and obtain all required permits.
- B. Contractor shall be responsible for any and all violations within the scope of this work.

1.6 DEFINITIONS

- A. Structured Cabling System – the physical infrastructure installed to support information technology/transport for voice and data applications, commonly referred to as a Telecommunications System. This includes, but is not limited to: Category cabling, terminations/blocks, modules, faceplates, etc., and optical fiber cabling, terminations, modules, etc.
- B. Suspension System – A unique assembly of rated hardware elements and accessories required for overhead installation (and attachment to building structure) of loudspeakers and other technical system components. Elements of a suspension system may include: wire rope, shackles, eyebolts, chain, beam clamps, strut channel, etc.

1.7 QUALITY ASSURANCE

- A. Contractor General Qualifications:
 - 1. Compliance with the requirements of Division 1.
 - 2. Licensed to perform work of this type in the project jurisdiction.
 - 3. At least five (5) years of verifiable direct experience with the devices, equipment and systems of the type and scope specified herein.

4. Prior successful experience of projects of similar size, scope and type as outlined in the Construction Documents.
5. Active membership in the National Systems Contractors Association (NSCA).
6. Active membership in The Audiovisual and Integrated Experience Association (AVIXA).
 - a. AVIXA APEX certification.
7. Fully staffed and equipped maintenance and repair facility.
8. Factory-authorized dealer for the major components specified.

B. Contractor Personnel Qualifications:

1. Skilled workers thoroughly trained and experienced in the necessary crafts and completely familiar with the specified requirements and the methods needed for proper performance of the work in this section. The workers shall have at least three (3) years direct experience in similar work, evidence of which shall be verified in writing with appropriate references.
2. Supervisor with at least five (5) years direct experience in similar work. The supervisor shall be present for and in responsible charge of all work in the fabrication shop and on the project site during all phases of the installation and testing of the system(s). To assure continuity, this supervisor shall be the same individual throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene. This person shall act as the Technical System Project manager and shall attend all scheduled project meetings.
 - a. Minimum of one full-time staff member who has attended technical system design and installation courses taught by Syn-Aud-Con in the past 10 years.
 - b. Minimum of one AVIXA CTS-I (Certified Technology Specialist - Installation) systems technician.
 - c. Minimum of one full-time staff member who has a minimum of three (3) years direct experience with and is factory-certified on the most recent version of the selected Digital Signal Processor (DSP) software and technology. This individual shall be responsible for the implementation of the DSP system including software. This individual shall be the same throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene.
 - d. Minimum of one full-time staff member who has a minimum of three (3) years direct experience with network-based AV transport and is factory-certified on the most recent version of the selected AV transport technology. The individual shall hold a current manufacturer's certification (i.e., Crestron DMC-E). This individual shall be responsible for the implementation and preliminary testing of the AV transport system. This individual shall be the same throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene.

- e. Minimum of one full-time staff member who has a minimum of three (3) years direct experience and is a factory certified Master Level Programmer on the most recent version of the AV control system software and technology. This individual shall be the same throughout the execution of the work unless illness or loss of personnel intervenes. A factory authorized independent programmer (i.e., Crestron Master CAIP) will also be accepted, providing the programmer meets the criteria identified in this paragraph.
- C. Provide additional information as required for review by the Owner's Representative, Architect, and Design Consultant to aid in proving acceptability.

1.8 SUBMITTALS

- A. Refer to requirements in Division 27 Section "General Communications Requirements".
- B. Include the following items specifically as it relates to AV:
 - 1. Submittal #1: AV System Product Data (Pre-Construction). A separate product data submittal is required for each specification section, i.e., 274100, 274116, etc.
 - a. Equipment List (1A)
 - b. Manufacturers' cut sheets (1B)
 - c. Product Substitutions (1C)
 - d. Project Implementation Schedule (1D)
 - 2. Submittal #2: AV System Shop Drawings (Pre-Construction)
 - a. AV Pathways, Devices, and Cabling (2A) – Follow requirements of Division 27 Section "Common Work Results for Communications". Indicate locations of all devices and equipment.
 - b. Signal Flow Shop Drawings (2B) – Any generic diagrams found within the Construction Documents shall be drawn to specific requirements. Alterations from basis of design found within the Construction Documents shall be reflected and identified. Include wire numbering scheme.
 - c. AV Control System (2C) - AV control system panel/screen layouts suitable for the Owner's Representative to understand the operation and flow (submitted no less than five months prior to system first use).
 - d. DSP Signal Flow (2D) - DSP signal flow configuration (submitted no less than three months prior to system first use).
 - 3. Submittal #3: AV System Fabrication Drawings (Pre-Construction)
 - a. Structural Details (3A)

- 1) No Suspended device shall be installed prior to the final approval of Structural Detail Submittals by the Consultant.
- 2) For Suspended equipment provide detailed, dimensioned drawings of each Suspension hardware assembly. Also indicate location relative to structure, location relative to other component(s) (Technical System or otherwise), configuration of suspended components, attachment to structure, suspension method, and calculations.
 - a) Calculations shall include weights of Technical System equipment including suspension hardware, and details of all suspension hardware including: manufacturer(s), part number(s) and pertinent technical information (i.e., Working Load Limit) of each part including nuts, bolts, and other accessories. All weight bearing hardware must be traceable, load rated, and domestically manufactured. All welds must be certified.
- 3) Prior to submission, these drawings must be approved and signed/sealed by a structural engineer licensed for the location of the project. The following guidelines are applicable:
 - a) Contractors participating in the Suspension of Technical System components shall conform to industry best practice standards as set forth in:
 - i) "Basic Principles for Suspending Loudspeaker Systems" (JBL Professional Technical Note Volume 1, Number 14); and
 - ii) ANSI E1.6-2 -2013 (Entertainment Technology – Design, Inspection, and Maintenance of Electric Chain Hoists for the Entertainment Industry); and
 - iii) ANSI E1.6-3- 2012 (Selection and Use of Serially Manufactured Chain Hoists in the Entertainment Industry).
 - b) All Suspended loudspeakers shall conform to ANSI E1.8-2012 (Entertainment Technology—Loudspeaker Enclosures Intended for Overhead Suspension—Classification, Manufacture and Structural Testing).
- b. Equipment Rack Shop Drawings (3B) - Equipment rack front elevation for each rack showing equipment, panel layout, and electrical circuiting.
- c. Panel, Patch Panel, and Plate Shop Drawings (3C) - All panel, patch panel, and plate layouts indicating locations of connectors, engraving, nomenclature, panel material, and finish. Include Structured Cabling Work required by the technical system.
- d. Millwork Shop Drawings (3D) - Sound console and mobile cart millwork details, and related equipment and panel layout (submitted no less than three months prior to the installation of other millwork).

- e. Video Wall Shop Drawings (3E) – Dimensioned elevations (front and side) for each video wall showing panel layout, ancillary equipment at wall location, low voltage/signal circuiting, and electrical circuiting.
- 4. Submittal #4: AV System Test Results (Prior to Substantial Completion)
 - a. Preliminary Testing Documentation Package (4A) – Provide preliminary results of system testing as described in Part 3 of this section for review prior to final acceptance. Include final results with Closeout Documentation.
- 5. Project Closeout
 - a. Refer to Division 27 Section “General Communications Requirements” and the Record Drawings and Operation and Maintenance Data sub-sections in Part 3 of this section for requirements.
- 6. Refer to child sections for additional requirements.

1.9 SUBSTITUTIONS

- A. Refer to Division 27 Section “General Communications Requirements”.

1.10 ELECTRONIC FILE SHARING

- A. Refer to Division 27 Section “General Communications Requirements” for information on obtaining electronic versions of the construction drawings.

1.11 BASE BID AND ALTERNATES

- A. In addition to the Base Bid, provide prices for designated Alternates, as defined below, and as further described in the specifications and on the drawings. Alternates shall be as described herein and on the drawings. Any work not designated as an Alternate shall be provided in the Base Bid.
- B. Any and all Alternates that are not accepted (i.e., not installed) shall include provisions for future installation of these Alternates. Typical provisions include engraving and installation for all panel-mounted receptacles reflecting the complete system, all wiring installed in conduit (except where conduit remains empty) with suitable identification (noted on the working drawings for inclusion with the record drawings), patch panel wiring and labeling, and appropriate rack space (including blank panels for Alternate equipment not installed).
- C. The Owner’s Representative reserves the right to: reject all bids; reject all Alternates; accept any Alternates in any order or combination; and determine the low Bidder on the basis of the sum of the Base Bid and accepted Alternates.
- D. ADD Alternate No. 1: Site background audio.

1.12 PROTECTION OF WORK

- A. Protect all work, materials, and equipment from damage due to any cause. Provide for the safety and new condition of the equipment and materials until final acceptance by the Owner’s Representative. Replace all damaged or defective materials and/or equipment as directed by the Architect or Design Consultant.

- B. Equipment racks, cabling racks, junction boxes, termination boxes, and other exposed equipment shall be kept covered and protected from airborne contaminants. Clean all debris from the equipment room(s)/location(s) and control areas, and clean all equipment and the interior rack floor, prior to system final acceptance activities.

1.13 TEMPORARY TECHNICAL SYSTEM

- A. Provide and operate a temporary technical system of reasonably equivalent function as determined by the Design Consultant if the work in this section, as a failure of the contractor, is incomplete or found not in conformance with the contract documents. The temporary system shall remain in use until acceptance of the permanent system.

1.14 WARRANTY

- A. Warrant all work executed under this contract, including all in-shop and onsite material, parts, and labor, for a period of twelve months after the date of final acceptance.
 - 1. Existing or any other Owner-furnished equipment shall not be included in this warranty.
 - 2. For equipment that has an advertised manufacturer's warranty longer than 12 months, include end date of warranty period.
- B. The warranty services are limited to normal business hours unless additional agreements are made between the Owner's Representative and the contractor.
- C. Warranty work relating to technically complex equipment and/or programming such as for codecs, digital signal processing, control systems, and video projectors shall be performed by a factory authorized technician.
- D. Damage to the system resultant from improper use or adjustment by others, negligence, acts of nature, or other causes which are beyond the contractor's control shall be excluded from the warranty.
- E. Visit the job two weeks prior to the end of the warranty period to check all equipment for proper system operation. Any defective equipment found shall be replaced or repaired under the terms of the system warranty.
- F. Update Record Drawings and Operation and Maintenance Data to reflect work done during Warranty period and provide the updates to the Owner's Representative and Design Consultant.
- G. Refer to General Conditions for additional requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Unless otherwise designated, provide all of one type of equipment from one manufacturer. For example, microphones of one type by one manufacturer, data switches of one type by one manufacturer, cabling of one type by one manufacturer, or loudspeakers of one type by one manufacturer.

- B. Equipment and wiring shown on the drawings represents the basis of design. Ensure similar or better performance is achieved by substituted equipment.
- C. All major components of technical system equipment shall be provided and installed by a qualified contractor as outlined in Part 1 of this section.
- D. All equipment shall be new and of professional quality.
- E. Some items listed in these specifications are custom-made products. Ensure when pricing and ordering equipment that the exact part number called out is used. If there is a discrepancy, contact the Design Consultant for clarification.
- F. Each software programmable device furnished (i.e., Digital Signal Processor, control system, etc.) shall include most recent software and appropriate computer interface (wired cable or wireless). Cable, software, source (uncompiled) code and all related aspects of all software-controlled equipment shall become the property of the Owner and will be furnished as a portion of the Operation & Maintenance (O&M) Data manuals (see Operation & Maintenance Manuals near the end of Part 3).
- G. The quantities of each item of portable or mobile equipment (and other portable or loose accessories), as well as those items associated with Alternates, are indicated in parenthesis. Such equipment is intended to be shared between rooms having technical systems, except where noted for use in one specific room.

2.2 AUDIO-VIDEO MATRIX ROUTER

- A. Audio-Video Matrix Router(s) shall be as recommended by the manufacturer(s) of the connected technical system equipment. These devices shall also be coordinated with the Owner's Representative's IT department to maintain common products (where possible). Each shall be labeled as shown on the technical system drawings and as required to match the Owner's Representative's IT labeling standard.
- B. Contractor shall be responsible for the selection of product(s) that are approved for use with all systems connected to the switch(es). Products listed in this portion of the specifications are representative at the time of design – furnish the most recent approved product.
- C. Audio-Video Matrix Router(s) shall have IPv4 and IPv6 routing, multicast routing, advanced quality of service (QoS), and security features in hardware. Disabling of power saving and other blocking features shall be available for proper signal traffic.
- D. Audio-Video Matrix Router(s) shall be provided with all licensing requirements, product activation requirements, etc. for proper operation.
- E. Audio-Video Matrix Router(s) shall be configured for proper operation of the system. Configuration shall comply with Owner's network standards.
- F. The use of "Small Business" type switches and the like are not permitted.
- G. Protocol Hardware Requirements

1. Ethernet Control

- a. Layer 2, minimum
 - b. 10/100baseT ports, minimum
 - c. Refer to primary control system manufacturer for network requirements.
- 2. Standards Based Protocols
 - a. AVB
 - (1) Must be certified product per AVNU.org list of certified products.
 - (2) For Biamp systems, refer to "List of AVB-capable Ethernet switches" support page at support.biamp.com.
 - (3) Refer to Switch Manufacturer's product data for requirements related to addition of "feature packs" or similar to enable AVB protocol.
 - b. Dante
 - (1) Layer 2, minimum
 - (2) 10/100/1000baseT ports, minimum
 - (3) QoS
 - (4) Refer to Audinate website "Networks and Switches" Support page for full requirements.
- 3. Proprietary Protocols
 - a. QLAN
 - (1) 1 Gpbs ports, non-blocking
 - (2) Layer 3
 - (3) IGMP Snooping
 - (4) Refer to QSC website "Q-SYS Networking Requirements" Support page for full requirements.

B. Audio-Video Matrix Router - Type 1:

- 1. Acceptable manufacturers and model series include:
 - a. Cisco
 - b. Extreme Networks Summit Series
 - c. HP

- d. Luminex
- e. Netgear
- f. Packedge
- g. Verified equal.

2.3 DATA PATCH PANELS & ACCESSORIES

- A. Data Patch Panels are acceptable for use in Ethernet, audio network, AVLAN, and digital multimedia network applications as required to provide a complete technical system.
- B. All Category and Fiber Optic cabling (of the acceptable applications listed above) entering a technical system rack shall be terminated to a Data Patch Panel. Rack inter- and intra-connect cabling utilizing factory-terminated cable assemblies are not required to pass thru a Data Patch Panel unless shown otherwise.
- C. Data Patch Panels shall be labeled per specification part 3 of this section.
- D. Category Cabling Patch Panels –
 - 1. Refer to Division 27 Section “Structured Cabling System” for product information and additional installation requirements.
- E. Fiber Optic Patch Panels & Enclosures –
 - 1. Refer to Division 27 Section “Structured Cabling System” for product information and additional installation requirements.
- F. Cable Management –
 - 1. Refer to Division 27 Section “Structured Cabling System” for product information and additional installation requirements.

2.4 A/V CONTROL SYSTEM – GENERAL PROGRAMMING REQUIREMENTS

- A. Touch screen control interfaces shall follow the guidelines outlined in the “Dashboard for Controls” documents created on behalf of AVIXA International. Reference the Design Guide, Design Reference, and Integrators Guide for this project. Documents are available for download on the AVIXA web site.
- B. Contractor shall be responsible for complete configuration of the control system features including touch screen layouts, colors, appearance, operation, and coordination with systems external to the Technical System.
- C. Participate in planning meeting(s) (web/phone) with Design Consultant and Owner's Representative to review programming concepts and requirements before commencement of work.
- D. Panel layout and navigational flow concepts shall be developed during planning meeting(s) with Design Consultant and Owner's Representative.

- E. Refer to submittal requirements for additional information.
- F. This specification describes the initial touch screen programming concepts and requirements. Account for [four (4) distinct changes][(#) hours of programmer time] for revisions requested by the Owner's Representative after the system is substantially complete.
- G. Touch screen and keypad overall user interfaces shall comply with the following minimum requirements:
 - 1. A common theme shall be employed and used with consistency throughout the layouts. Theme shall be discussed with the Owner's Representative. The Owner's standard theme template shall be used if available.
 - 2. Where Owner logos or colors are used, Owner branding guidelines shall be followed. Trademarks shall be used appropriately. Official graphical representations (logos, word marks, logotypes, etc.) may not be altered. Owner colors shall utilize official and exact color (Pantone, CMYK, RGB, hex, etc.) as provided by the Owner, visual matching is not allowed. Content shall be obtained from an official and authorized source, e.g., the use of content from Google images is not appropriate. Owner branding is encouraged where appropriate; however, proper use and compliance remains the responsibility of the Contractor.
 - 3. The use of a password hierarchy shall be employed as directed by the Owner's Representative as they deem appropriate.
 - 4. Power ON/OFF sequence shall control all applicable devices. Sequence time shall be the required time for all controlled devices to cycle. Projector lamp warm-up and cool-down period shall be taken into account. Shutdown shall utilize two-step verification.
 - 5. Animated activity indicators (spinning ring, progress bar, etc.) shall be utilized to provide visual feedback while the system is processing tasks in the background. This will prohibit multiple button presses by the user and show feedback that the control system is processing the request. Relevant text shall be utilized where appropriate, e.g., "Please wait while the system shuts down."
 - 6. Source selection shall be available for all devices. Sources shall be laid out and grouped in a logical manner. A 'blank source' or 'image blanking' feature shall be utilized to result in no image being displayed.
 - 7. Button presses shall show instant visual feedback that they have been engaged and shall accurately reflect the response received from the device being controlled.
 - 8. Current system status shall be always visible and be consistent across all adjoined screens. Buttons shall show current status (engaged or disengaged) via color, illumination, outline, greyscale, etc. as relevant. Sliders and level indicators shall show current and true system status (i.e., show true level based on system feedback, not status based on last touch screen input) via color, knob location, percentage, etc. as relevant.
 - 9. All program source devices, such as Blu-ray players, shall have the control screens emulate the appearance and functionality of all operational controls of the handheld remote control

or user interface furnished with each device. The furnished handheld remote control and control system shall be interoperable allowing either to be used simultaneously without causing any lockups, inconsistencies, or false control system visual status. The use of (properly vetted) manufacturer control system modules is recommended.

10. Volume control of wired microphones, wireless microphones, and/or AV system program volume levels shall be discrete and shall be properly interfaced with the DSP (where applicable). The use of a master volume control is prohibited.
11. Where applicable, show the current operation mode. For example, in the case where two rooms combine/separate, the word "Combined" or "Separated" shall be displayed on each applicable screen.
12. Control of other building systems shall be coordinated with appropriate parties. Lighting and shading systems shall be controlled via preset recall. Refer to the TA series drawings showing required interfaces.

2.5 CABLE - BULK

- A. The products in this section have been approved for use in the project as necessary to facilitate a complete and working system. Inclusion in this section does not indicate a requirement for use.
- B. Product must be procured from the original cable manufacturer.
- C. AWG wire sizes indicated herein or on the drawings are the minimum size conductors required. Larger size conductors (i.e., smaller AWG number) are permitted assuming no impact on the project will occur (such as the resulting need for larger or additional conduit, cable trays, chases, etc.) to accommodate such cable.
- D. Where cable is run exposed (such as in ceiling plenums, cable trays, chases, or below accessible floors):
 1. Verify which locations do and do not require plenum-rated cable.
 2. Furnish the appropriate cable type.
 3. Obtain written authorization from the Architect (or the Architect's designated Engineer) in this regard.
- E. Category cabling:
 1. Refer to Division 27 Section "Telecommunications Requirements for Audio Video Systems" for product information and additional installation requirements.
- F. Fiber Optic cabling:
 1. Refer to Division 27 Section "Telecommunications Requirements for Audio Video Systems" for product information and additional installation requirements.
- G. Twisted Pair – Shielded: Twisted pair, shielded 22 AWG cable; interior rated 2 conductor cable with drain wire suitable for microphone, line, or production intercom level circuits:

1. Communications plenum rated cable (CMP) is suitable for use in all environments including environmental air plenums as defined per NEC Article 800.
 - a. The use of performance equivalent substituted cables of lesser type is permitted at the Contractor's discretion where allowable by NEC Article 800, local codes, and the connected equipment manufacturer's listed requirements.
 - b. Performance equivalence to the below specified products shall be determined by the cable manufacturer's listed product equivalents provided in tables and cut sheets.
2. Tinned copper cables are required in locations subject to corrosion, such as natatoriums.
3. 22 AWG/CMP: 22 AWG Communications Plenum rated bare copper conductor cable:
 - a. Belden 9451P or 6500FC; or
 - b. Clark Wire SPA22GSP; or
 - c. Gepco IP222AL or 61801HS; or
 - d. West Penn 25291B.
4. 22 AWG/CMR: 22 AWG Communications Riser rated bare copper conductor cable:
 - a. Belden 8451 or 9451 or 5500FE; or
 - b. Clark Wire SPA22GS; or
 - c. Gepco IR222AL or 61801 or 61801EZ; or
 - d. West Penn 291 or 452.
5. 22 AWG/CMP/MC: 22 AWG Communications Plenum rated bare copper multi-conductor cable, individually shielded pairs, color coded (not for interconnection within equipment racks):
 - a. 12 pair:
 - 1) Clark Wire 22EPS12P; or
 - 2) Gepco 6612HS
 - b. 8 pair:
 - 1) Clark Wire 22EPS8P; or
 - 2) Gepco 6608HS
 - c. 6 pair:
 - 1) Belden 6545PA; or

- 2) Clark Wire 22EPS6P; or
 - 3) Gepco 6606HS.
 - d. 4 pair:
 - 1) Clark Wire 22EPS4P; or
 - 2) Gepco 6604HS.
 - e. 3 pair:
 - 1) Belden 6542PA.
 - f. 2 pair:
 - 1) Belden 6541PA or 9451DP.
- 6. 22 AWG/CMR/MC: 22 AWG Communications Riser rated bare copper multi-conductor cable, individually shielded pairs, color coded (not for interconnection within equipment racks):
 - a. 24 pair:
 - 1) Belden 1821R; or
 - 2) Clark Wire 724; or
 - 3) West Penn WP45424.
 - b. 16 pair:
 - 1) Belden 1819R; or
 - 2) Clark Wire 716; or
 - 3) Gepco GA61816GFC; or
 - 4) West Penn WP45416.
 - c. 12 pair:
 - 1) Belden 1818R or 9768, or
 - 2) Clark Wire 712; or
 - 3) Gepco GA61812GFC; or
 - 4) West Penn D434 or WP45412.
 - d. 8 pair:

- 1) Belden 1817R; or
 - 2) Clark Wire 708; or
 - 3) Gepco GA61808GFC; or
 - 4) West Penn WP4548.
- e. 6 pair:
- 1) Belden 1816R or 8778; or
 - 2) Clark Wire 706; or
 - 3) Gepco GA61804GFC; or
 - 4) West Penn D432 or WP4546.
- f. 4 pair:
- 1) Belden 1815R; or
 - 2) Clark Wire 704; or
 - 3) Gepco GA61804GFC.
- g. 3 pair:
- 1) Belden 8777; or
 - 2) West Penn D431.
- h. 2 pair:
- 1) Belden 9451D; or
 - 2) Clark Wire RS22G2; or
 - 3) Gepco D61801EZGF; or
 - 4) West Penn 77510.
- H. Twisted Pair – Unshielded: Twisted pair, 2-conductor interior installation loudspeaker cable:
1. Class 3 remote-control, signaling, and power-limited plenum rated cable (CL3P) is suitable for use in all environments including environmental air plenums as defined per NEC Article 725.
 - a. The use of performance equivalent substituted cables of lesser type is permitted at the Contractor's discretion where allowable by NEC Article 725, local codes, and the connected equipment manufacturer's listed requirements.

- b. Performance equivalence to the below specified products shall be determined by the cable manufacturer's listed product equivalents provided in tables and cut sheets.
 - c. Wire gauge shall not be reduced to gain a higher cable rating.
- 2. Tinned copper cables are required in locations subject to corrosion, such as natatoriums.
- 3. ** AWG/CL3P: As listed AWG Class 3 Plenum rated bare copper conductor cable:
 - a. Belden 1862A or 6200UE (16 AWG), 6300UE (18 AWG); or
 - b. Gepco IP122BA19 (12 AWG), IP142BA19 (14 AWG), IP162BA19 (16 AWG), IP182BA7 (18 AWG); or
 - c. West Penn 25210 (10 AWG), 25227B (12 AWG), 25226B (14 AWG), 25225B (16 AWG), 25224B (18 AWG).
- 4. ** AWG/CL2P: As listed AWG Class 2 Plenum rated bare copper conductor cable:
 - a. Belden 6T00UP (10 AWG), 1860A or 6000UE (12 AWG), 1861A or 6100UE (14 AWG), 1863A (18 AWG); or
 - b. Clark Wire CW1202P (12 AWG), CW1402P (14 AWG), CW1602P (16 AWG), CW1802P (18 AWG).
- 5. ** AWG/CL3R: As listed AWG Class 3 Riser rated bare copper conductor cable:
 - a. Belden 5000UE (12 AWG), 5100UE (14 AWG), 5200UE (16 AWG), 5300UE (18 AWG); or
 - b. Clark Wire CW1202HS (12 AWG), CW1402HS (14 AWG); or
 - c. Gepco IR122BA19 (12 AWG), IR142BA19 (14 AWG), IR162BA19 (16 AWG), IR182BA7 (18 AWG); or
 - d. West Penn 227 (12 AWG), 226 (14 AWG), 225 (16 AWG), 224 (18 AWG).
- 6. ** AWG/CL2R: As listed AWG Class 2 Riser rated bare copper conductor cable:
 - a. Clark Wire CW1202 (12 AWG), CW1402 (14 AWG), CW1602 (16 AWG), CW1802 (18 AWG).
- 7. ** AWG/CL3: As listed AWG Class 3 rated bare copper conductor cable:
 - a. Belden 1313A (10 AWG), 1311A (12 AWG), 1309A (14 AWG), 1307A (16 AWG); or
 - b. Gepco 122HBW (12 AWG), 142HBW (14 AWG).
- 8. ** AWG/CL2: As listed AWG Class 2 rated bare copper conductor cable:

- a. Belden 5T00UP (10 AWG); or
 - b. West Penn HA210 (10 AWG).
- I. Twisted Pair – Unshielded – EXT: Twisted pair, unshielded exterior use cable; 2-conductor loudspeaker, sunlight resistant, direct burial:
- 1. Exterior cable shall be listed as suitable for use in Class 3 General Purpose indoor environments as defined per NEC Article 725.
 - 2. ** AWG/EXT: As listed AWG indoor/outdoor rated bare copper conductor cable:
 - a. Belden 8808WB (8 AWG), 1313A (10 AWG), 1311A (12 AWG), 1309A (14 AWG), 1307A (16 AWG); or
 - b. Clark Wire CW1002DB (10 AWG), CW1202DB (12 AWG), CW1402DB (14 AWG), CW1602DB (16 AWG); or
 - c. Gepco SSU102P (10 AWG), SSUB122 (12 AWG), SSUB142 (14 AWG), SSUB162 (16 AWG); or
 - d. West Penn C208 (8 AWG), C210 (10 AWG), AQ227 (12 AWG), AQ226 (14 AWG), AQ225 (16 AWG).
- J. Single conductor – Unshielded: Single conductor, unshielded cable:
- 1. LS Cable, loudspeaker cable for use when conduit size is limited:
 - a. THHN or THWN single conductor stranded copper. Utilize the maximum available color range.
- K. RG-59: Single 75-ohm coax, RG-59/U precision video cable:
- 1. RG-59/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 1505A; or
 - b. Clark Wire CD7559; or
 - c. Gepco VPM2000; or
 - d. West Penn 819.
 - 2. RG-59/P: Plenum rated cable:
 - a. Belden 1506A; or
 - b. Clark Wire CD7559P; or
 - c. Gepco VPM2000TS; or

- d. West Penn 25819.
- 3. RG-59/Flex: Non-plenum flexible cable, for use with portable cables, exposed, or other locations where cable movement can or does occur:
 - a. Belden 1505F; or
 - b. Clark Wire CD7559F; or
 - c. Gepco VHD2000M.
- L. RG-6: Single 75-ohm coax, RG-6/U precision video cable:
 - 1. RG-6/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 1694A or Gepco VSD2001; or
 - b. Belden 1694wb (outdoor water block); or
 - c. Clark Wire CD7506; or
 - d. Clark Wire CD7506DB (direct burial, water block); or
 - e. West Penn 6350.
 - 2. RG-6/P: Plenum rated cable:
 - a. Belden 1695A; or
 - b. Clark Wire CD7506P; or
 - c. Gepco VSD2001TS; or
 - d. West Penn 256350.
- M. RG-11: Single 75-ohm coax, RG-11/U precision video cable:
 - 1. RG-11/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 7731A; or
 - b. Clark Wire CD7511; or
 - c. Gepco VHD1100; or
 - d. West Penn 1135.
 - 2. RG-11/P: Plenum rated cable:

- a. Belden 7732A; or
- b. Clark Wire CD7511P; or
- c. Gepco VHD1100TK.

N. Television Distribution, coax:

- 1. RG-59/TV-NP: Single 75-ohm coax, RG-59/U Television equipment room cable; Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 1505A; or
 - b. Clark Wire CD7559; or
 - c. Gepco VPM2000; or
 - d. West Penn 819.
- 2. RG-59/TV-P: Single 75-ohm coax, RG-59/U Television equipment room cable; Plenum rated:
 - a. Belden 1506A; or
 - b. Clark Wire CD7559P; or
 - c. Gepco VPM2000TS; or
 - d. West Penn 25819.
- 3. RG-6/TV-NP: Single 75-ohm coax, RG-6/U Television drop cable; Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 7915A; or
 - b. Belden 5399B5; or
 - c. Clark Wire CV7506-CA; or
 - d. West Penn 841.
- 4. RG-6/TV-P: Single 75-ohm coax, RG-6/U Television drop cable; Plenum rated:
 - a. Belden 6339Q8 (quad shield); or
 - b. Carol C3525 (quad shield); or
 - c. Clark Wire CV7506P-CA (dual shield); or
 - d. West Penn 25841 (dual shield); or

- e. Carol C3525 (dual shield).
- 5. RG-6/TV-DB: Single 75-ohm coax, RG-6/U Television drop cable; Suitable for direct burial:
 - a. Belden 1190A; or
 - b. West Penn 6310.
- 6. RG-11/TV-NP: Single 75-ohm coax, RG-11/U Television distribution cable; Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 1523A; or
 - b. Carol 495027; or
 - c. Clark Wire CV7511-CA; or
 - d. West Penn 821.
- 7. RG-11/TV-P: Single 75-ohm coax, RG-11/U Television distribution cable; Plenum rated:
 - a. Belden 1153A; or
 - b. Carol 395029; or
 - c. Clark Wire CV7511P-CA; or
 - d. West Penn 25821.
- 8. RG-11/TV-DB: Single 75-ohm coax, RG-11/U Television distribution cable; Suitable for direct burial:
 - a. Belden 1525A; or
 - b. Clark Wire CV7511DB-CA; or
 - c. West Penn 1110.
- O. RG-58: Single 50-ohm coax, RG-58/U radio frequency cable:
 - 1. RG-58/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 7806R; or
 - b. Clark Wire CV5058; or
 - c. West Penn 812.
 - 2. RG-58/P: Plenum rated cable:

- a. Belden 82240 or 88240; or
 - b. Clark Wire CV5058P; or
 - c. West Penn 25812.
- P. RG-8: Single 50-ohm coax, RG-8X and RG-8/U radio frequency cable:
- 1. RG-8X/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 7808R or 9258; or
 - b. Clark Wire CV5008X; or
 - c. Gepco V5020; or
 - d. West Penn 807.
 - 2. RG-8X/P: Plenum rated cable:
 - a. West Penn 25810.
 - 3. RG-8/U/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 9913; or
 - b. Clark Wire RF50LL; or
 - c. West Penn 810.
 - 4. RG-8/U/P: Plenum rated cable:
 - a. Belden 89913; or
 - b. Clark Wire RF50LLP; or
 - c. West Penn 25812.
- Q. RG-213: Single 50-ohm coax, RG-213/U radio frequency cable:
- 1. RG-213/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 8267; or
 - b. Clark Wire CV50213.
- R. Control cable, power and control in one jacket, one unshielded 18 WG pair, one shielded 22 AWG pair:

1. Control cable - NP, not plenum rated:
 - a. Belden 1502R or Gepco 18/22AXL; or
 - b. Clark Wire ULK2218; or
 - c. Crestron CRESNET-NP; or
 - d. West Penn 77350.
 2. Control cable - P, plenum rated:
 - a. Belden 1502P or Gepco 18/22AXLP; or
 - b. Clark Wire ULK2218P; or
 - c. Crestron CRESNET-P; or
 - d. West Penn D25350.
- S. RS-232: Low capacitance computer cable for EIA RS-232/422, 24 AWG, 4-conductor, shielded, minimum conductor-to-conductor capacitance: 22pF/ft, PVC jacket:
1. RS-232/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 8102; or
 - b. Clark Wire SMP2404.
 2. RS-232/P: Plenum rated cable:
 - a. Belden 88102; or
 - b. Clark Wire SMP2404P.

2.6 CABLES – FACTORY TERMINATED – INSTALLED

- A. The products in this section have been approved for use in the project as necessary to facilitate a complete and working system. Inclusion in this subsection does not indicate a requirement for use.
- B. Factory terminated cable assemblies specified in this subsection are only permitted for use within racks or between devices external to racks. Permitted for rack inter-connect when racks are in close proximity (same room) and may pass thru conduit if necessary in this situation. Not permitted for use in conduit unless specifically noted as such.
- C. Factory terminated cable assemblies shall be the minimum length needed to accomplish the connection. Portable cable assemblies are specified in Division 27 Section “Audio Video Systems Equipment” and are required to be furnished in addition to those required for system installation.

- D. All cable assemblies must be factory tested and certified.
- E. Category cabling:
 - 1. Refer to Division 27 Section "Structured Cabling System" for product information and additional installation requirements.
- F. Fiber Optic cabling:
 - 1. Refer to Division 27 Section "Structured Cabling System" for product information and additional installation requirements.
- G. DisplayPort, version 1.1a or higher, Acceptable lengths: 1'-25':
 - 1. Clark Wire DP Series (3', 6', 10', 15'); or
 - 2. Comprehensive DisplayPort Standard Series (3', 6', 10', 15', 25'); or
 - 3. Extron DisplayPort M-M Series (3', 6', 12', 25'); or
 - 4. Approved Equal.
- H. DVI, Dual Link DVI-D cable, Acceptable lengths: 1'-16':
 - 1. Clark Wire DVID Series (3', 6', 10', 16'); or
 - 2. Comprehensive Pro AV/IT Series (3', 6', 10', 15'); or
 - 3. Extron DVID DL Pro Series (3', 6', 12'); or
 - 4. West Penn CN-E08 Series (6', 10', 15'); or
 - 5. Approved Equal.
- I. DVI-Flex, Flexible Single Link DVI-D cable, Acceptable lengths: 1'-16':
 - 1. Comprehensive MicroFlex Low Profile Series (1.5', 3', 6', 10', 15'); or
 - 2. Extron DVID SL Ultra Series (1.5', 3', 6', 9', 12'); or
 - 3. Approved Equal.
- J. HDMI Locking Cable, version 1.4 or higher compliant, locking connectors, male HDMI to male HDMI, Acceptable lengths: 1'-25':
 - 1. Belden HD-800 Series (2', 4', 8', 25'); or
 - 2. Clark Wire HDMI-L Series (3', 6', 10', 16'); or
 - 3. Perfect Path 800 Series (2', 4', 8', 16', 25'); or

4. Approved Equal.
 - K. HDMI Fiber Optic Cable, version 1.4 or higher compliant, male HDMI to male HDMI, Acceptable lengths: 25'-328':
 1. Celerity UFO Series (35', 40', 50', 60', 80', 100', 160', 200', 300'); or
 2. Liberty DL-HDM-M-***M Series (8m, 10m, 15m, 23m, 30m, 50m, 60m, 100m); or
 3. Cables To Go RapidRun Optical Series (25', 35', 50', 65', 80', 100', 125', 150', 175', 200'); or
 4. Approved Equal.
 - L. USB, Type B male (device = square) to Type A male (computer = flat) or Type A male to Type A male USB 2.0 compliant, Acceptable lengths: 1'-25':
 1. Comprehensive; or
 2. Extron; or
 3. Approved Equal.
 - M. Video Cable BNC, RG-59 BNC to BNC, 75-ohm, Acceptable lengths: 1'-25':
 1. Canare VAC Series (3', 5', 25'); or
 2. Comprehensive Pro AV/IT Series (3', 6', 10', 25'); or
 3. Hosa BNC-59-1 Series (3', 5', 25'); or
 4. Whirlwind VID BNC3 Series (5', 25'); or
 5. Approved Equal.
- 2.7 CONNECTORS
- A. The products in this section have been approved for use in the project as necessary to facilitate a complete and working system. Inclusion in this section does not indicate a requirement for use.
 - B. All XLR receptacles located outdoors, in boxes that are located outdoors, in natatoriums, or in areas where moisture or other corrosive materials are present shall have gold plated contact pins.
 - C. XLR Cable Connector, cable mounted connector for line-level, microphone level, and intercom circuits:
 1. Amphenol AC series; or
 2. Neutrik X-series; or
 3. Switchcraft E Series Q-G.

- D. XLR Panel Connector, panel mounted audio connector for line-level, microphone level, and intercom circuits, color shall match plate color where possible:
 - 1. Amphenol AC "DZ" series; or
 - 2. Neutrik D-Series; or
 - 3. Switchcraft standard AAA Series Q-G with metal handle.
- E. XLR Combo Connector, female XLR and 1/4" TRS receptacle in one chassis-mount connector:
 - 1. Neutrik NCJ6FI-S.
- F. 1/4" TRS Cable Connector, three-conductor (Tip Ring Sleeve) connector with a metal barrel and solder lugs:
 - 1. Amphenol TS3PN; or
 - 2. Canare F-16; or
 - 3. Neutrik NP3C; or
 - 4. Switchcraft 267.
- G. 1/4" TS Cable Connector, two-conductor (Tip Sleeve) connector with a metal barrel and solder lugs:
 - 1. Amphenol TM2PN; or
 - 2. Canare F-15 plug; or
 - 3. Neutrik NP2C plugs; or
 - 4. Switchcraft 250.
- H. 1/4" TRS Panel Connector, three-conductor (Tip Ring Sleeve) connector with the sleeve contact isolated from the panel or plate to which it is mounted:
 - 1. Neutrik NJ3FP6C; or
 - 2. Switchcraft E112BL.
- I. 1/8" TRS Cable Connector, 1/8" (3.5mm) three-conductor mini-plugs which have a metal barrel and solder lugs:
 - 1. Amphenol KS3P; or
 - 2. Canare F-12; or
 - 3. Neutrik NTP3RC; or

4. Switchcraft 35HDNN plug.
- J. Locking LS Cable Connector, twist-lock cable mount male loudspeaker connector, minimum 2-two conductors. Coordinate connector with associated intended panel mount connector, including those on loudspeakers:
1. Amphenol SP-2-FN (two conductor); or
 2. Neutrik speakON NL2FC (two conductor); or
 3. Amphenol SP-4-FN (four conductor); or
 4. Neutrik speakON NL4FC (four conductor); or
 5. Neutrik speakON NL8FC (eight conductor).
- K. Locking LS Panel Receptacle, twist-lock chassis mount female loudspeaker connector, minimum two conductors. Coordinate receptacle with associated intended cable connector:
1. Amphenol SP-2-MD (two conductor); or
 2. Neutrik speakON NL2MP (two conductor); or
 3. Amphenol SP-4-MD (four conductor); or
 4. Neutrik speakON NL4MP. Male connector (four conductor); or
 5. Neutrik speakON NL8MPR-BAG (eight conductor)
- L. RJ45 Panel (Faceplate) Connector-6, data connector rated for shielded Category 6 cable:
1. Neutrik etherCON NE8FDY-C6* with SCDX cover
- *Division 27 "Telecommunications Requirements for Audio Video Systems" Contractor shall terminate cable onto etherCON connector installed in custom faceplate.
- M. BNC Cable Connector, 75-ohm BNC, compression fitting for coaxial cable furnished:
1. Liberty CM-RG-BNC series; or
 2. West Penn CN-CS-BNC and CN-FS-BNC series.
- N. BNC Panel Connector, 75-ohm BNC, pass-through, D-style mounting:
1. Neutrik NBB75DFI; or
 2. Approved Equal.
- O. Terminator, RF or SDI terminator plug:
1. Extron T-BNC series; or

2. Pomona 3840 series; or
3. Trompeter TNA series.

P. Terminal Block Terminations

1. Utilize as applicable and only as allowed per Part 3.
2. Acceptable mounting methods include:
 - a. For small quantities in AV Closets: Mount DIN rail within rear of AV equipment rack. Utilize as preferred method wherever feasible and provide a compatible DIN rail rack mount kit.
 - b. For large quantities in AV Closets: Mount DIN rail(s) to plywood backing on wall. Utilize wall mounting DIN rail brackets.
 - 1) Microphone level cable shall be mounted within an enclosure.
 - c. For field locations: Provide a minimum NEMA 1 rated enclosure and locate DIN rail(s) within enclosure. Ensure enclosure is properly labeled and identified on as-builts.
3. Captive Screw Terminal Block: modular terminal blocks for mounting on DIN rails:
 - a. Entrelec (TE) Screw Clamp series; or
 - b. Legrand Viking 3 series; or
 - c. Approved equal.
4. Terminal Block DIN Mounting Rails: DIN rails for mounting of terminal blocks:
 - a. Crestron DIN-EN series; or
 - b. Hoffman DIN Rail LMK series; or
 - c. Middle Atlantic FWD-DIN1H; or
 - d. Approved equal.

2.8 STORAGE

- A. Cable Storage Bracket, one 2x4 wooden board eight feet long with eight 1-inch diameter wooden dowels each 12-inches long installed on one-foot centers. Paint color to match equipment racks if located in the same room, otherwise, color as selected by the Architect. Mount bracket(s) at wall location if shown on drawings, otherwise, mount as later directed by the Owner's Representative (two required):
 1. Custom by contractor.

- B. Lockable Steel Storage Cabinet, 36"W x 18"D x 72"T combination cabinet with 4 half-width adjustable shelves, full length top shelf, and half-width vertical cavity (for microphone stands). Glue and screw a rubber mat to the bottom of the cavity for microphone stands to prevent slippage. Color to match equipment racks if located in the same room, otherwise color as selected by the Architect. Mount cabinet if shown on drawings, otherwise mount as later directed by Owner's Representative. (quantity one (1) cabinet required, four keys required):

1. Globalindustrial.com WB894113 series; or
2. Lockers.com model 9274 Combination Storage Cabinet; or
3. Approved Equal.

2.9 AC POWER

A. General

1. A complete AC power connection solution for each equipment rack and cabinet is required.
2. Provide spare NEMA 5-15R or 5-20R outlets (single duplex receptacle) for temporary equipment (beyond that required for connected equipment, rack fan, etc.). These outlets shall be fed from an un-switched "Normal" power circuit.
 - a. For racks 16 RU or less: two spare outlets (minimum)
 - b. For racks greater than 16 RU: four spare outlets (minimum)
3. All power strips shall maintain integrity of system grounding requirements.
4. All equipment shall be connected such that maximum rated performance can be obtained without exceeding the AC circuit load capacity.
5. Coordinate with Electrical drawings and Division 26 specifications. Where outlets are provided under this section as a portion of power strips or power distribution units, receptacle types and colors shall match the supplied AC power circuit.
6. Comply with all NEC requirements, including separation of loads classified as Life Safety from Normal loads via an independent Vertical / Horizontal Power Strip, PDU, and/or UPS.

B. Uninterruptable Power Supply Requirements

1. UPS shall be provided in quantities as indicated on signal flows and/or rack elevations, and as described for components and equipment within this Section and associated Subsections.
2. A UPS connected to a Normal power load shall be provided with enough battery capacity to bridge short duration loss of power and brownout events. The intent is to protect and prolong the life of sensitive processor-based equipment, reduce power cycle time upon restoration of Normal power, and/or allow the User time to safely shut down components.

3. A UPS connected to Emergency (NEC Article 700), Legally Required Standby (NEC Article 701), or Optional Standby (NEC Article 702) AC power circuits shall be provided with enough battery capacity to bridge the maximum operation load of the connected equipment during the time from loss of Normal power to load handover to the electrical standby power system (typically generator startup time).
4. Each UPS with an ethernet port shall be connected to the network. The Contractor shall configure the UPS (using additional software where required) per direction from the Owner's Representative. Configuration shall include, but not be limited to:
 - a. Remote access and diagnostics
 - b. Automated reporting for non-normal events (such as battery condition or power interruption)
- C. PS/V: Vertical Power Strip, single 120V 20A circuit, NEMA 5-20P plug input, minimum fourteen NEMA 5-15R outlets, mount to rear of rack interior (furnish where provided electrical receptacle quantities do not meet system requirements):
 1. APC AP7530 with 40170-6INCH L5-20P adaptor; or
 2. Eaton EPBZ97; or
 3. Middle Atlantic PD-2420SC-NS; or
 4. Tripp Lite PDUV20 with included L5-20P adaptor; or
 5. Approved equal.
- D. PS/H: Horizontal Power Strip, single 120V 20A circuit, NEMA 5-20P plug input, minimum eight rear-facing NEMA 5-15R outlets, single rack space (furnish where provided electrical receptacle quantities do not meet system requirements):
 1. APC AP9563; or
 2. Eaton EPBZ85; or
 3. Middle Atlantic PD-920R-NS; or
 4. Tripp Lite PDU 1220; or
 5. Approved equal.
- E. PDU/V: Vertical Power Distribution Unit, capable of multiple circuits and outlets, configured for circuit quantity, voltage, and amperage provided to rack; mount to rear of rack interior (furnish in coordination with provided electrical power):
 1. Juice Goose PD Series; or
 2. Middle Atlantic MPR Series; or

3. Middle Atlantic PDW Series; or
4. Approved equal.

F. UPS:

1. 1RU: Uninterruptable Power Supply, single rack space chassis, line interactive, surge suppression, 120V 20A circuit, minimum 750VA load, plug input, minimum four rear-facing NEMA 5-15R outlets:
 - a. APC Smart-UPS SUA750RM1U; or
 - b. Eaton 5P750R; or
 - c. Middle Atlantic UPS-S1000R; or
 - d. Tripp Lite SmartPro SMART750RM1U; or
 - e. Approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

3.2 PREPARATION

- A. Coordinate locations and sizes of junction boxes, outlets, and conduit with the work of other trades. Field verify compliance with the construction documents.
- B. Carefully inspect areas where equipment will be installed. Notify the Architect of any conditions that would adversely affect the installation and subsequent operation of the system.
 1. Repeat inspection on a regular basis to ensure ongoing work by other trades does not pose a conflict to Contractor's pending work.

3.3 INSTALLATION

A. General

1. Contractor shall demonstrate a reasonable standard of care. Installation shall be rendered in a workmanlike manner observing direction set forth herein as well as industry standard best practices.
2. In addition to any spare cabling shown on drawings, utilize industry best practice to pull additional spare cabling in conduit where logical. Neatly bundle a usable length of cable at each end of each spare circuit. All spare circuits shall be labeled and noted on the field drawings for inclusion into the record drawings.
3. Install any floor-mounted receptacles so that release buttons (for both receptacles and cable connectors) are easily accessible when cable connectors are installed.

4. Blank panels and/or vent panels shall be installed in unused rack spaces. Ensure that air flow within the rack is maintained (i.e., cool air can enter the rack and hot air can exit the rack).
5. Equipment racks and other exposed equipment shall be kept covered and protected from airborne contaminants. Clean all equipment racks and the interior rack floor, prior to system final acceptance activities.
6. For racks installed in credenzas, fasten carpet tiles or low friction sliders to the bottom of the rack to protect the finish of the furniture.
7. Where the design location requires products, materials, or equipment to be visible to the public, manufacturers logos shall be removed if possible. Unless otherwise directed, neatly remove or logos.
8. AC power switches located on the front panel of equipment mounted in racks shall be covered by a security cover or utilize front panel lockout features. Exclusions from this list are items requiring user interface such as tuners and wireless microphone receivers.
9. Furnish all equipment with factory finish where possible using the standard available factory color(s) as selected by the Architect. Notify the Architect regarding color options of relevant equipment prior to ordering equipment from each manufacturer.

B. Suspended Systems

1. General

- a. Contractor shall provide Suspension system, including connection to structure, for all suspended components including but not limited to: loudspeakers, video projectors, flat panel displays, televisions, projection screens, etc.
- b. Suspension system design shall be created by the Contractor and include fully dimensioned detail documentation stamped by a structural engineer licensed in the location of the project per submittal requirements in Part 1 of this document.
- c. Contractor shall include a safety cable or other backup support mechanism.
- d. Suspension systems and installation shall conform to industry best practice standards as set forth in:
 - 1) "Basic Principles for Suspending Loudspeaker Systems" (JBL Professional Technical Note Volume 1, Number 14)
- e. Coordinate with General Contractor any supplemental building structure necessary to facilitate the approved suspension design.
- f. Field verify conditions for compliance with the approved suspension plan prior to installation, placement of equipment orders, or material fabrication. Coordinate with other trades as necessary.

2. Loudspeakers

- a. Install loudspeakers so there are no obstructions to loudspeakers' coverage pattern.
- b. Loudspeakers shall be installed such that they do not produce or cause mechanical rattles in the surrounding structure. There shall be no audible vibration or noise caused by improper mechanical installation or defective components.
- c. Paint loudspeaker and/or grille assembly (at discretion of Architect or Design Consultant) color as selected by the Architect. Use primer per manufacturer's recommendations. Do not paint loudspeaker cones or high frequency diaphragms. Materials and labor provided by Contractor.
- d. Provide access to loudspeakers during installation, testing, and final acceptance activities to allow for modifications to location or installation. Access includes all necessary resources required to obtain direct physical contact to loudspeakers (front and rear), including: scaffolding, motorized lift, etc.
- e. Provide ability to reorient loudspeakers in all axes (yaw, pitch, and/or roll) if so requested by Design Consultant during system final acceptance activities.
 - 1) Do not perform final suspension connections prior to final acceptance by the Design Consultant including: permanent cable swage, elimination of wire rope service loop, etc.

C. Video

1. Coordinate structural backing required for wall mounted flat panel displays/televisions prior to the installation of drywall or other wall materials.

D. Grounding

1. Comply with NEC and BICSI grounding requirements.
2. Each equipment rack within a row of racks and each row of racks within a room shall be electrically bonded to each other. Bonding shall be via copper ground bus. Any bolts shall fasten to unpainted sheet metal.

E. Equipment Power Control

1. Low voltage "ON/OFF" control of system equipment shall be provided via the control system.
2. Operation of the following components is required, at a minimum:
 - a. Power amplifiers as indicated in Part 2 requirements
 - b. UPS connected devices where components do not require power under system shutdown
 - c. Components equipped with power state control

3. Make all low-voltage connections as required to provide a complete and working control system.
4. Refer to drawings for additional low-voltage sequencing system requirements.
5. Refer to electrical drawings for AC power information.
6. Coordinate with Electrical Contractor as necessary to verify proper circuit assignment and sequencing order.

F. AC Power Sequencing

1. Where a control system is provided, power sequencing shall be a portion of the logic.

3.4 RACK BUILDING, CABLE MANAGEMENT AND TERMINATION

A. Employ techniques to fulfill AVIXA F502.01:2019 "Rack Building for Audiovisual Systems" as a minimum standard with the additional requirements as described in this paragraph.

1. Reference below for additional requirements and stipulations related to zip tie utilization.

B. General

1. Do not violate the minimum cable bend radius as specified by the cable manufacturer.
2. Dress cables so terminations are free from stress due to gravity acting on the cabling. Use cable supports as required depending on the size and stiffness of the cable.
3. Terminate cables with sufficient service loop to allow at least two re-terminations without having to open a cable bundle or pathway.
4. All circuits, including various audio signal levels, shall be separated according to function. Where audio and video circuits are installed in conduit or other raceway, separate conduits are required for the various circuit functions.
5. Where circuits are exposed in the equipment racks or large junction or pull boxes, circuits shall be bundled according to function. Refer to "Conduit/Circuit Group Divisions" and "Conduit Routing and Separation" schedules for additional information.
6. All solder connections shall be made with soldering iron and rosin core solder. All solder connections shall be checked for "cold" solder joints.
7. If equipment is removed or replaced for service, ensure the proper cable termination points are apparent when the equipment is re-installed.
8. Use Velcro tie wraps (hook and loop) for all category, coaxial, or fiber cables and additionally as practical for other types of cables. Do not use zip ties on any category, coaxial, or fiber cables and limit use where possible otherwise.
9. Do not tighten cable wraps so the cable is deformed. Zip ties should never be used in locations prone to damage due to cable sagging.

C. Equipment Racks

1. Utilize Velcro cable wraps (hook and loop) for dressing cables within the rack(s). Cable wraps shall be hand tightened and spaced at various inconsistent distance intervals. The use of zip ties is not allowed inside equipment racks.
2. Install rack-mounted equipment manufactured without IEC removable power cords so the power cords are dressed using removable fasteners such as Velcro and there are no obstructions to the item being pulled out from the front of the rack. Avoid coiled or bundled cable loops.
3. For rack-mounted equipment manufactured with IEC removable power cords, provide power cord assemblies of the minimum length needed to accomplish connection to the PDU. Avoid excess power cabling including coiled or bundled cable.
4. Factory terminated cable assemblies are only permitted for use within racks, between devices external to racks, as portable equipment, or for use in conduit as specifically noted as follows: Permitted for rack inter-connect when racks are in close proximity (same room) and may pass thru conduit if necessary, in this situation. Cable assemblies shall be the minimum length needed to accomplish the connection.
5. Install rack equipment to enable repair or replacement without hindrance. If there are obstructions prohibiting the disconnection of terminations on the back side of the technical equipment, there must be sufficient cabling to permit the equipment to be pulled from the front allowing for easy disconnection and reconnection.

D. Paralleling and Extension Connections

1. Circuits shall not be joined by butt-splice, solder-splice, wire nut, or similar.
2. Circuits requiring parallel connection as indicated on signal flows shall be extended via approved termination in an appropriately sized junction box and shall conform to the following guidelines:
 - a. Approved connections include DIN mounted terminal blocks as specified in Part 2.
 - b. Field splicing techniques such as wire nuts, "twist and solder", etc. are not allowed.
 - c. Any circuit requiring parallel connection shall be permanently labelled on every cable as defined herein.
 - d. Care must be taken to maintain appropriate protection and shielding of circuits in order to maintain a fully functional system.
3. Circuits requiring extension (non-data) due to field conditions such as excessive conduit bends, etc., shall be extended via approved termination in an appropriately sized junction box and shall conform to the following guidelines:
 - a. Extension of circuits is to be avoided if at all possible.

- b. Contact the Design Consultant via documented project communication. Inform the Design Consultant of the circumstances regarding the desired extension. Contractor and Design Consultant will coordinate to determine the most appropriate course of action.
 - c. Approved connections include DIN mounted terminal blocks as specified in Part 2.
 - d. Any circuit requiring extension shall be permanently labelled on every cable as defined herein.
 - e. Care must be taken to maintain appropriate protection and shielding of circuits in order to maintain a fully functional system.
4. Document each parallel connection and extension on the field drawings and transfer same to the final record drawings.

E. Telecommunications Cabling

- 1. Refer to Division 27 Section "Structured Cabling System" for all work associated with data-related cabling including Category and Fiber Optic cabling.
- 2. All data-related cabling entering a rack shall be terminated to a Data Patch Panel. Rack inter- and intra-connect cabling utilizing factory-terminated cable assemblies are not required to pass thru a Data Patch Panel.
- 3. All Fiber Optic cabling entering a rack shall be terminated to a Fiber Patch Panel. Rack inter- and intra-connect cabling utilizing factory-terminated cable assemblies are not required to pass thru a Fiber Patch Panel.

F. Microphone/Line Level Audio

- 1. Audio circuit termination shall observe the methods set forth in "Sound System Interconnection" RaneNote 110, © 2011 by Rane Corporation. This reference document may be obtained at: <https://www.ranecommercial.com/legacy/library.html>
- 2. Key methods include, but are not limited to the following:
 - a. All audio circuits shall be balanced two-wire circuits, with a separate grounding shield conductor, unless noted otherwise. All circuits shall have either the red or white wires as the "high" or "+" side of the line and connect to pin 2 of microphone-type XLR audio connectors and the tip of 3-conductor phone connectors. The black wire of the two-wire circuit shall be the "low" or "-" side of the line and connect to pin 3 of microphone connectors and the ring of 3-conductor phone connectors. The shield conductor shall connect to pin 1 of microphone connectors or to the sleeve of phone connectors.
 - b. Shield conductors shall be connected at each end of each wire to the pin 1 of each XLR, shield connection for each electronic device, etc. No shield wires shall be left unconnected except where noted on the drawings, nor shall any shield come in contact with conduit, pull boxes, or other building steel. Audio line-level circuit

shield wires shall be grounded to rack sheet metal only via rack-mounted equipment. Shields shall be electrically isolated in multi-conductor cables. Shields for audio line-level circuits connected to audio transformers shall be connected to transformer electro-static shields and case ground.

- c. In the case of an unbalanced source feeding into a balanced input and the cable run is short (i.e., less than fifteen feet), connect the signal connection of the unbalanced connector to the "high" side of the balanced input. Connect the "ground" connection of the unbalanced line to the "low" side of the balanced connector. Connect the cable shield to the shield connection of the balanced input but do not connect it to the unbalanced connector. If the cable run is longer than fifteen feet, balance the line at the unbalanced source using specified balancing devices.
- d. In the case of a balanced source feeding into an unbalanced input and the cable run is short (i.e., less than fifteen feet), connect the "high" side of the balanced output to the signal input of the unbalanced connection. Connect the "shield" of the balanced connection to the "ground" of the unbalanced connection. Leave the "low" side of the balanced output floating.

G. Loudspeaker Level Audio

1. Loudspeakers in the same acoustic space shall all be wired to produce consistent polarity with a mono input signal. They shall also be polarized such that a positive acoustic pressure on a microphone results in a positive acoustic pressure at all loudspeakers.

H. Video

1. Compression fittings shall be used for all BNC and F connector terminations.
2. Terminate all unused RF and SDI outputs with impedance matching terminators.
3. Neatly dress all cables behind a flat panel display/television. Cables and connections should not be visible from the viewing locations. Power cables for displays shall not be bundled with signal cables nor visible.
4. For fixed projector or pole mounted flat panel display installations, signal cables shall be routed within the mounted pipe. Signal cables shall not be tied to the outside of the pipe. Provide cabling of appropriate distance to minimize excess cable at device. Bundle excess cable above the ceiling, not at the device.

3.5 LABELING

- A. Adhere to AVIXA F501.01:2015 "Cable Labeling for Audiovisual Systems" as a minimum standard with additional requirements as described in this paragraph.
- B. Refer to Division 27 Section "Structured Cabling System" for all labeling requirements associated with data-related cabling including Category and Fiber Optic cabling.
- C. Develop and utilize a consistent numbering scheme across the entire project. Utilize system names and building references where applicable, such as the rack number or rack room in a

distributed system. All labels for input/output plates and control panels shall be consistent with the final room numbering for the facility.

- D. Adhere to the labeling standard across all platforms, including within the DSP programming.
- E. Refer to general notes, the signal flows, and panel and plate details for expected labeling scheme of system equipment and components. Comply with any specific color coding as described.
- F. All equipment in equipment racks shall be labeled front and rear for ease of identification. Labels shall be of a contrasting color with that of equipment color to promote visibility.
- G. Install permanent labeling on the front of each equipment rack in a row of racks identifying the rack designation (number).
- H. Within each rack and at other remote locations for technical system equipment, label all associated AC power receptacles reflecting the appropriate circuit breaker. Ensure that the circuit breakers are labeled as to the rack or remote equipment location.
- I. Document the labeling standard for inclusion in the Operation and Maintenance Data.
- J. Document all labels for the Record Drawings.
- K. Pre-approved labelling systems include:
 - 1. Brother P-touch EDGE with HGeS2***PK labels; or
 - 2. Brady Equipment Identification Labels.

3.6 SYSTEM CONFIGURATION

A. Coordination

- 1. Coordinate and take responsibility for the approval of all system configuration components as described in this paragraph.
- 2. Coordinate all aspects of the technical system network, including configuration and connection with to the Owner's LAN. Utilize Owner's designated configuration style, standards, and security requirements.

B. Software

- 1. Furnish, install, and configure the most recent approved, non-beta, software for each device or system.
- 2. Provide software as identified in other areas of these specifications or on the drawings.
- 3. Provide software not specifically identified but required to allow for system operation and/or to allow for more efficient system configuration, setup, and operation.

C. Firmware

1. Ensure the firmware for each device is the most recent manufacturer approved version and is installed and operational.

D. Operating Systems

1. Gain approval of the operating system version and type from the Owner's IT representative and associated equipment manufacturer(s).
2. Ensure the operating system for each device is the most recent, installed, and fully operational.
3. Ensure the latest security patches are installed.

E. Network Configuration

1. All technical system devices with an Ethernet port shall be connected to the associated network.
2. Secure the entire network, documenting all passwords. Comply with the Owner's IT representative's requirements with respect to password selection and network security implementation.

F. Network Documentation

1. Document the IP and MAC addresses of all IP capable equipment for inclusion with the Operation & Maintenance Manuals.

3.7 CONTRACTOR'S TESTING, ADJUSTMENT, AND SUBMITTAL REQUIREMENTS

- A. At the completion of the installation, perform the following tests on the system to ensure proper installation and operation. The technical system shall be fully tested with all equipment on site, installed, connected, and fully operational.
- B. Adhere to ANSI/Infocomm 10:2013 "Audiovisual Systems Performance Verification" as a minimum standard with additional requirements as described in this paragraph.
- C. The Contractor shall submit the results of all tests prior to on-site system review by the Design Consultant. Where available, provide documentation obtained directly from the test equipment. Other acceptable documentation includes screen captures, photos, and spreadsheets.

D. General

1. Utilize the technical support services offered by the manufacturers of the various technical system components to ensure optimum performance.
2. All test equipment used for these tests shall be on site during the system final acceptance activities should verification of submitted measurements be required.
3. Ensure that all equipment is on the jobsite and fully operational. This includes portable (not installed) items and other loose equipment. Remove all devices from shipping or packaging containers, ready for use, and place in equipment storage cabinet.

4. The functional tests shall include operational tests of all program source equipment (record and playback), wireless microphone system, mixing console, system inputs and outputs, all patch panel receptacles, intercom system, video routing, video distribution, operational controls, AC power sequencing, operation of software, and all system electronics. Functional tests include examination for hum, buzz, hiss, ghosts, hum bars, oscillation, thumps, unintended reception of other signals such as AM or FM radio, TV, CB, ham radio, cell phones, or any other unwanted signals through the system.
5. Ensure all inputs and outputs are wired to the appropriate devices per construction documents.
6. Verify system startup and shutdown operates in the proper sequence.
 - a. System head end components shall be energized at the beginning of the startup sequence in an appropriate order to guarantee proper communication with associated devices.
 - b. Loudspeaker power amplifiers shall be energized at the end of the sequence in order to eliminate unwanted transients being reproduced through system loudspeakers.
 - c. System shutdown sequence shall be in reverse order.
7. Where a system computer is furnished, load and configure all necessary control software. Examples include but are not limited to the following as applicable: wireless microphone management, amplification management, projector/display management, audio console configuration/control, DSP configuration/management, and active loudspeaker management.
8. Where audio or video digital signal transport is required, ensure all network setup is complete including the installation and licensing of network management application software.

E. Required testing equipment

1. Certain systems/subsystems require testing and documentation via approved test equipment.
 - a. Systems requiring testing via approved devices will be identified below.
 - b. Required test devices will be listed in related sections.
 - c. Provide unified testing results of similar systems. Describe testing procedure including all test equipment used.
 - d. Provide original results from testing equipment (as applicable).
2. Failure to submit testing documentation conducted via approved devices will result in delayed final acceptance by the Design Consultant.
3. Contractors unable to provide required test equipment shall employ the services, at their own expense, of a certified subcontractor to assist in testing and documentation.

F. Audio System

1. Electronics

- a. Test all system audio electronic components for uniform frequency response from input to power amplifier output:
 - 1) Supply pink noise to a single system input which engages most of the system electronics. For example, connect pink noise to a microphone receptacle on the stage for a Performing Arts facility.
 - 2) With all signal processing bypassed (equalization band pass filters, crossovers, dynamics, etc.), independently route the signal through audio console, DSP, and any other system processing components to an amplifier output.
 - 3) With speaker load disconnected, measure the signal response of the selected amplifier output (to obtain viable measurement results, ensure output level is set to match the ability of the measurement device to display accurate information. This can be accomplished via attenuation of signal or insertion of a speaker level to line level attenuator).
 - 4) Verify the measured response is uniform and matches the reference input signal within $\pm 1\text{dB}$ from 30 Hz to 18 kHz.
 - 5) Required test equipment - Signal Generation:
 - a) Terrasonde/Sencore Audio-Toolbox; or
 - b) Japan Audio Society CD-1 test compact disc
 - c) NTI Minirator MR-PRO
 - 6) Required test equipment – Measurement Device:
 - a) Rational Acoustics SMAART system v7 or later; or
 - b) NTI Audio XL2 Analyzer; or
 - c) Studio Six Digital Audio Tools RTA or FFT Module, with
 - i) Studio Six Digital iAudioInterface 2
 - b. Repeat measurement for each amplifier output channel.
- ### 2. Loudspeaker Impedance
- a. Measure and record the impedance of all loudspeaker circuits at the output of each amplifier. During this process, also check each loudspeaker circuit for shorts to ground.

- b. Required test equipment:
 - a) Dayton Audio DATS; or
 - b) NTI Minirator MR-PRO; or
 - c) Sennheiser ZP-3; or
 - d) Terrasonde/Sencore Audio Toolbox
- 2) Unacceptable measurement devices for loudspeaker impedance include the following:
 - a) Digital Multimeter (DMM); or
 - b) TOA ZM-104; or
 - c) TOA ZM-104A
- 3. Loudspeaker Band Pass/Amplifier Assignment Confirmation
 - a. For full range loudspeakers, apply full spectrum pink noise at sufficient level in order to:
 - 1) Verify subjectively that each loudspeaker is emitting full spectrum signal (both woofer and tweeter/horn are operating)
 - 2) Confirm each loudspeaker is connected to the proper amplifier chassis and output channel.
 - 3) Verify proper phase of each loudspeaker.
 - 4) Required test equipment
 - a) Galaxy Audio CPTS Cricket Polarity Tester; or
 - b) NTI Audio MR-PRO generator with XL2 Analyzer; or
 - c) Studio Six Digital Audio Tools Speaker Polarity Module; with
 - i) Studio Six Digital iAudioInterface 2 and Type 1 or 2 Test microphone; or
 - ii) Studio Six Digital iPrecisionMic; or
 - iii) Studio Six Digital iTestMic; or
 - d) Studio Six Digital Speaker Pop; with
 - i) Studio Six Digital iAudioInterface 2 and Type 1 or 2 Test microphone; or

- ii) Studio Six Digital iPrecisionMic; or
 - iii) Studio Six Digital iTestMic
 - b. For loudspeakers with multiple band pass sections (bi-amp, tri-amp, etc.), apply appropriately band-limited pink noise at sufficient level to each device or band pass (i.e., high frequency section, mid frequency section, low frequency section):
 - 1) Verify subjectively that each loudspeaker is emitting appropriately band-passed spectrum signal.
 - 2) Confirm each band pass is connected to the proper amplifier chassis and output channel.
 - 3) Verify phase of each band pass
 - 4) Required test equipment
 - a) Galaxy Audio CPTS Cricket Polarity Tester; or
 - b) NTI Audio MR-PRO generator with XL2 Analyzer; or
 - c) Studio Six Digital Audio Tools Speaker Polarity Module; with
 - i) Studio Six Digital iAudioInterface 2 and Type 1 or 2 Test microphone; or
 - ii) Studio Six Digital iPrecisionMic; or
 - iii) Studio Six Digital iTestMic; or
 - d) Studio Six Digital Speaker Pop; with
 - i) Studio Six Digital iAudioInterface 2 and Type 1 or 2 Test microphone; or
 - ii) Studio Six Digital iPrecisionMic; or
 - iii) Studio Six Digital iTestMic
- 4. Loudspeaker Rattle
 - a. Verify each loudspeaker is connected to the respective power amplifier and test each loudspeaker throughout its usable frequency range using 1/3-octave bands of pink noise to ensure loudspeaker and related building systems do not rattle.
 - b. Required 1/3-octave band pink noise sources and test equipment include:
 - 1) Terrasonde/Sencore Audio-Toolbox; or
 - 2) Japan Audio Society CD-1 test compact disc

- 3) NTI Minirator MR-PRO
5. Loudspeakers Uniformity of Coverage
 - a. Perform audio system verification per ANSI/AVIXA 1M-2009 for all loudspeakers. Document per guidelines set forth in the standard.
6. Loudspeakers Equalization
 - a. Perform sound system equalization to optimize system performance for the intended uses.
 - b. Every loudspeaker shall be equalized.
 - c. Required test equipment:
 - 1) Calibrated Type 1 or Type 2 microphones shall be used
 - 2) Studio Six Digital Audio Tools for the classrooms, meeting rooms, conference rooms gymnasium, lobby; with
 - a) Studio Six Digital iPrecisionMic; or
 - b) Studio Six Digital iTestMic; or
 - 3) SmaartLive (most current non-beta version) with SmaartLive approved:
 - a) Appropriate laptop
 - b) Microphone interface
 - 4) EASRA (most current non-beta version) with EASRA approved:
 - a) Appropriate laptop
 - b) Microphone interface
7. Microphone/Line Level
 - a. Verify that all microphone and line level cabling and connectors are installed with Pins 1, 2, and 3 wired properly and there are no shorts to ground. Ensure proper polarity.
 - b. Verify that all microphone connectors, extension cables, and microphones are wired properly and in polarity.
 - c. Required test equipment:
 - 1) Alphonson ACT-100 Remote Tester; or
 - 2) NTI Minirator MR-PRO with Cable Test Adapter

- 3) A microphone is NOT an acceptable measurement device for cable tests.

8. Wireless Microphones

- a. Setup and configure each wireless microphone system using the software provided by the manufacturer of the wireless microphone system. The following tasks are required:
 - 1) Utilize wireless microphone management system if applicable, e.g., Shure Wireless Workbench, to perform an RF spectrum sweep.
 - 2) Perform frequency coordination with Owner. Take into account any existing wireless microphone system(s).
 - 3) Calculate spare RF channels (based on 5% of the total wireless system channels).
 - 4) Perform frequency assignment of all transmitters/receivers per the results of the frequency coordination and RF spectrum sweep.
 - 5) Verify all receivers are set to maximum line level audio output.
 - 6) Set all handheld wireless transmitter microphone sensitivity settings to allow high level voice output without AF over modulation. All transmitters should be set the same.
 - 7) Set all body pack wireless transmitter microphone sensitivity settings to allow high level voice output without AF over modulation. All transmitters should be set the same.
 - 8) Using subjective listening, adjust the body pack settings to match the audio level of the handheld transmitters.
 - 9) Walk the entire performance coverage area using speech as the program material to verify signal performance. Utilize wireless microphone management system if applicable, e.g., Shure Wireless Workbench, to perform a QOS test.
 - 10) Document wireless microphone frequency assignments including coordinated spare channels.

9. Assistive Listening System

- a. Setup and configure the assistive listening system. Verify proper input signal level.
- b. Walk the entire coverage area using speech as the program material to verify signal performance.
- c. Set all receivers to match the selected transmit channel(s).

G. Video System

1. Verify that all video systems utilizing HDMI or DisplayPort cabling are tested to confirm the signal path passes full system bandwidth, full system resolution, HDCP, correct color space and bit depth, correct frame rate, HDR signal and metadata as applicable, and audio as applicable. Required test equipment includes:
 - a. Hall Research PGA-VHD; or
 - b. Murideo Fox & Hound A/V Testing and Troubleshooting Kit; or
 - c. Murideo Fresco Field Test Suite; or
 - d. Quantum Data QD780C; or
 - e. Purelink HDG 2.0; or
 2. Setup and calibrate each visual display using current edition of Spears & Munsil High-Definition Benchmark Disc. Perform calibration with environmental lighting set to level representative of the system while in use. Verify each source and variety of resolutions. For projector/screen combinations, the screen drop shall be set to maximize observation from all seats and the image shall fill the available space on the screen.
 3. Calibrate each video image using a repeatable, calibrated system. Provide documentation for each calibrated image. Results shall also become a part of the Operation/maintenance manuals. Required test equipment:
 - a. Datacolor Spyder5ELITE Display Calibration; or
 - b. SpectraCal CalMAN Ultimate software (most recent version) running on Contractor-provided laptop which exceeds the minimum requirements stipulated by SpectraCal.
 - 1) Supported Meters: as recommended by SpectraCal
 - 2) Supported Pattern Sources: as recommended by SpectraCal; or
 - c. X-Rite ColorMunki Display
- H. Control System
1. Verify performance of the Control System including the operation of all control features.
- I. Adjustment
1. Repair or replace any defects or malfunctions found prior to the commencement of final acceptance activities by the Design Consultant.
- J. Testing Documentation Submittal
1. Document the results of all tests and compile into a complete Testing Documentation submittal with the following items:

- a. Results of the tests detailed herein; and
 - b. Documentation of changes to the systems as a result of any project Change Order, ASI, field directive, Owner Representative direction or the Testing and Adjustment process. Scans of current field set are acceptable for this submittal; and
 - c. Digital photographs or explanation of reasoning for failed test results due to reasons such as site conditions, constraints, equipment availability, equipment failure, direction required from design team or Owner's Representative, etc.; and
 - d. Written notice to the Design Consultant that the system(s) are ready for final acceptance.
2. Include the final approved Testing Documentation package in the Operation and Maintenance Data package.
 3. Modify the Record Drawings to include any changes as a result of the adjustment process.
- K. Contact the Design Consultant should problems or concerns arise during the testing activities.
- L. Transmit the Testing Documentation submittal to the Design Consultant in a timely fashion to allow the Consultant appropriate time for review and comment prior to scheduling of final acceptance. The Consultant cannot visit the site or begin the acceptance phase until the submittal has been approved.
- M. Should the Design Consultant be required to invest time performing some or all of the tests, the Contractor will compensate the Design Consultant for all associated costs.
- 3.8 FINAL ACCEPTANCE

- A. After completion of the system installation and after the preliminary tests and adjustments are complete, the contractor in conjunction with the Design Consultant shall perform on-site acceptance of the technical system. This process will include, but not be limited to the following, as applicable:
1. Random verification of contractor tests
 2. System check-out
 3. Tailoring of the technical system's frequency response to the facility's acoustical environment (where required)
 4. Observation of video system to verify proper image display
 5. Function and operability of the control system.
- B. Provide the services of the designated supervisor and any other technicians who are familiar with the system, for approximately one eight-hour day. Additional time may be required due to Alternates accepted by the Owner's Representative, or due to Addenda or Change Orders (if any) which modify the scope of work. The supervisor shall provide personal assistance during these activities. This duration does not include time for correcting wiring errors, equipment

malfunctions, or problems related to the installation of the technical system. This work could occur at any time day, night, weekends, or holidays without additional claims for expense.

- C. At the discretion of the Design Consultant, the Contractor shall participate in the control and adjustment of computer-controlled systems including but not limited to the following systems: Main control (Crestron/AMX/Q-SYS), DSP, wireless microphone, amplifier, active loudspeaker, etc.
- D. At the completion of the final acceptance period, the Contractor shall compile all system configuration settings (files) with copies as required for inclusion in the O&M Manuals described later in these specifications.
- E. In addition, provide the following: hand and power tools appropriate for the type of installation, ladders, lifts, and/or scaffolding as required to reach all high-mounted devices, spare wire and cable of the types used in the installation, selection of wiring fasteners used in the installation, complete set of the most recent reviewed shop drawings, complete set of all manufacturers' original installation/operation/maintenance manuals, and specific test equipment used during the preliminary testing activities.
- F. After the technical system is operational, the Contractor shall provide verbal instruction to designated Owner's Representative as to proper methods of system operation. Video record the instruction class and provide the recording in a usable digital format to the Owner's Representative.
- G. Provide operational assistance for the first major use of the completed system as directed by the Owner's Representative, including being present for: one prior rehearsal associated with the event (if applicable); a technical check immediately prior to the event; and the event itself.

3.9 OPERATION AND MAINTENANCE DATA

- A. At the completion of the project, compile thorough copies of the Operation and Maintenance (O&M) Data per Division 27 Section "General Communications Requirements".
- B. O&M data shall be assembled according to rooms or areas as it relates to the project site. The intent is to allow the Owner's Representative to easily locate information relating to a specific system/room without having to spend an inordinate amount of time searching. Include complete information for each system/room – this may involve duplication of information.
- C. Include ANSI E1.47-2017 (Entertainment Technology – Recommended Guidelines for Entertainment Rigging System Inspections) within the O&M data.
- D. As applicable, save full digital version to the system computer.

END OF DOCUMENT 274100

DOCUMENT 274116 - AUDIO VIDEO SYSTEMS EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This section describes the equipment for the audio-video (AV) system (hereafter referred to as the "Technical System").

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section, as do the following:
 - 1. Division 27 "Audio Video Systems".

PART 2 - PRODUCTS

2.1 GENERAL

- A. Refer to Division 27 Section "Audio Video Systems" for general product requirements.
- B. All components of the technical system equipment shall be provided and installed by a qualified contractor as outlined in Division 27 Section "Audio Video Systems".
- C. All electronic audio devices shall have electronic or transformer balanced inputs and outputs except for specific program source equipment and mixing console inputs and/or outputs. If an electronic device specified or furnished has an unbalanced input and/or output, make provisions to balance said input/output (i.e., active signal balancing device as approved) unless other arrangements have been agreed upon with the Design Consultant.

2.2 COMMON EQUIPMENT

- A. Refer to Division 27 Section "Audio Video Systems" for common equipment and components.
- B. Microphone – Lapel: omnidirectional lapel microphone with clip (quantity two (2) required):
 - 1. Sennheiser MKE 2 Gold; or
 - 2. Shure Microflex MX150 B/O-TQG; or
 - 3. Approved equal.

2.3 MICROPHONE ACCESSORIES – PORTABLE

- A. Microphone Stand – SB/SHA: microphone floor stand, with solid base, single hand height adjustment (quantity one (1) required):
 - 1. K&M 26085 (black); or
 - 2. QuickLok A-988 BK (black); or

3. Ultimate Live-ST; or
4. Approved equal.

2.4 WIRELESS MICROPHONE SYSTEMS

- A. Furnish complete UHF diversity wireless microphone system(s) including the following components (select components from one manufacturer listed below):
- B. Wireless Microphone Receiver: furnish single, dual, or quad channel models with rack mount kits as required to achieve the number of receiver channels as shown on the drawings:
 1. Sennheiser EM 500 G3 single channel receiver with included GA3 rack adapter; or
 2. Shure ULXD4 (single channel), or ULXD4D (dual channel), or ULXD4Q (four channel) digital wireless receiver with encryption capability (encryption must be off when one receiver shares more than one transmitter) with included rack mount kit; or
 3. Approved equal.
- C. Wireless Beltpack Transmitter: furnish beltpack transmitter with lapel microphone (quantity two (2) required):
 1. Sennheiser SK 500 G3 beltpack transmitter with lapel microphone as specified elsewhere; or
 2. Shure ULXD1 with lapel microphone as specified elsewhere; or
 3. Approved equal.
- D. Wireless Handheld Transmitter – Dynamic (quantity two (2) required):
 1. Sennheiser SKM 500-935 G3 handheld microphone transmitter with included MZQ 1 clip and MZW 1 windscreen; or
 2. Shure ULXD2 with RPW118 (Beta 58A) head, 95T9279 microphone clip (included), and A58WS windscreen; or
 3. Approved equal.
- E. Wireless In-Line RF Amp: RF amplifier powered from wireless microphone receiver or antenna distribution amplifier:
 1. Sennheiser AB3 series in-line RF amplifier; or
 2. Shure UA830USTV line amplifier; or
 3. Approved equal.
- F. Wireless Remote Antenna: omnidirectional ½-wave remote mounted antenna:

1. Sennheiser A1031-U Omni-directional Antenna; or
 2. Shure UA8 Omni-directional Antenna; or
 3. Shure UA860SWB (470-1100 MHz; weather resistant); or
 4. Approved equal.
- G. Wireless rechargeable battery system – main position: including batteries, chargers, and power supplies to charge all transmitters simultaneously. Label each battery using a logical scheme so batteries can be tracked as they are shuffled among transmitters. Document labels into a spreadsheet which will become a portion of the Operation & Maintenance manuals described in Part 3 of these specifications. Secure chargers to base of drawer using Velcro™ (one rechargeable battery and associated charging slot required for each transmitter furnished):
1. Sennheiser BA2015G2 battery, LA215 dual charger station with NT3-120 power supply, LA2 handheld microphone charging adapter; or
 2. Shure SB900A battery, SBC200-US dual charger with power supply, SBC200 dual charger expansion, SBC800-US Eight Battery Charging Station; or
 3. Approved equal.
- H. Wireless rechargeable battery system – stage position: chargers, and power supplies only. Secure chargers to base of drawer or other mounting surface using Velcro™. Coordinate exact mounting location with Owner's Representative (two charging slots required):
1. Sennheiser LA215 dual charger station with NT3-120 power supply, LA2 handheld microphone charging adapter; or
 2. Shure SBC200-US dual charger with power supply, or
 3. Approved equal.
- I. Each receiver shall be connected via Ethernet to the computer. Furnish the most recent configuration software, install on the computer, and configure each receiver and transmitter for optimum operation. Test each and all receiver/transmitters to ensure no problems arise.
- J. Where remote 1/4 wavelength antennas are used, and mounting conditions allow, mount each antenna on a standard metal wall plate to serve as a ground plane.
- K. Provide all connections and components necessary for proper operation of the wireless systems described above.
- L. Coordinate the selection of transmitter/receiver frequencies to be free of interference from outside sources or interference between wireless systems. Select the frequency from an unused channel between (470 - 698 MHz) per FCC regulations Part 74, subpart H.
- M. Label each receiver/transmitter combination as noted on the drawings or as coordinated with the Owner's Representative. See Labeling and Placards section in this specification for additional labeling requirements.

2.5 PROGRAM SOURCE EQUIPMENT

- A. Some of the program source equipment specified is consumer-grade equipment. Upon award of a contract, endeavor to procure these items as soon as possible to avoid delays caused by searching for discontinued product(s).
- B. Rack-mount kit for equipment that requires rack mounting but is not provided with rack mount ears or optional rack mount kit:
 - 1. Lowell RMK series; or
 - 2. Middle Atlantic Products RSH series; or
 - 3. Approved equal.
- C. For each portable item of program source equipment, furnish one set of input/output cables (6-foot minimum length) and adapters (as required) to allow for connection to technical system inputs/outputs.
- D. DVD Player: Blu-ray: rack-mountable, HDMI output, Ethernet port for server/online music playback, USB port for AV playback, with RS-232 control:
 - 1. Denon DN-500BD MKII; or
 - 2. Approved equal.

2.6 DIGITAL SIGNAL PROCESSING (DSP)

- A. The AC power cord of the DSP shall be connected to a rack-mount uninterruptible power supply (UPS). Refer to the AC Power section for specific models. The UPS shall be connected to an unswitched (unsequenced) AC power circuit.
- B. The Contractor shall create all schematics for the DSP and submit as a shop drawing. Refer to Submittals section for additional information.
- C. Provide one computer with mouse and system features as recommended and approved by the manufacturer of the DSP system for use during final acceptance.
 - 1. If a computer is provided or designated for use as a system operation and configuration device, DSP software shall be loaded and the computer shall be operational during system final acceptance.
 - 2. If a permanent computer is not configured for technical system usage, furnish a wireless 802.11ac router and laptop computer configured to allow for wireless control of the DSP during system final acceptance. This equipment shall remain on site until final acceptance activities have been completed. Retain ownership of the router and laptop computer.
- D. Password protection shall be included. One password shall be provided to allow operator access to select functions. Another password shall be provided for technical staff to access all aspects of the software.

E. DSP programming of Fire Alarm connection

1. General

- a. Sound system operation in relation to fire alarm system is subject to NFPA, local building codes, and the local Authority Having Jurisdiction.
- b. Sound system mute for fire alarm audible notification shall be provided for all assembly areas, locations with systems capable of prolonged operation in excess of 100dBA, and all facility background music systems.
- c. Coordinate with the fire alarm contractor and local AHJ.

2. Sound system shunt initiation signal

- a. Fire alarm system connection shall be via DSP contact closure in location as indicated on signal flows.
- b. Upon fire alarm activation, and subsequent reception of shunt signal from the fire alarm system via normally open contact closure to the DSP, all sound system audio shall mute.
- c. DSP shall be programmed to mute audio sources until the alarm is cleared, upon which normal operation shall resume. Activation of shunt signal may include General Alarm, keying of the fire alarm microphone, or initiation of preprogrammed severe weather (or the like) announcement.
- d. DSP programming shall include clear visible status of alarm state for troubleshooting purposes.

3. Supplemental voice via audio system

- a. Fire alarm supplemental voice connection shall be via DSP paging station in location as indicated on signal flows.
- b. A contact closure shall be utilized for sound system mute independent of supplemental voice operation. Supplemental voice DSP state shall activate upon receipt of system mute.
- c. When in fire alarm shunt mode, the paging input shall be the only active audio source.

4. Refer to signal flows and coordinate connections with Fire Alarm System Contractor to ensure compatibility with connections to Fire Alarm System. The following components may be required, dependent on system configurations:

- a. Loudspeaker Level to Line Level Transformer: 25V, 70V, or 100V loudspeaker level input, unbalanced line level output, selectable input voltage, for connection from loudspeaker level fire alarm connection to line level DSP input:

- 1) RDL TX-70A.

- b. Logic Controlled Relay – Momentary: momentary latching logic-controlled relay, contact closure output, for connection from DSP GPIO to fire alarm relay module when DSP GPIO does not have native contact closure outputs:

- 1) RDL ST-LCR1.

- F. Furnish all components for a fully functioning digital signal processing system.
- G. DSP system basis of design is shown on the signal flows. Unterminated I/O or additional I/O cards shall be provided as shown on the signal flows for future use or additional requirements.
- H. Substitutes to the basis of design will be considered if all features and functionality of the system requirements are met. I/O requirements shall meet or exceed the quantity of the basis of design. Processing requirements shall meet or exceed the basis of design to ensure proper operation of the system. The following manufacturers are pre-approved substitutes to the basis of design shown on the signal flows:
 - 1. Biamp Tesira with:
 - a. The most recent Tesira software; or
 - 2. BSS Soundweb London with:
 - a. The most recent Audio Architect software; or
 - 3. QSC Q-Sys with:
 - a. The most recent Q-Sys Designer software; or
 - 4. Symetrix Edge with:
 - a. The most recent SymNet Composer software.

2.7 POWER AMPLIFIERS

- A. Power amplifiers in this section shall be by one manufacturer and operated in multi-channel mode to provide a minimum of two amplifier channels within one chassis unless noted otherwise.
- B. All power amplifier inputs shall be either balanced analog inputs or digital network.
- C. All front panel controls and AC power switches shall be either:
 - 1. concealed via a perforated metal security cover,
 - 2. concealed via manufacturer-supplied security cover,
 - 3. electronically disabled.

The security cover shall not block air-flow for amplifier internal cooling.

- D. All power amplifiers shall have standby/sleep mode functionality. This functionality shall be implemented on a system wide scale to provide a fully controlled power sequencing system. Preferred solution is network based; if amplifier does not have necessary features via network control, contact closure solution shall be utilized. Contact closure solution shall utilize a control system for triggering power on/off cycle.
 - 1. Upon system shutdown, power amplifiers shall enter standby/sleep mode per manufacturer's functionality.
- E. Power amplifiers are listed by series, with the basis of design model shown on the signal flows. Deviation from the basis of design to an approved substitute shall be allowed as follows:
 - 1. Power rating for high impedance (70V) operation shall meet or exceed the basis of design load requirement on the channel. Load shall be calculated based on total power (addition of all loudspeaker tap values) as indicated on the signal flows.
 - 2. Power rating for low impedance operation shall meet or exceed the basis of design load requirement on the channel. Load shall be as indicated on the signal flows.
 - 3. Channel count per chassis shall produce the most efficient solution of maximum channels vs appropriate power rating.
 - 4. Proposed substitute should take into account:
 - a. alterations of audio network requirements, as applicable. Alterations may include the need for additional network infrastructure, including network switches.
 - b. alterations of audio system requirements, as applicable. Alterations may include the need for additional digital signal processing infrastructure.
 - c. standby/sleep mode functionality. Alterations may include the need for additional network infrastructure or control system infrastructure.
 - d. all other parameters, including but not limited to rack requirements and environmental considerations (AC power, thermal dissipation, weight, etc.).
- F. Power Amplifier – Type 1: power amplifier, high (70V) or low impedance operation switchable per output, network control, loudspeaker processing, audio network capabilities, with the following characteristics required as shown on signal flows.
 - 1. Acceptable Products:
 - a. Ashly nXp Series with required audio network card:
 - b. Bose PM N Series with required audio network card:
 - c. Crown DriveCore Install (DCI) Series with required audio network:
 - d. Lab.gruppen D Series with required audio network:
 - e. QSC CXD-Q or CX-Q Series:

2.8 LOUDSPEAKERS – INSTALLED

A. General loudspeaker requirements:

1. Where visible, paint out or remove the manufacturer's logo on each loudspeaker.
2. Loudspeaker, and related mounting bracket(s) where appropriate, color shall be as selected by the Architect from the available color selection offered from each loudspeaker manufacturer.
3. For loudspeakers located outdoors or in an indoor humid environment (such as natatoria):
 - a. Encapsulate all exposed loudspeaker wiring terminations in clear silicon type sealant or Star Brite Liquid Electrical Tape (800) 327-8583.
4. Utilize the most recent manufacturer-recommended DSP settings if available.

B. Loudspeaker Type 1 , ceiling, four-inch loudspeaker, minimum sensitivity (1W/1m): 83 dB SPL, complete with enclosure, and integrated 70 volt transformer, switchable to 8 ohm:

1. Biamp Desono DX-IC4; or
2. JBL Control 14C/T; or
3. QSC AD-C4T; or
4. Approved equal.

C. Loudspeaker Type 2, trapezoid enclosure, five-inch loudspeaker, integrated 70 volt transformer, switchable to 8 ohm, weather resistant, furnish hanging method:

1. Biamp Desono DX-S5; or
2. JBL Control 25-1; or
3. QSC AD-S5T; or
4. Approved equal.

D. Loudspeaker Type 3, trapezoid enclosure, weather resistant, eight-inch loudspeaker, integrated 70 volt transformer, switchable to 8 ohm, weather resistant, furnish hanging method:

1. Biamp Desono DX-S8; or
2. JBL Control 28-1; or
3. QSC AD-S8T; or
4. Approved equal.

- E. Loudspeaker Type 4, trapezoid enclosure, four-inch loudspeaker, integrated 70 volt transformer, switchable to 8 ohm, weather resistant, furnish hanging method:
 - 1. Biamp Desono MASK4CT; or
 - 2. JBL Control 23-1; or
 - 3. QSC AD-S4T; or
 - 4. Approved equal.
- F. Loudspeaker Type 5 , Pendant, three-inch loudspeaker, minimum sensitivity (1W/1m): 83 dB SPL, complete with enclosure, and integrated 70 volt transformer, switchable to 8 ohm:
 - 1. Biamp Desono P30DT; or
 - 2. JBL Control 14C/T; or
 - 3. QSC AD-C4T; or
 - 4. Approved equal.
- G. Loudspeaker Type 5, trapezoid enclosure, six three-inch loudspeaker, integrated 70 volt transformer, switchable to 8 ohm, weather resistant, furnish hanging method:
 - 1. Biamp Desono ENT206; or
 - 2. Approved equal.

2.9 ASSISTIVE LISTENING SYSTEM - FM 72MHZ

- A. The transmitter shall be installed in the audio equipment racks and the transmitting antenna shall be remotely mounted/suspended at the location shown on the drawings. The antenna shall be installed in a vertical orientation.
- B. Select interference-free frequencies corresponding to the following initial assignments, subject to revision (as approved) to avoid interference. Coordinate wording with the Owner's Representative. Permanently and clearly label each receiver to match:
 - 1. Transmitter channel A "Farmers Market"
- C. The Assistive Listening System (ALS) shall include all hardware as required to provide a fully-functional system. The contractor shall engage the design services of the ALS manufacturer.
- D. ALS Transmitter 72MHz: transmitter, rack mount, operates in the 72MHz band:
 - 1. Listen Technologies LT-800-072-1 with LA-326 rack mount kit; or
 - 2. Telex Soundmate ST-300 with RM-S rack mount kit; or
 - 3. Williams Sound PPA T45 with RPK 005 rack mount kit.

- E. ALS Dipole Antenna 72MHz: antenna, coax or dipole, tuned for operation in the 72MHz band. Contractor shall select the cable connecting the transmitter to the antenna based on input from the ALS manufacturer:
 - 1. Listen Technologies LA-116 (coax) or LA-122 (telescoping dipole) or LA-123 (helical); or
 - 2. Telex Soundmate HGA-1 (coax); or
 - 3. Williams Sound ANT024 (telescoping dipole) or ANT034 (helical).
- F. ALS Receiver 1CH-72MHz: beltpack style receiver, tuned for operation in the 72MHz band (quantity thirty five (35) required to comply with ADA requirements):
 - 1. Listen Technologies LR-400-072 with LA-362 NiMH batteries or LR-4200-072 (iDSP) with LA-365 Li⁺ battery; or
 - 2. Telex Soundmate SR-400 with NiMH batteries; or
 - 3. Williams Sound PPA R38N with BAT 026-2 NiMH batteries.
- G. ALS Ear Speaker: single ear speaker (one required for every other receiver furnished):
 - 1. Listen Technologies LA-401; or
 - 2. Telex Soundmate ES-1; or
 - 3. Williams Sound EAR 022.
- H. ALS Headphone: light-weight headphones (one required for every other receiver furnished):
 - 1. Listen Technologies LA-402; or
 - 2. Telex Soundmate HED-2; or
 - 3. Williams Sound HED 021.
- I. ALS Neckloop: neck loop for use with T-coil equipped hearing aids (quantity nine (9) required to comply with ADA requirements):
 - 1. Listen Technologies LA-166 or LA-430 (iDSP); or
 - 2. Telex Soundmate NL-4S; or
 - 3. Williams Sound NKL 001.
- J. ALS Charger: charging case (one charging slot required for each receiver furnished):
 - 1. Listen Technologies LA-317 4-Slot Charging/Carrying Case or LA-423 4-Port (iDSP) USB Charger; or
 - 2. Listen Technologies LA-321, 8-slot Charging/Carrying Case; or

3. Listen Technologies LA-311 16-Slot or LA-380 12-Slot (iDSP) Charging/Carrying Case; or
 4. Telex Soundmate BH-200, Charging Station for two receivers; or
 5. Williams Sound CHG 3512 PRO 12-Slot Charging/Carrying Case .
- K. ALS Signage: signage notifying occupants that the assistive listening system is available. Mount signage as directed by the Owner's Representative (one required for each entrance to each applicable room):
1. Listen Technologies LA-304; or
 2. Telex Soundmate WP-1; or
 3. Williams Sound IDP 008.
- L. flat panel displays - general
- M. Flat panels in this section shall be LCD, by one manufacturer, unless noted otherwise.
- N. All LCD flat panel displays specified in this section shall have the following features or options included, unless noted otherwise:
1. Display response time of 10ms or less
 2. LED backlighting
 3. VESA mounting compatible
 4. Minimum viewing angle of 175° horizontal x 175° vertical
- O. LCD flat panels are listed by series, with the basis of design model shown on the signal flows. The minimum requirements for inputs, outputs, control connections and optional interfaces/accessories shall be as indicated on signal flow diagrams.
- P. Deviation from the basis of design to a proposed substitute will be allowed as follows:
1. All audio, video, and control connections shown on signal flow (connectors shown on equipment block but without any connections are not required for substitution) shall meet or exceed the basis of design with respect to quantity, type, version, and supported protocols. This shall include the standard features of the display as well as any optional interfaces/accessories.
 - a. Example connections include but are not limited to:
 - 1) TV tuner (NTSC, ATSC, and Clear QAM compatible),
 - 2) HDMI (HDCP compatible),
 - 3) DVI-D (HDCP compatible),

- 4) SDI (SD, HD, 3G, Dual Link, 6G),
 - 5) Displayport (HDCP Compatible),
 - 6) HD15 RGB with 3.5mm audio,
 - 7) Component with stereo audio,
 - 8) Composite with stereo audio,
 - 9) Multi-channel audio,
 - 10) RJ45 LAN,
 - 11) RJ45 HDBaseT,
 - 12) RS232 control via DB9 connector, and
 - 13) USB.
2. Contractor shall be responsible that the proposed substitute meets or exceeds the basis of design and will:
 - a. have an equivalent aspect ratio.
 - b. meet the capabilities of any built-in speakers.
 - c. physically fit in the location with sufficient space for ventilation and servicing.
 - d. have an equivalent brightness rating and backlighting technology (edge light, direct back light, etc.)
 - e. utilize the same touch sensing technology (resistive, capacitive, etc.)
 - f. be compatible with the display mount.
 - g. allow for multiple mounting orientation capabilities (horizontal, vertical/portrait, etc.).
 - h. have an equivalent manufacturer's warranty.
 - 1) Consider functionality features such as standby/sleep mode, picture-in-picture, video and audio processing capabilities, etc.
3. Contractor shall submit details, including shop drawings where applicable, for each proposed substitute which include information relating to the above.

2.10 DISPLAY – LARGE FORMAT DIRECT VIEW LED

A. DVLED Display System – 2.5MM Indoor

1. Maxhub Raptor LA220V07; or

2. Primeview FusionMax 220; or
3. Approved equal.

B. Display Descriptions

1. Wall Segment Type 1
2. Overall physical size: 112.6" H x 192.7" W
 - a. Overall nominal pixel resolution:
 - 1) 1920 x 1080
 - 2) Minimum 3 HDMI inputs
 - b. Quantity: 1
3. LED Module Details
 - a. Pixel pitch:
 - 1) 2.5mm.
 - b. Pixel configuration: 3-in-1 SMD (Surface Mount Device)
 - c. Minimum brightness after calibration: 600nits
 - d. Horizontal viewing angle (minimum): 170 degrees
 - e. Vertical viewing angle (minimum): 170 degrees
 - f. Color processing: 16bit
 - g. Grayscale processing: 10bit
 - h. Video frame rate: 60 FPS
 - i. LED lifespan: 100,000 hours
 - j. Service Access: Front
 - k. IP Rating – Indoor – No IP rating required
 - l. Maximum depth from mounting surface: < 2"

C. Required Manufacturer's Services:

1. Onsite system adjustment and commissioning (amount per Manufacturer's recommendation)

D. Spare Parts

1. Spare parts shall consist of a minimum of 5% of major components, including but not limited to LED modules

E. Ancillary Elements

1. Secondary Structural Support

- a. Provide all "secondary" structural framing/mounting design, fabrication, and procurement to accommodate mounting of the DVLED panels to the project provided "primary" steel structure.
- b. Coordinate with the Project Structural Engineer for connection points, loads, etc.
- c. Refer to the Structural design documentation and Architectural details for further information.

2.11 DISPLAY – COMMERCIAL LCD FLAT PANEL

A. LCD flat panels in this section shall be by one manufacturer, unless noted otherwise.

B. All LCD flat panel displays specified in this section shall have the following features or options included, unless noted otherwise:

1. Display response time of 10ms or less
2. LED backlighting
3. VESA mounting compatible
4. Viewing angle of 175° horizontal x 175° vertical (or greater)

C. LCD flat panels are listed by series, with the basis of design model shown on the signal flows. The minimum requirements for inputs, outputs, control connections and optional interfaces/accessories shall be as indicated on signal flow diagrams.

D. Deviation from the basis of design to an approved substitute will be allowed as follows:

1. All audio, video, and control connections shown on signal flow (connectors shown on equipment block but unconnected are not required for substitution) shall meet or exceed the basis of design with respect to quantity, type, version, and supported protocols. This shall include the standard features of the display as well as any optional interfaces/accessories.
 - a. Example connections include but are not limited to TV tuner (NTSC, ATSC, and Clear QAM compatible), HDMI (HDCP compatible), DVI-D (HDCP compatible), SDI (SD, HD, 3G, Dual Link, 6G), Displayport (HDCP Compatible), HD15 RGB with 3.5mm audio, component with stereo audio, composite with stereo audio, multi-channel audio, RJ45 LAN, RJ45 HDBaseT, DB9 for RS232 control, and USB.
2. Proposed substitute shall have an equivalent aspect ratio.

3. Proposed substitute shall meet the capabilities of any built-in speakers.
 4. Proposed substitute shall have an equivalent brightness rating and backlighting technology (edge light, direct back light, etc.)
 5. Proposed substitute weight shall be considered with respect to the display mount. It shall be the responsibility of the contractor to confirm the mount is compatible with the substitute display.
 6. Proposed substitute mounting orientation capabilities (horizontal, vertical/portrait, etc.) shall meet or exceed basis of design.
 7. Proposed substitute manufacturer's warranty shall meet or exceed the basis of design.
 8. Proposed substitute shall take into account functionality features such as standby/sleep mode, picture-in-picture, video and audio processing capabilities, etc.
- E. Acceptable manufacturers and model series include:
1. FPD Type 1:
 - a. NEC M*** series
 - b. LG UH*** series
 - c. Samsung QMC*** series

2.12 FLAT PANEL DISPLAY/TELEVISION MOUNTS

- A. Unless noted otherwise, provide the appropriate mount for each display furnished. Mount color as selected by Architect. Match mount to the display and the mounting surface.
- B. Full assembly (display, mount, and all associated connections/equipment) shall be adequately supported with the appropriate safety factor to building structure. Appropriate structural backing/support shall be provided. No mounts shall fasten directly to the roof deck. Refer to submittal requirements.
- C. Furnish all components to provide a complete installation, including fastening systems suitable for the mounting surface.
- D. All recessed or built-in displays/televisions require shop drawings showing the surrounding architecture to ensure proper fit and ventilation requirements.
- E. Refer to drawings for anticipated mount type required for each display location.
- F. Provide outdoor rated mount variants in locations as applicable.
- G. Mounts shall be selected and installed to ensure the full display/mount assembly meets all ADA requirements, including Protrusion Limits into Circulation Paths of no more than 4" (as defined by the ADA Accessibility Guidelines). Additional considerations may include:

1. The use of thin mounts in lieu of standard depth display mounts to reduce mounting depth.
 2. Where wall standoffs are utilized, ensure overall depth is no greater than 4".
 3. The use of "right angle" plugs or terminations may be required to maintain minimum cable bend radius.
 4. The use of recessed back boxes may be required to accommodate plugs or terminations and any display mounted equipment.
 5. The use of recessed back boxes with thin profile articulating mounts may be utilized in lieu of thin mounts.
- H. Flat Panel Mount – Wall – Articulating ADA: articulating arm wall mount that pulls out, rotates, and tilts down, fully adjustable, lockable, sized for display as required; with recessed back box for retain mount within wall cavity, maximum depth of mount at face of wall no greater than 0.5":
1. Chief RIW Series mount with PAC501B in-wall back box; or
 2. Peerlees-AV IM760PU-S; or
 3. RP Visuals Wallmate Series; or
 4. Approved equal.

2.13 AV OVER IP NETWORK TRANSPORT

- A. Twisted Pair audio and video products shall all be supplied from the same manufacturer through the signal chain (i.e. transmitter – switch – receiver).
- B. AV over IP - Decoder: stand alone, unbalanced line output, receives HDMI and control over Dante/AES67, PoE:
1. Visionary Solutions D4100 Decoder; or
 2. Approved equal.
- C. AV over IP - Encoder - 2G – HDMI – WP: dual gang Decora style", stereo balanced line output, sends HDMI and control over Dante/AES67, PoE:
1. Visionary Solutions E-WP-H Encoder: (color approval required) with optional matching cover plate; or
 2. Approved equal.
- D. Network Audio - 4x2 multi I/O w/BT - 2G - WP: dual gang Decora style wallplate with stereo 1/8", dual RCA inputs and Bluetooth, 1/8" stereo line level output, Dante/AES67, PoE:
1. AtteroTech unD6IO-BT receiver (color approval required) with optional matching cover plate; or

- 2. Approved equal.
- E. Networked Paging Station
 - 1. QSC PS-1600H; or

- 2. Approved equal.

2.14 A/V CONTROL SYSTEM – EQUIPMENT

- A. The AC power cord of the Control System Processor shall be connected to a rack-mount uninterruptible power supply (UPS). Refer to the AC Power section for specific models. The UPS shall be connected to an unswitched (unsequenced) AC power circuit.
- B. Control system equipment shall be furnished from one manufacturer only. Program the system to provide acceptable operation by the Design Consultant and/or Owner's Representative.
- C. Select equipment that can be fully controlled by the control system furnished.
- D. The drawings reflect a specific system manufacturer. If a different system manufacturer is furnished, shop drawings are required indicating proposed wiring configuration, control panel layouts, and equipment used. All of the features shown for the system on the drawings shall be maintained with the substitute system including coordination and costs related to back boxes, electrical, and other associated items.
- E. All systems shall be accessible remotely via the Owner's LAN or as directed by the Owner's Representative.
- F. All control equipment necessary shall be furnished to provide a complete operating system:
- G. Control System - Processor
 - 1. Control System - Processor: built-in router with control subnet
 - a. QSC Core Flex 8; or
 - b. Approved equal.
- H. Touch control panel
 - 1. Touch Screen – Wall
 - a. 7-Inch
 - b. QSC TSC-70-G3.

2.15 A/V CONTROL SYSTEM – GENERAL PROGRAMMING REQUIREMENTS

- A. Refer to Division 27 Section "Audio Video Systems" for general programming requirements with the following revisions and additions:
 - 1. Famers Market:

a. General Buttons

- 1) There shall be a "Paging System On", "System Off", and "Previous" button on every page except the splash screen.
- 2) "Paging System On"
 - a) Pressing the Paging System On button shall be a toggle button resulting in the following system actions. When pressing the button to disengage the paging system there shall be a pop-up window to confirm the action:
 - b) Energizes the audio system if not on
 - c) Routes the paging stations to the audio system
 - d) "System Off"
 - i) Pressing the System Off button shall result in a pop-up window to confirm the action
 - (1) "Yes", page flip to the System Off page.
 - (2) "No", return to pervious page
 - ii) Once shut down is completed the panel shall return to the Splash page.
 - e) "Previous"
 - i) Pressing the Previous button shall result in returning to the pervious page without making any changes to the system

b. "Splash" Page

- 1) The Splash Page shall have the City logo, City name, and name of the room with the following: "Touch screen to start".
 - a) Touching the screen shall result in a pop-up window with the following: "ENTER PIN CODE TO PROCEED", a number keypad to enter a four (4) digit pin code and a "CONTINUE" button and "CANCEL" button .
 - i) Pressing the "CONTINUE" button shall result in the following:
 - (1) Correct pin shall result in page flip to the Start/Home page
 - (2) Incorrect pin shall result in a pop-up window with the following: "INCORRECT PIN CODE", hold for five seconds than clear pop-up window and clear entered pin code.
 - ii) Pressing the "CANCEL" button shall result in the following:
 - (1) Closes the pop-up window.

c. "Start/Home" Page

1) The Start/Home Page shall have a "Video" and "Audio" mode selection buttons.

a) "Video"

i) Pressing the Video button shall result in the following system actions:

(1) Page flip to the video mode page

(2) Energize the video wall

(3) Energizes the audio system

f) "Audio"

i) Pressing the Audio button shall result in the following system actions:

(1) Page flip to the audio mode page

(2) Energizes the audio system

a) Any devices already energized/deployed which are required when switching operation modes shall remain in their existing operational condition.

d. "Video" Mode Page

1) The Video Mode Page shall have areas for video source selections and program volume control. Provide an audio mute button near the program volume control and a video blank button near the video source selection area.

a) Program volume control shall be on the outputs of the DSP.

b) Video Source Selection

i) The Video Source Selection shall have an area for video source routing. All sources shall be allowed to route to either all the flat panel displays as a group and/or the video wall.

ii) Visual indicate source selected for the destination(s).

c) Sources

i) Video Input East

ii) Video Input West

iii) Wireless Presentation Device

iv) TV

- (1) Pressing the TV button shall result in a pop-up window with the following: "ENTER PIN CODE TO PROCEED", a number keypad to enter a four (4) digit pin code, "CONTINUE" button, and "CANCEL" button.
- d) Destinations
 - i) Video Wall
 - ii) Flat Panel Displays
- e) Audio shall follow video.
- f) "Audio" button
 - i) Pressing this button shall result in a page flip to the audio control page.
- g) "Home"
 - i) Pressing this button shall result in a page flip to the Start/Home page without making any changes to the system.
- e. Audio Mode Page
 - 1) The Audio page shall have and area for wireless microphones level controls.
 - a) All wireless microphones level control shall be on the input of the DSP.
 - 2) The Audio page shall have and area for program audio level control.

2.16 CABLES – FACTORY TERMINATED – PORTABLE

- A. Factory terminated cable assemblies in this section are approved for portable use only.
- B. Portable cable assembly quantities are identified in parenthesis and are required to be furnished in addition to those required for system installation. Portable cable lengths are a minimum not to exceed the maximum acceptable length identified in the cable descriptions below. Where specific lengths are cited adjacent to quantities, these lengths are to be taken as ideal lengths. If a pre-approved model series is not offered in the specific length cited, then the cable length closest to the cited length shall be provided unless the difference is greater than twenty percent. In this case, contact the Consultant for direction.
- C. All cable assemblies must be factory tested and certified.
- D. HDMI Cable, version 1.4 or higher compliant, male HDMI to male HDMI, Acceptable lengths: 1'-16' (quantity two (2) 6' required):
 - 1. Comprehensive Pro AV/IT Series; or
 - 2. Extron HDMI Ultra Series; or

3. Liberty HALO Series; or
4. Approved Equal.

2.17 CABLE ADAPTERS – PORTABLE

- A. All unbalanced adapters requiring assembly shall be wired pin 2/tip "hot" and pin 3/ring tied to the shield. XLR adapters shall not have pin 1 connected to case ground.
- B. Audio Adapter – TRS1/8 to TRS1/8 6', three conductor 1/8" male connector to three conductor 1/8" male connector with six foot cable (quantity two (2) required):
 1. Hosa CMM Series; or
 2. Comprehensive MPS-MPS-6ST Series; or
 3. Approved equal.

2.18 PORTABLE ACCESSORIES

2.19 STANDBY EQUIPMENT

- A. The following equipment shall be on-hand at the time of system final acceptance and system first-use for possible replacement of defective equipment or for field conditions noted. Maintain ownership of this standby equipment. However, if any item of this standby equipment is used to replace defective equipment, the installed item of standby equipment becomes Owner's property. Assume ownership of the defective equipment:
 1. Power Amplifier (one of each type required).
 2. Loudspeaker Type 1 (one required).
 3. Loudspeaker Type 2 (one required).
 4. Loudspeaker Type 3 (one required).
 5. Loudspeaker Type 4 (one required).
 6. Backup software for programmable devices.
 7. Laptop computer for all programmable devices.
- B. Allowances for overnight shipping shall be included and utilized if any component is required for Owner's initial operation, first-use, or as directed by either the Owner's Representative or the Design Consultant prior to Substantial Completion.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS

- A. Refer to Division 27 Section "Audio Video Systems" for common requirements.

3.2 LABELING

- A. Refer to Division 27 Section "Audio Video Systems" for labeling requirements.

END OF DOCUMENT 274116

DOCUMENT 281010 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY

PART 1 - GENERAL

1.1 SUMMARY

- A. As part of a complete and functioning Electronic Security System and associated infrastructure, provide conductors and cables of appropriate type. This section includes:
 - 1. Low-voltage Control and Power Cables
- B. Conductor and cable requirements are unique to each manufacturer equipment / device. Unless otherwise noted, exact conductor and cable types are to be coordinated by the ESC to meet the requirements of the Electronic Security manufacturer

1.2 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Conductors and cables as specified in this section shall be supported and installed into pathways, backboxes, firestopping, and other general/common work per Division 28 Section "Common Work Results for Electronic Security Systems".
- C. Refer to Section "Communication Horizontal Cabling " Division 27 Specifications for all Category 6A and Fiber Optic Cable requirements.
- D. Refer to Division 27 Section "Telecommunications Equipment Room Fittings " for grounding and bonding requirements.

1.3 SUBMITTALS

- A. Follow the requirements for submittals in Division 27 Sections "General Communication Requirements"
- B. The following additional requirements are due at the following submittal phases:
 - 1. Pre-Construction Submittal
 - a. Cut sheets shall contain the following information for each of the cables specified.
 - 1) Manufacturers name and logo
 - 2) Cable outside diameter
 - 3) Number of conductors/strands in each cable and binder group
 - 4) Gauge or strand thickness
 - 5) Cable jacket material and rating (ie Plenum, Riser, wet-rated, etc.)
 - 6) Maximum pulling tension

- 7) Jacket/Sheath color
- 8) Individual conductor or strand insulation colors (if applicable)
- 9) Minimum bend radius
 - a) During installation and post installation, if it differs.

b. Shop Drawings

- 1) Cable types required by this Section are to be identified on Shop Drawings for the following Electronic Security sub-systems: (separate 281010 Shop Drawings for this section are not needed)
 - a) Access Control
 - b) Audio Video Intercom
 - c) Video Surveillance
 - d) Intrusion Detection
- 2) On the Shop Drawings for those Electronic Security sub-systems, show the proposed routing of all conductors and cables and the means of support:
 - a) Cable Tray
 - b) Conduit (solid line)
 - c) J-hooks every 48"-60" (dashed line), if allowed by Contract Documents
- 3) On the Shop Drawings for those Electronic Security sub-systems, include details showing the proposed termination and labeling (ID) scheme at each device and panel for each conductor/cable.

2. Preliminary Project Completion Submittal

- a. Follow all requirements as specified in Division 27 Section "Common Work Results for communication."
- b. Update the approved shop drawings with any changes in cable routing, and submit as part of Preliminary Record Drawings per Division 27 Section "General Communication Requirements".
- c. Test Results
 - 1) Include conductor/strand test as part of the Functional Test Reports for each Electronic Security sub-system.

- d. Cable ID spreadsheet, saved in PDF and Microsoft Excel file formats, which shall include the following for each cable installed under this section:
 - 1) Electronic Security Sub-System
 - 2) Device Type
 - 3) Device Identifier
 - 4) Device Room Number (if not part of Device Identifier)
 - 5) Headend Panel Identifier
 - 6) Headend Panel Room Number (if not part of Headend Panel Identifier)
 - 7) Cable Identifier

TABLE 1: CABLE IDENTIFICATION SPREADSHEET

<u>Sub-System</u>	<u>Device Type/ID</u>	<u>Device Rm</u>	<u>Headend ID</u>	<u>Headend Rm</u>	<u>Cable ID</u>
Access Control	Card Reader 01 AC-CR01-ACP01	Vestibule 101	ACP-01	IDF 114	

3. Final Project Completion Submittal
 - a. Follow all requirements as specified in Division 28 Section "Electronic Security Systems".
 - b. Incorporate any changes from punch list items.
 - c. Include updated Cable ID spreadsheet.

1.4 DEFINITIONS

- A. Damp Location – as defined by the NEC, locations protected from weather and not subject to saturation with water or other liquids but subject to moderate degrees of moisture. For the purposes of Work under this division, assume all Damp Locations require wet-rated cabling.
- B. Point of Entrance (Building Entrance) – as defined by the NEC, the point within a building where the security cabling routed through a Wet Location emerges from an external wall, a concrete floor slab, or IMC/RMC.
- C. Qualified Electrician – one who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved; in regards to this project, a Qualified Electrician is also licensed in

the jurisdiction of the project to install electrical equipment (ie Journeyman or Master Electrician License).

- D. Wet Location - as defined in the NEC, installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Conductors and cables shall meet the following the requirements:

1. UL Listed and Approved for the intended application
 - a. Where areas above accessible ceilings are serving as plenum (air) return, and conductors/cabling is not installed in conduit from device to serving panel or Equipment Room, the conductors/cabling shall be Plenum (CMP) rated.
 - b. Where conductors/cabling are installed in conduit from device to serving panel or Equipment Room, the conductors/cabling shall be Riser (CMR) or Plenum rated.
 - c. Where conductors are/cabling are routed through a Wet Location,
2. Cable type and conductor size/quantity shall be as recommended or required by the device/equipment manufacturer. Where the Contract Documents differ from manufacturer recommendations or requirements, notify the Architect requesting clarification.
3. Conductor sizes, if shown, are minimum. Where approved by the Design Consultant and at no extra cost to the Owner, larger conductor sizes may be installed at Contractor's option in order to utilize stock sizes, provided raceway sizes are increased to correspond with fill ratio requirements defined the NEC.
4. Conductors and cables shall be shielded.
 - a. Submit RFI for any manufacturer equipment that recommends non-shielded cable.

- B. The following Manufacturers are conditionally approved:

1. Belden
2. Draka
3. General Cable
4. Tappan
5. West Penn Wire

2.2 LOW-VOLTAGE CONTROL AND POWER CABLES

- A. For 10 AWG through 24 AWG, and single conductors through 24-pair applications, as needed per project.
- B. General requirements:
 - 1. Shielded (overall shield)
 - 2. Stranded and insulated conductors
 - 3. PVC jacket
 - 4. Size conductors per manufacturer recommendations and power/voltage drop based on installed cable length.
- C. Manufacturer shall be:
 - 1. Submit product cutsheets concurrently with Shop Drawings, identifying cable type, manufacturer, and part number on the Riser Diagram.
 - a. Call out non-plenum (Riser-rated and Wet-rated) cables (where specifically allowed)

2.3 COXIAL CABLING

- A. For distances up to 1000':
 - 1. RG-59
 - a. General requirements:
 - 1) 75-ohm Impedance
 - 2) 20 AWG solid copper conductor
 - b. Plenum-rated cable shall be by:
 - 1) Belden 1506A; or
 - 2) West Penn 25819.
 - c. Wet Locations shall utilize:
 - 1) Belden 5439X5
 - 2) Equal from West Penn
- B. For distances over 1000' and up to 1600':
 - 1. RG-11

- a. General requirements:
 - 1) 75-ohm Impedance
 - 2) 14 AWG solid copper conductor
- b. Plenum-rated cable shall be by:
 - 1) Belden 6139B8
 - 2) Equal from West Penn
- c. Wet Locations shall utilize:
 - 1) Belden 1525A
 - 2) Equal from West Penn

PART 3 - EXECUTION

3.1 CABLE INSTALLATION

A. Pre-Installation

- 1. Following the Notice to Proceed, the ESC's Quality Control Specialist or Project Manager (as defined in Division 28 section "Electronic Security Systems") shall coordinate with the Contractor or Sub-Contractor responsible for Division 28 "Common Work Results for Electronic Security Systems" (ie the conduits, backboxes, etc), if Contractors are different. Items of coordination shall include, but are not limited to:
 - a. Conduit routing
 - b. Conduit type for Building Entrance(s) – (see requirements below)
- 2. Conduit routing and type shall be indicated on at least one of the following Pre-Construction Shop Drawings:
 - a. Division 28 "Common Work Results for Electronic Security"
 - b. Division 28 "Electronic Security Systems"
- 3. After conduits/pathways are installed, but prior to cable installation, ESC's Quality Control Specialist and Project Manager shall inspect the Common Work (pathways and backboxes), paying special attention to:
 - a. Conduit sizes and quantities matches Construction Documents and Project requirements
 - b. Minimum bend radius

- c. Quantity of bends in conduit between pullboxes (180 degree change in direction, maximum)
- d. Building Entrance conduits are of appropriate type
- e. Any visible indication of improper or incomplete installation that may damage cable as it is installed.

B. General Requirements

1. Unless otherwise noted, all cables shall be routed through concealed conduit raceway.
 - a. Contractor is responsible for determining final cable and conduit routing; conduits may be consolidated in overhead pullboxes in accordance with Division 28 Section "Common Work Results for Electronic Security"; proposed (cable and) conduit routing and sizing shall be indicated on pre-construction shop drawings.
2. Install continuous conductors between outlets, devices and boxes without splices or taps. Do not pull connections into raceways. Leave at least 12 inches of conductor in backbox at each device location.
3. A Qualified Electrician shall install all control wire operating at 120V nominal and above. Control wiring operating at less than 120V (e.g., 12V and 24V) may be installed under the Division furnishing it.
4. All cables shall be plenum-rated, unless noted otherwise.
5. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.
 - a. Except when supported by ladder racking within each Telecommunications room, UON.
6. At the same time horizontal cables are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. Use polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inches of slack at each end of pull cord.
7. Do not install kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable
8. Comply with all referenced standards and guidelines.
9. Cables shall be masked, covered, or otherwise protected from being painted or coming in contact with any other substance that may degrade the performance or physical characteristics of the cable jacket or insulation over time.

10. Where space allows, all cables shall be provided with slack/service loops near each end of the cable, one in the accessible ceiling space or overhead J-box at the device and one at the Equipment Room. Each slack/service loop shall be:
 11. A minimum of 3 feet (1 meter) in length, unless noted otherwise.
 12. Prior to using any cable pulling lubricants provide the Design Consultant with written documentation from the cable manufacturer supporting the cable manufacturers' acceptance of its use in compliance with all required warranties as part of these contract documents. The use of non-water based lubricants shall be provided when pulling PVC jacketed and all cables not suitable for contact with water.
 13. Install all cables and conductors in compliance with the requirements of Article 725 of the NEC, paying special attention to the following:
 - a. Cables shall be installed in a neat and workmanlike manner.
 - b. Separation requirements dependent upon installation location and proximity to other circuits.
- C. Outside plant (OSP)/wet-rated cable installation: for cables placed in Wet Locations or as required by these construction documents. (I.e. all cables which extend beyond the footprint/envelope of the building or pathways leading to floor-boxes embedded in a ground floor slab)
1. No portion of outdoor only (unlisted) cables may be installed with the cable jacket exposed in any plenum or other air handling space nor shall they be allowed to transition between different levels of the building.
 2. Rigid or intermediate metallic conduit shall be used to route outdoor (unlisted) cabling to the serving Equipment Room in accordance with the NEC; or a suitably-sized junction box shall be provided in an accessible location within 50' of where the outdoor cabling/conduit enters the building to allow the cable to transition from wet-rated to plenum-rated.
 - a. Indicate this location on pre-construction shop drawings and final Record Drawings.
 3. All cables which extend beyond the envelope/footprint of the building shall be installed with entrance protectors in accordance with Division 27 Section "Telecommunication Equipment Room Fittings".
- 3.2 CABLE IDENTIFICATION
- A. Label all cabling with machine-printed labels according to the labeling scheme identified on the drawings or as described in Division 28 Section "Electronic Security Systems". Where the drawings and specifications are silent, submit RFI through appropriate channels requesting labeling scheme.
1. Shop drawings shall include floor plan and/or riser diagram that indicates proposed cable/device identification for each device.
- B. Cables shall be labeled within 6" at each end.

- C. All cable labels shall be thermal-transfer type and utilize self-adhesive labels. The following are approved manufacturers:

- 1. Brady, IDXPert
- 2. Hellermann Tyton, Spirit 2100
- 3. Panduit LS9
- 4. Or equivalent

3.3 GENERAL CABLE TESTING

- A. Pre-installation testing:

- 1. Visually inspect all cables, cable reels/boxes, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
- 2. Do not install any cable with less than the manufacturer's guaranteed number of serviceable conductors.

- B. Post-installation testing (but prior to termination to devices/panels):

- 1. Conduct cable continuity testing upon completion of installation on each conductor.
- 2. Remove all defective cables from pathway systems. Do not abandon cables in place.

3.4 CABLE TERMINATIONS

- A. Cable connections to device and security panel shall be soldered and heat-shrunk from jacket to jacket. Exposed conductors, even within an enclosure or backbox, are not allowed.

3.5 ACCEPTANCE

- A. The ESC's Quality Control Specialist shall conduct an inspection after conductors and cabling have been installed to ensure compliance with the Construction Documents and project requirements.
- B. Functional tests of the conductors and cables connected to equipment will be conducted by the ESC as part of Test Reports as specified in Division 28 "Electronic Security Systems" and individual Electronic Security sub-system Sections.

END OF DOCUMENT 281010

SECTION 284600

FIRE DETECTION AND ALARM

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. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Division 7 Section "Penetration Firestopping" for material and methods for firestopping systems.
 - 2. Division 26 Section "Common Work Results for Electrical," for materials and methods for coordination, sleeves and common installation requirements.

1.2 DESCRIPTION OF WORK

- A. This Section requires the Contractor to furnish all materials required to install the fire alarm system. The Contractor shall be responsible for installing, testing, and start-up of a complete functioning fire alarm system, and each element thereof, as specified or indicated on the Drawings or reasonably inferred, including every article, device or accessory (whether or not specifically called for by item) necessary to facilitate each system's function as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation and utilities.
- B. Division 28 of the Specifications and Drawings numbered with prefixes FP generally describe these systems, but the scope of the Fire Alarm work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Fire Suppression, Mechanical, Plumbing, Fire Alarm and Electrical Drawings and Specifications; and Addenda.
- C. The Drawings have been prepared diagrammatically and are intended to convey the scope of work, indicating the general location and arrangement of the major equipment, devices, appliances, etc. without showing all the exact details as to elevations, circuits, routing, and other installation requirements. Use the Drawings as a guide when laying out the system and verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.
- D. The scope of work in this section includes:
 - 1. Fire alarm control unit
 - 2. Remote annunciator
 - 3. Manual fire alarm pull stations

4. System smoke detectors
5. Notification appliances
6. Sprinkler system waterflow and valve tamper alarms
7. Air handling unit shutdown
8. Battery stand-by power
9. Digital alarm communicator transmitter (DACT)

1.3 QUALITY ASSURANCE

- A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.
- B. All work shall be installed in strict conformance with manufacturer's requirements and recommendations. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.
- C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.
- D. Installation of devices shall be performed or supervised by a National Institute for Certification of Engineering Technologies (NICET) Level 2 or higher Fire Alarm Technician. Submit copies of the certification for employees through shop drawing submittals.

1.4 APPLICABLE CODES AND STANDARDS

- A. Execute Work in accordance with the National Fire Protection Association Standards and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities. Upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.
- B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.
- C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.
- D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes.
 1. NFPA 70, "National Electrical Code", 2017 Edition. NFPA 72, "National Fire Alarm and Signaling Code", 2016 Edition.

3. Underwriters Laboratories, "Fire Protection Equipment Directory", Latest Edition.
 4. International Building Code (IBC) 2018 Edition with local amendments.
 5. International Fire Code (IFC) 2018 Edition with local amendments.
- E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.
- 1.5 DEFINITIONS
- A. General:
1. Furnish: The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations."
 2. Install: The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."
 3. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use."
 4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.
 5. Engineer: Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".
 6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
 7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the AHJ over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.
 8. FACP: Fire Alarm Control Panel.
 9. NICET: National Institute for Certification in Engineering Technologies.

- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

1.6 COORDINATION

- A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.
- B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping in the manner anticipated in the design.
- C. The Contractor shall maintain a foreman on the jobsite at all times to coordinate their work with other contractors and subcontractors so that various components of the Fire Alarm systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the work in such a manner that the work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.
- D. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and their subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.
- E. Where coordination and interfacing with other systems or equipment is required, it shall be the responsibility of the fire alarm system installer (contractor) to either provide the relays, contacts, power supplies and other necessary hardware or see to it that such hardware is provided with the other systems or equipment.
- F. The contractor shall coordinate work in this section with all related trades. Work and/or equipment provided in other sections and related to the fire alarm system shall include, but not be limited to:
 - 1. Sprinkler waterflow and valve tamper switches shall be provided by the fire sprinkler installer, but wired and connected by the fire alarm installer.
 - 2. Duct smoke detectors shall be furnished, wired and connected by the fire alarm system installer. The HVAC installer shall furnish necessary duct opening to install the duct smoke detector's housing.
 - 3. Air handling fan control circuits and contacts to be furnished by the HVAC control equipment.

4. Conduit shall be by Division 26 "Common Work Results for Electrical".

- G. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.7 MEASUREMENTS AND LAYOUTS

- A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.8 SUBMITTALS

- A. Refer to Division 1 and General Conditions for submittal requirements, in addition to requirements specified herein. Submittals not complying fully with the submittal requirements will be rejected.
- B. Contractor shall prepare installation drawings (working shop drawings) based upon this design. Requests for deviations from the approved design shall be submitted in writing to the Engineer of Record for approval.
- C. Shop drawings shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code and relevant laws, ordinances, rules and regulations. Drawings that are not legible, or that do not contain sufficient detail to verify compliance with applicable codes and standards, will be rejected without further review.
- D. Submittals and shop drawings shall not contain HEI's firm name or logo, nor shall it contain the HEI's engineers' seal and signature. They shall not be copies of HEI's work product. If the contractor desires to use elements of such product, the license agreement for transfer of information at the end of this section must be used.
- E. Submit Shop Drawings as early as required to support the project schedule. Allow for two weeks Engineer review time plus mailing time plus a duplication of this time for resubmittal if required. Submit Shop Drawings as soon as possible before construction starts.
- F. Before submitting Shop Drawings and material lists, the Contractor shall verify that the equipment submitted is mutually compatible and suitable for the intended use. Contractor shall verify that the equipment will fit the available space and allow ample room for maintenance. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- G. Refer to Division 1 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the shop drawings have been posted. If electronic submittal procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives.

Contractor shall allow the Engineer review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the electronic submittal and shall clearly indicate the materials, performance criteria and accessories being proposed. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

- H. The Engineer's checking and subsequent acceptance of such submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications unless the Contractor has, in writing, called the Engineer's and Architect's attention to such deviations at the time of submission, and secured written acceptance; nor shall it relieve the Contractor from responsibility for errors in dimensions, details, sizes of members, or quantities; or for omissions of components or fittings; or for not coordinating items with actual building conditions and adjacent work.
- I. Product Data: Provide a bill of materials and product cutsheets showing material specifications, electrical characteristics and connection requirements. Highlight or indicate specific product options and accessories as applicable to the project.
- J. Shop Drawings:
 - 1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - 2. Shop drawings shall be prepared by a NICET Level II or higher certified technician. Submit copies of the certification for the designer with submittal.
 - 3. The fire alarm system equipment vendor shall provide shop drawings showing fire alarm floor plans and a full building riser diagram. Fire alarm floor plans and riser diagram shall show fire alarm control panel, annunciator, all fire alarm initiating devices and notification appliances. Show typical wiring diagrams of control panel/s, annunciator and each device and wiring connections required. Show all interfaces to other systems, such as temperature control systems, and security systems.
 - 4. The fire alarm floor plans and riser diagram shall show wiring to all fire alarm devices/appliances, indicating wire sizes and quantities as well as conduit/raceway sizes and locations of end-of-line (EOL) resistors. The fire alarm floor plans and riser diagram shall clearly show the routing of all fire alarm system wiring, including all horizontal routing and vertical routing (in chases).
 - 5. Routing of all fire alarm wiring shall comply with the "Survivability" requirements of NFPA 72.
 - 6. Provide a Sequence of Operations Matrix that explains how the submitted fire alarm system functions.
 - 7. Include voltage drop calculations for notification-appliance circuits.
 - 8. Include battery-size calculations.

- 9. Shop drawing scale shall match the Engineer's drawings where possible. Scale shall not be less than $3/32" = 1'-0"$.
 - 10. Shop drawings shall be produced using computer-aided design. Hand drawn documents will not be reviewed or approved.
 - K. Indicate within the submittal all applicable UL listings and all applicable approvals or certifications.
 - L. Qualification Data: Submit copies of the certification for the Installer.
 - M. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of products.
- 1.9 ELECTRONIC DRAWING FILES
- A. In preparation of shop or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall complete and send the form attached at the end of this section along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.
- 1.10 SUBSTITUTIONS
- A. Refer to Division 1 and General Conditions for Substitutions.
 - B. Materials, products and equipment described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
 - C. No substitution will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten calendar days prior to the date for receipt of Bids. Each such request shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including drawings, cuts, performance and test data and other information necessary for an evaluation. A statement setting forth changes in other materials, equipment or other Work that incorporation of the substitute would require shall be included. The burden of proof of the merit of the proposed substitute is upon the proposer. The Engineer's decision of approval or disapproval to bid of a proposed substitution shall be final.
 - D. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
 - E. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE DATA

- A. Refer to Division 1 and General Conditions for Operational and Maintenance Manuals.
- B. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- C. The O&M Manuals shall be provided in labeled 3-ring binder with cover, binding label, tabbed fly sheets and plastic insert folders for Record Drawings. Include the following sections with the appropriate information for each section:
 - 1. Typewritten Index.
 - 2. Qualifications. Provide designer and installer qualification.
 - 3. Bill of Materials. Provide complete nomenclature, model number and vendor information for all parts.
 - 4. Operating Instructions. Complete instructions detailing operation and maintenance of all equipment installed.
 - 5. Product Data: Provide product cutsheets for all equipment utilized and installed.
 - 6. Riser diagram.
 - 7. Device addresses.
 - 8. Record copy of site-specific software.
 - 9. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - a. Equipment tested.
 - b. Frequency of testing of installed components.
 - c. Frequency of inspection of installed components.
 - d. Requirements and recommendations related to results of maintenance.
 - e. Manufacturer's user training manuals.
 - 10. Manufacturer's required maintenance related to system warranty requirements.
 - 11. Abbreviated operating instructions for mounting at fire alarm control unit and each annunciator unit.
 - 12. Guarantee. Copy of all guarantees and warranties issued.
 - 13. Contact list with minimum three service representative phone numbers.

1.12 RECORD DRAWINGS

- A. A set of prints shall be kept on the jobsite during construction for the purpose of noting changes to location of all fire alarm equipment, devices, appliances and circuits as finally installed. During the course of construction, the Contractor shall indicate on these drawings, changes made from the Contract Drawings. Particular attention shall be made to those items which need to be located for servicing.
- B. The record drawings shall show actual locations of initiating devices, notification appliances, and end-of-line devices. Show the approximate location, size and type of all wiring and routing of wiring. Drawings should also include one-line riser diagrams showing all devices.
- C. The Contractor shall sign-off on the Record Drawings as being an accurate representation of the completed installation.
- D. Refer to Division 1 and General Conditions for Record Drawings
- E. At the completion of the project, the Contractor shall obtain at their expense, reproducible copies of the drawings and incorporate changes noted on the jobsite work prints onto these sheets. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", with date. The drawings and associated system calculations shall be delivered to the Architect.

1.13 SPARE PARTS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Provide 10% of the total or a minimum of one (1) manual pull station.
 - 2. Provide 10% of the total or a minimum of two (2) of each type of automatic smoke detector.
 - 3. Provide 5% of the total or a minimum of two (2) of each strobe type and candela rating.
 - 4. Provide 5% of the total or a minimum of two (2) of each horn type. Combination horn /strobe units matching the units installed are acceptable.
 - 5. Keys and Tools: One extra set for access to locked or tamper proofed components.

1.14 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products indicated in this section with minimum three years documented experience.
- B. Installer: Company specializing in installing the products indicated in this section with minimum three years documented experience. Shall be bondable and licensed Contractor and employ full-time factory-trained and certified installers and technicians. Installers shall provide with the fire alarm submittal proof of factory training for each installer.
- C. Final checkout and verification: Shall be conducted by a technician certified by the National Institute for Certification in Engineering Technologies (NICET) registered as level 2 or higher in the fire protection technology certification program. Provide certification information with fire alarm submittal.

- D. The equipment manufacturer's service department shall be fully stocked in standard parts and components and engaged in the maintenance of fire alarm systems. On-the-premises service shall be available within 4 hours of notification, 7 days a week, 24 hours a day.

1.15 GUARANTEES AND WARRANTIES

- A. Refer to Division 1 and General Conditions for Guarantees and Warranties.
- B. Furnish service and maintenance of fire alarm system including wiring and raceways for one year from date of substantial completion.
- C. All components, system software, parts and assemblies shall be guaranteed against defects in materials and workmanship for the one-year period stated above, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty.
- D. Labor (including travel expenses) to trouble-shoot, repair, reprogram, or replace components shall be furnished by this contractor at no charge during the warranty period.
- E. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software.

PART 2 - PRODUCTS AND MATERIALS

2.1 SYSTEM DESCRIPTION

- A. Noncoded, UL-listed addressable system, with multiplexed signal transmission and horn/strobe evacuation.
- B. All components provided shall be listed for use with the selected system.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Source Limitations for Fire alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested, and will operate, as a system.

2.2 MANUFACTURER

- A. Subject to compliance with requirements, provide products manufactured by the following manufacturers as indicated on the Drawings:
 - 1. Notifier
 - 2. SimplexGrinnell
 - 3. Siemens-Cerberus Division
 - 4. Kidde/Edwards
 - 5. Gamewell-FCI

6. Silent Knight
7. Approved Equal
 - a. Approved equals will not be considered unless formally submitted during the bidding process as an RFI.

2.3 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire alarm signal initiation shall be by one or more of the following devices:
 1. Manual pull stations.
 2. Smoke detectors.
 3. Automatic sprinkler system water flow.
- B. Fire alarm signal shall initiate the following actions:
 1. Identify alarm and specific initiating device at fire alarm control unit and remote annunciators (if provided).
 - a. A pulsing alarm tone shall occur within the control panel until acknowledged.
 - b. The alarm LED shall flash on the control panel and remote annunciator panel until the alarm has been acknowledged at the control panel/remote annunciator panel. Once acknowledged, this same LED shall latch on and the custom label for the address in alarm shall be displayed on the alphanumeric LCD readout. A subsequent alarm received from another address after acknowledged shall flash the alarm LED on the control panel showing the new alarm information.
 2. Transmit an alarm signal to the alarm supervising station.
 3. The audible and visible alarm signal shall operate until it is manually silenced or acknowledged.
 4. Record events in the system memory.
 5. All fan-powered air-handling equipment shall shutdown and remain down until the fire alarm control panel is reset.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
 1. Valve supervisory switch.
 2. Duct-smoke detectors
 3. User disabling of zones or individual devices.
 4. Loss of communication with any panel on the network.

D. System Supervisory Signal Actions:

1. Identify specific device causing supervisory signal fire alarm control unit and remote annunciators (if provided).
 - a. Visible and audible supervisory alarm indicated by address at fire alarm control panel.
 - b. Manual acknowledge function at fire alarm control panel and remote annunciator panel silences audible supervisory alarm; visible alarm is displayed until device is returned to its normal position/supervisory condition is cleared.
2. Record events in the system memory.
3. After a time delay of 90 seconds transmit a supervisory signal to the alarm supervising station.
4. Duct-mounted smoke detectors shall shutdown their respective unit upon detection of smoke and remain down until manually reset.
5. Individual fan-powered air distribution equipment less than 2,000 cfm that is not provided with duct detection shall shutdown when the respective air handling unit is shutdown.

E. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire alarm control unit.
5. Ground or a single break in internal circuits of fire alarm control unit.
6. Abnormal ac voltage at fire alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire alarm control unit or annunciator.

F. System Trouble Signal Actions:

1. Identify specific device causing trouble signal fire alarm control unit and remote annunciators (if provided).

- a. Visible and audible trouble alarm indicated by address at fire alarm control panel.
 - b. Manual acknowledge function at fire alarm control panel and remote annunciator panel silences audible trouble alarm; visible alarm is displayed until device is returned to its normal position/trouble condition is cleared.
2. Record events in the system memory.
 3. After a time delay of 90 seconds, transmit a trouble signal to the alarm supervising station.

2.4 FIRE ALARM SYSTEM CONTROL UNIT

A. General Requirements for Fire alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
 - a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
 - c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
 - d. The FACP shall be listed for connection to a central-station signaling system service.
 - e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
 - f. The control unit shall have dedicated alarm, supervisory and trouble LED's and dedicated alarm, supervisory and trouble acknowledge, and alarm silence switches.
 - g. Lamp Test: Manual lamp test function causes each LED to function at fire alarm control panel.
 - h. Drill Sequence of Operation: Manual drill function causes alarm mode operation as described above.
 - i. The FACP shall be provided with surge protection.
 - j. Install in a surface mounted enclosure.

- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
- C. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals and digital alarm communicator transmitters shall be powered by 24-V dc source.
1. The location of the dedicated branch circuit disconnecting means shall be permanently identified at the control unit.
 2. The circuit disconnecting means shall have a red marking and be provided with a breaker lock or other approved method to avoid accidental operation.
 3. Alarm current draw of entire fire alarm system shall not exceed 80 percent of the power-supply module rating.
- D. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
1. Batteries: Sealed lead acid.
 2. The secondary power system shall operate system in standby mode for 24 hours followed by alarm mode for 5 minutes.
- E. System Supervision: Automatically detects and reports open circuits, shorts, and grounds of wiring for initiating device, signaling line, and notification appliance circuits. Alarm, supervisory and trouble signals shall be monitored by the supervising station over a Digital Alarm Communicator Transmitter (DACT), or other approved method.
- 2.5 DIGITAL ALARM COMMUNICATOR TRANSMITTER
- A. Digital alarm communicator transmitter (DACT) shall be acceptable to the central station and shall comply with UL 864.
- B. The installing contractor shall select the appropriate DACT equipment based on the available communication methods.
- C. Coordinate with General Contractor to ensure proper connections are provided for communication to and from the DACT. Two (2) separate communication methods are required and shall not be subject to a common failure within the scope of work identified within these contract documents. Unless noted otherwise, the installing contractor shall utilize two (2) of the following communication methods:
1. Copper wire (POTS) telephone line for fire alarm use as required by NFPA 72.
 - a. If two (2) POTS telephone lines are utilized per NFPA 72, additional communication methods are not required.
 2. Building 10/100 Base network (LAN), DSL modem, or cable modem.

3. GSM cellular networks in the area including 2G, 3G and 4G.
 - a. The transmitter shall automatically detect and choose the best network in the area based on signal strength and immediately self-adjust for operation as necessary.
 4. Other alternative method complying with the performance requirements of NFPA 72 for 'Communication Methods for Supervising Station Alarm Systems that is acceptable to the Authority Having Jurisdiction and the Engineer of Record. Approval of any alternative methods must be obtained from the Engineer of Record via an RFI prior to submitting bids for the scope of work.
- D. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire alarm control unit and automatically transmit across the primary communication method. If service on the primary communication method is interrupted for longer than 45 seconds, the transmitter shall initiate a local trouble signal and transmit a signal indicating loss of primary communication to the supervising station over the secondary communication method. Transmitter shall automatically report communication restoration to the supervising station. If service is lost on both communication methods, transmitter shall initiate a local trouble signal.
- E. Digital data transmission shall include the following:
1. Address of the alarm initiating device.
 2. Address of the supervisory signal.
 3. Address of the trouble signal.
 4. Loss of ac supply.
 5. Loss of power.
 6. Low battery.
 7. Abnormal test signal.
 8. Communication bus failure.
- F. Secondary Power: Integral rechargeable battery and automatic charger.
- G. Self-Test: Conducted automatically every 24 hours with report transmitted to supervising station.
- 2.6 REMOTE ANNUNCIATOR
- A. Description: Alphanumeric display and LED indicating lights shall match those of fire alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.
1. Mounting: Flush.

2.7 INITIATING DEVICES

- A. Manual Fire Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
 - 1. Double action mechanism requiring two actions to initiate an alarm, pull lever type; with integral addressable module arranged to communicate manual station status (normal, alarm, or trouble) to fire alarm control unit.
 - 2. Station Reset: Key or wrench operated switch.
- B. System Smoke Detectors: Photoelectric type complying with UL 268 operating at 24-V dc, nominal with integral addressable module arranged to communicate detector status (normal, alarm, or trouble) to fire alarm control unit.
 - 1. Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base.
 - 2. Device shall have an integral visual-indicating light, LED type, indicating detector has operated and power-on status.
 - 3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 4. Photoelectric detectors shall have sensitivity between 0.5 and 3.5 percent/foot smoke obscuration.
- C. Duct Smoke Detectors: Photoelectric type complying with UL 268A with a standard, relay or isolator detector mounting base. Provide manufacturer's standard housing to protect the measuring chamber from damage and insects. Provide drilling templates and gaskets to facilitate locating and mounting the housing.
 - 1. Provide for variations in duct air velocity between 100 and 4,000 feet per minute.
 - 2. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied. Provide an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet.
 - 3. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
 - 4. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor control circuit.
 - 5. Provide remote alarm LEDs and remote test stations as shown on the plans.
 - 6. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.

2.8 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
 - 1. Combination Devices: Factory integrated audible and visible devices in a single mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections. Minimum audible level and strobe intensity shall meet all requirements for separate appliances.
 - 2. Provide strobe synchronization as required per NFPA 72.
 - 3. Wall mounted notification appliances shall be manufacturer standard red finish.
 - 4. Ceiling mounted notification appliances shall be manufacturer standard red finish.
- B. Alarm Horns: Comply with UL 464. Electric vibrating polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.
- C. Visible Alarm Notification Appliances (Strobes): Xenon strobe lights complying with UL 1971, unfiltered or clear filtered white light, with candela ratings as indicated on drawings. Strobes shall meet all requirements of the Americans with Disabilities Act.

2.9 AUXILIARY DEVICES

- A. Waterflow Alarm Switches: Shall be provided by the Fire Sprinkler Installer and shall be wired complete and ready for use by the Fire Alarm System Installer. Switch shall have an adjustable delay to minimize false alarms due to fluctuations in water pressure.
- B. Valve (Tamper) Switches: Shall be provided by the Fire Sprinkler Installer and shall be wired complete and ready for use by the Fire Alarm System Installer.
- C. Monitor Module: Addressable microelectronic module providing a system address for alarm initiating devices for wired applications with normally open contacts. Include address setting means on the module.
- D. Control/Relay Module: Provide intelligent control relay modules. The Control Relay Module shall provide one form "C" dry relay contact rated at 2 amps @ 24 VDC to control external appliances or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. The position of the relay contact shall be confirmed by the system firmware.
- E. Fire Department Key Box: Shall be by Knox Company or as otherwise specified by the authority having jurisdiction. Provide internal switch(es), as required by the Authority Having Jurisdiction, to indicate supervisory condition(s) at the fire alarm control and annunciator panels.

2.10 DEVICE GUARDS

- A. Description: Welded wire mesh of size and shape for smoke detectors, notification appliances, or other device requiring protection as indicated on the plans.
 - 1. Factory fabricated and furnished by device manufacturer.
 - 2. Finish: Factory finished to match the color of the protected appliance or device.

2.11 FIRE ALARM WIRE AND CABLE

- A. Fire Alarm Power Branch Circuits: Building wire as specified in Division 26.
- B. Fire alarm Wire and Cable: NRTL listed and labeled as complying with NFPA 70 (NEC) Article 760. All wiring, including wiring to existing modified devices and appliances shall be new.
- C. Signaling Line, Initiating Device and Notification Appliance Circuits: Power limited fire protective signaling cable, solid copper conductor, 300 volts insulation, suitable for temperature, conditions and location installed. Minimum wire size for initiating device circuits, control circuits and notification appliance circuits shall be determined by calculations and manufacturer's requirements or recommendations. Wire and cable shall be twisted and shielded if recommended by the system manufacturer.
- D. The type of cable chosen should be based on fire alarm system requirements, specification requirements and applicable code requirements. Consideration should also be given to the length of cable runs and potential interference.
- E. Initiating, notification, and control circuits shall be sized based on 20% additional power consuming devices.
- F. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."
- G. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket and red identifier stripe, NRTL listed for fire alarm and cable tray installation, plenum rated.
- H. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits: Provide circuitry, which meets the performance requirements during abnormal conditions, based upon the class of the circuitry selected.
 - 1. Initiating Device Circuits: Class B.
 - a. Pathway Survivability: Level 0.
 - b. Notification Appliance Circuits: Class B.
 - c. Pathway Survivability: Level 0.
 - d. Signaling Line Circuits: Class B.

e. Pathway Survivability: Level 0.

2. Any circuits interconnecting fire alarm control panels between separate buildings shall be provided with surge protection.

2.12 ACCESS TO EQUIPMENT

A. All detectors, modules, equipment, etc. shall be located so as to provide easy access for operation, service inspection and maintenance.

B. Access Doors:

1. Provide access doors for all concealed equipment, except where above lay-in ceilings.
2. Access doors shall be adequately sized for the devices served with a minimum size of 18" x 18", furnished by the respective Contractor or Subcontractor and installed by the General Contractor.
3. Access doors must be of the proper materials for type of construction where installed.
4. The exact location of all access doors shall be verified with the Architect prior to installation.
5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.
 - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
 - b. For gypsum wallboard or plaster: perforated flanges with wallboard bead.
7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
 - a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
8. Locking Devices: Flush, screwdriver-operated cam locks.
9. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
 - a. Arrow United Industries.
 - b. Bar-Co., Inc.

- c. J.L Industries.
- d. Karp Associates, Inc.
- e. Milcor Div. Inryco, Inc.
- f. Nystrom Building Products
- g. Wade
- h. Zurn

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall install, program and test all new equipment identified in this contract in accordance with the applicable codes, standards, and manufacturer's instructions.
- B. The installation supervisor shall be on the job site during the entire installation. The installation supervisor shall maintain marked up copies of the drawings at the job site showing as-built conditions. These drawings shall be updated daily and available for Owner review.
- C. The Contractor shall provide all required conduit and all associated hardware, and shall install (pull), connect, and test all cable for a complete fire alarm system. All wiring shall be installed in accordance with the guidelines of these specifications and documents as well as the NFPA codes and standards listed in these specifications.

3.2 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 and requirements of authorities having jurisdiction for installation and testing of fire alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
 - 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

- B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.
- C. Manual Fire alarm Boxes: Provide manual fire alarm boxes as shown on drawings. Mount manual fire alarm box on a background of a contrasting color. The operable part of manual fire alarm box shall be at 48 inches above floor level unless noted otherwise.
- D. Smoke Detectors: Provide detectors as shown on drawings.
 - 1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke detector spacing.
 - 2. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
 - 3. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
 - 4. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
 - 5. Install ceiling mounted detectors in areas with exposed structure tight to underside of floor/roof deck unless noted otherwise on drawings.
- E. Duct Smoke Detectors: Comply with NFPA 72. Install sampling tubes so they extend the full width of the duct. Tubes more than 36 inches long shall be supported at both ends.
 - 1. Do not install smoke detector in duct smoke detector housing during construction. Install detector only during system testing and prior to system turnover.
 - 2. Provide duct detection and shutdown for fan powered air distribution equipment exceeding 2,000 cfm.
 - 3. Provide equipment and connections to shutdown fan powered air distribution equipment with a capacity less than 2,000 cfm that are part of an air distribution system with a capacity greater than 2,000 cfm.
- F. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, or valve-tamper switch that is not readily visible from normal viewing position.
- G. Install ceiling mounted visible and audible/visible notification appliances in areas with exposed structure to bottom of floor/roof structure or at 30 ft AFF, whichever is lower.
- H. Install ceiling mounted visible and audible/visible notification appliances in areas with finished ceilings flush with bottom of ceiling or at 30 ft AFF, whichever is lower.

- I. Install wall mounted visible and audible/visible notification appliances with visible element (strobe) between 80 inches and 96 inches above finished floor unless noted otherwise on drawings.
- J. Install wall mounted audible devices with the top of the device at least 90 inches above finished floor or 6 inches below the ceiling, whichever is lower, unless noted otherwise on Drawings. If combination devices are installed, they shall be installed per the visible signal device requirements.

3.4 PATHWAYS

- A. Pathways above suspended ceilings and in nonaccessible locations may be routed exposed where permitted by NFPA 70 & 72.
- B. Exposed pathways shall be:
 - 1. Installed in conduit.
 - 2. Routed parallel to main structural elements.
 - 3. Routed above the bottom of structural elements.
 - 4. Routed to minimize visibility.
 - 5. Painted to match surrounding finishes.
- C. All detection and control circuits associated with smoke control systems shall be fully enclosed within continuous raceways.
- D. Minimum allowable conduit size shall be $\frac{3}{4}$ inch. The conduit shall be sized so that conduit fill does not exceed 75% of NFPA 70 maximum fill requirements. Cables in vertical risers shall not exceed 50% of NFPA 70 maximum fill requirements. Conduit installation shall be as required by the Contractor's layout and as described in these specifications. All conduit field routing shall be acceptable to the Owner. Routing not acceptable shall be rerouted and replaced without expense to the Owner.
- E. All wire, cable, conduit and raceways shall be concealed in walls, ceiling spaces, electrical shafts or closets in finished areas except as specifically noted otherwise. Conduit and raceways may be exposed in unfinished areas or where specifically approved by the Owner.
- F. Except as otherwise specified or indicated on the drawings, all conduit shall be installed parallel or perpendicular to dominant surfaces with right angle turns made of symmetrical bends or fittings. Except where prevented by the location of other work, a single conduit or a conduit group shall be centered on structural members.
- G. Conduit shall be located at least six inches from hot water or steam pipes, and from other hot surfaces. Conduit shall not block access to any existing equipment or fixtures.
- H. Mount end-of-line device in box with last device or separate box adjacent to last device in circuit for conventional hardwired class B initiating and notification appliance circuits.

- I. Conduit shall be securely fastened to all boxes and cabinets. Threads on metallic conduit shall project through the wall of the box to allow the bushing to butt against the end of the conduit. The locknuts both inside and outside shall then be tightened sufficiently to bond the conduit securely to the box. Conduit shall enter cabinets from the bottom and sides only.

3.5 CONNECTIONS

- A. All wiring shall be terminated at devices or panels using terminal connectors for screw type terminals. All terminal connectors for conductors shall be pre-insulated ring type or pre-insulated spade type. Pre-insulated terminal connectors shall include a vinyl sleeve, color coded to indicate conductor size. Pre-insulated terminal connectors shall include a metallic support sleeve bonded to the vinyl-insulating sleeve and designed to grip the conductor insulation.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 1. Provide equipment and connections to shutdown fan powered air distribution equipment with an individual capacity less than or equal to 2,000 cfm that are part of an air distribution system with a design capacity greater than 2,000 cfm.
 2. Supervisory connections at valve supervisory switches.
 3. Supervisory connections at low-air pressure switch of each dry-pipe sprinkler system.

3.6 INSTALLATION OF ACCESS DOORS

- A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.
- B. Adjust hardware and panels after installation for proper operation.

3.7 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. All conduits and junction boxes shall be labeled as specified in Division 26 (red).
- C. The location of end-of-line resistors shall be identified with a label indicating "EOL."
- D. Provide label at each initiating device indicating the device address. Label shall be visible from the floor below or immediately adjacent to the device.

3.8 GROUNDING

- A. Ground fire alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.9 FIELD QUALITY CONTROL

- A. Systems shall be checked and tested in accordance with the instructions provided by the manufacturer to insure that the system functions as required and is free of grounds, opens, and shorts. Each device shall be tested.
 - 1. Smoke detectors shall be tested with products of combustion.
- B. Upon completion of the system installation and before the Date of Final Acceptance, a factory-trained technician shall perform all necessary tests and adjustments and shall then file a Letter of Certification and a Certificate of Completion (NFPA 72) with the Owner indicating that the system functions and conforms to the Fire Alarm System Specifications.
- C. Upon completion of the system installation, a factory-trained technician shall perform all necessary tests and adjustments in the presence of the Owner's designated personnel. Test in accordance with NFPA 72 and requirements of the authority having jurisdiction. Perform the following tests at a minimum:
 - 1. Visual Inspection: Conduct visual inspection prior to testing. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - a. Test audible appliances for the public operating mode according to manufacturer's written instructions.
 - b. Test visible appliances for the public operating mode according to manufacturer's written instructions.
- D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- E. Fire alarm system will be considered defective if it does not pass tests and inspections.
- F. Include services of factory trained and certified technician to supervise installation, adjustments, final connections, and system testing as performed by the fire alarm contractor's factory-trained technicians.

3.10 DEMONSTRATION

- A. The equipment supplier's factory trained technician shall train the Owner's personnel in the proper use and maintenance of the system. Training sessions shall be conducted as needed, not to exceed a total of 2 sessions, with each session lasting a maximum of 4 hours each.
- B. Demonstrate normal and abnormal modes of operation, and required responses to each.

City of Lee's Summit
Lee's Summit - Market Plaza

END OF DOCUMENT 284600

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes Concrete Paving:
 - 1. Walks.
- B. Related Requirements:
 - 1. Section 321373 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified ready-mix concrete manufacturer testing agency.
- B. Material Certificates: For the following, from manufacturer:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Curing compounds.
 - 4. Applied finish materials.
 - 5. Bonding agent or epoxy adhesive.
 - 6. Joint fillers.
- C. Material Test Reports: For each of the following:
 - 1. Aggregates.
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").
- B. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.8 FIELD CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 - 2. Do not use frozen materials or materials containing ice or snow.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 - 3. Fog-spray forms and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.2 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 CONCRETE MATERIALS

- A. Concrete mix shall be City approved mix for concrete pavement. Submit concrete mix specifications for approval by Landscape Architect.
- B. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
 1. Portland Cement: ASTM C150/C150M, gray white portland cement Type I Type II Type I/II Type III Type V.
 2. Fly Ash: ASTM C618, Class C or Class F.
 3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
 4. Blended Hydraulic Cement: ASTM C595/C595M, Type IS, portland blast-furnace slag Type IP, portland-pozzolan Type IL, Portland-limestone Type IT, ternary blended cement.
- C. Normal-Weight Aggregates: ASTM C33/C33M, Class 4S Class 4M Class 1N Insert class, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.
 1. Maximum Coarse-Aggregate Size: 1-1/2 inches 1 inch 3/4 inch nominal.
 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Air-Entraining Admixture: ASTM C260/C260M.
- E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
 1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
 2. Retarding Admixture: ASTM C494/C494M, Type B.
 3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
 4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
 6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

- F. Water: Potable and complying with ASTM C94/C94M.

2.4 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry or cotton mats.
- B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
1. Products: Subject to compliance with requirements, provide one of the following:
- a. BASF Corporation; MasterKure ER 50 (Pre-2014: Confilm.
 - b. Bon Tool Co.; 32-301-B7 BonWay Evaporation Retarder.
 - c. Brickform; a division of Solomon Colors; Evaporation Retarder.
 - d. ChemMasters, Inc; Spray-Film.
 - e. Dayton Superior; AquaFilm Concentrate J74.
 - f. Euclid Chemical Company (The); an RPM company; Eucobar.
 - g. Kaufman Products, Inc; VaporAid.
 - h. Lambert Corporation; LAMBCO Skin.
 - i. Laticrete International, Inc.; E-CON.
 - j. Metalcrete Industries; Waterhold.
 - k. Nox-Crete Products Group; MONOFILM.
 - l. Sika Corporation; SikaFilm.
 - m. SpecChem, LLC; SpecFilm.
 - n. TK Products; TK-2120 TRI-FILM.
 - o. Vexcon Chemicals Inc.; Certi-Vex EnvioAssist.
 - p. W.R. Meadows, Inc; EVAPRE.
 - q. Insert manufacturer's name; product name or designation.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.
1. Products: Subject to compliance with requirements, provide one of the following:
- a. Anti-Hydro International, Inc; A-H Curing Compound #2 DR WB.
 - b. ChemMasters, Inc; Safe-Cure Clear DR.

- c. Dayton Superior; Clear Cure VOC J7WBClear Resin Cure J11WCure & Seal 309 EFCure & Seal 309 J18.
- d. Euclid Chemical Company (The); an RPM company; Aqua-Cure VOXDiamond Clear VOXKurez DR VOXKurez W VOX.
- e. Kaufman Products, Inc; DR Cure.
- f. Lambert Corporation; AQUA KURE - CLEAR.
- g. Laticrete International, Inc.; L&M CURE R.
- h. Nox-Crete Products Group; Res-Cure DHRes-Cure DS.
- i. Right Pointe; Clear Water Resin.
- j. SpecChem, LLC; PaveCure Rez.
- k. TK Products; TK-2519 DC WB.
- l. Unitex by Dayton Superior; Hydroseal 18.
- m. Vexcon Chemicals Inc.; Certi-Vex Enviocure 100.
- n. W.R. Meadows, Inc; 1100-CLEAR SERIES.
- o. Insert manufacturer's name; product name or designation.

2.5 RELATED MATERIALS

- A. Joint Fillers: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D8139, semirigid, closed-cell polypropylene foam in preformed strips.
- B. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Epoxy-Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
 - 1. Types I and II, nonload bearing Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.6 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
 - 2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.

- B. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent. Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 - 1. Fly Ash or Pozzolan: 25 percent.
 - 2. Slag Cement: 50 percent.
 - 3. Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 25 percent.
- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
 - 1. Air Content, 1-1/2-inch Nominal Maximum Aggregate Size: 5-1/2 4-1/2 2-1/2 percent plus or minus 1-1/2 percent.
 - 2. Air Content, 1-inch Nominal Maximum Aggregate Size: 6 4-1/2 3 percent plus or minus 1-1/2 percent.
 - 3. Air Content, 3/4-inch Nominal Maximum Aggregate Size: 6 5 3-1/2 percent plus or minus 1-1/2 percent.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 0.30 percent by weight of cement.
- E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing admixture high-range, water-reducing admixture high-range, water-reducing and retarding admixture plasticizing and retarding 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.
- F. Concrete Mixtures: Normal-weight concrete.
 - 1. Compressive Strength (28 Days): 4000 psi.
 - 2. Maximum W/C Ratio at Point of Placement: 0.45 0.50 Insert ratio.
 - 3. Slump Limit: Minimum of 3 to maximum of 5 inches.

2.7 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M and ASTM C1116/C1116M. Furnish batch certificates for each batch discharged and used in the Work.

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.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.
 1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
 2. For concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
 1. Completely proof-roll subbase. Limit vehicle speed to 3 mph.
 2. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 312000 "Earth Moving."
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
 - 1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
 - 1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
 - 2. Provide tie bars at sides of paving strips where indicated.
 - 3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
 - 5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
 - 1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
 - 2. Extend joint fillers full width and depth of joint.
 - 3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
 - 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.

5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
 - a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.
 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 developing random contraction cracks.
 - a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.
 3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

3.5 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
- B. Remove snow, ice, or frost from subbase surface before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

- E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
- F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
- H. Screed paving surface with a straightedge and strike off.
- I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.
- K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
 - 1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

3.6 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
2. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.7 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to 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.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture-retaining-cover curing as follows:
 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or 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.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain at least one composite sample for each [100 cu. yd.] [5000 sq. ft.] or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 - 2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 - 3. Air Content: ASTM C231/C231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - 4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
 - 5. Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 - 6. Compressive-Strength Tests: ASTM C39/C39M; test one specimen at seven days and two specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

- D. Test results shall be reported in writing to Architect/Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect/Engineer but will not be used as sole basis for approval or rejection of concrete.
- F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect/Engineer.
- G. Concrete paving will be considered defective if it does not pass tests and inspections.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- I. Prepare test and inspection reports.

3.9 REPAIR AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect/Engineer.
- B. Drill test cores, where directed by Architect/Engineer, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
- C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 321316 - DECORATIVE CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Integral color concrete paving.
- B. Related Requirements:
 - 1. Section 321313 "Concrete Paving" for cast-in-place concrete paving with other finishes, curbs and gutters, and stamped detectable warnings.
 - 2. Section 321373 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within decorative concrete paving and in joints between decorative concrete paving and other paving or adjacent construction.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each decorative concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer ready-mix concrete manufacturer.
- B. Material Certificates: For the following, from manufacturer:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Curing compounds.
 - 4. Applied finish materials.
 - 5. Bonding agent or epoxy adhesive.
 - 6. Joint fillers.
- C. Material Test Reports: For each of the following:
 - 1. Aggregates.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer of decorative concrete paving systems.
- B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").
- C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution prior to beginning work.
 - 1. Build mockups of full-thickness sections of decorative concrete paving to demonstrate typical joints; surface color, pattern, and texture; curing; and standard of workmanship.
 - 2. Build mockups of decorative concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Landscape Architect and not less than 48 inches by 48 inches.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Landscape Architect specifically approves such deviations in writing.

1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.8 FIELD CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 - 2. Do not use frozen materials or materials containing ice or snow.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 - 3. Fog-spray forms and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.2 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
 - 1. Use flexible or uniformly curved forms for curves of a radius of 100 feet or less.
- B. Forms for Textured Finish Concrete: Units of face design, size, arrangement, and configuration indicated. Provide solid backing and form supports to ensure stability of textured form liners.
- C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.3 STEEL REINFORCEMENT

- A. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, fabricated from as-drawn steel wire into flat sheets.
- B. Reinforcing Bars: ASTM A615/A615M, Grade 60; deformed.
- C. Steel Bar Mats: ASTM A184/A184M; with ASTM A615/A615M, Grade 60 deformed bars; assembled with clips.
- D. Joint Dowel Bars: ASTM A615/A615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.
- E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
 - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2.4 CONCRETE MATERIALS

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

- B. Contractor shall use concrete mix used on-site for sidewalks. Mix shall be City approved mix for color concrete. Submit concrete mix specifications for approval by Landscape Architect.
- C. Integral Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. The Bomanite Company.
 - 1) Integral color: ~~XXXXXXXXXX~~
 - b. Or approved equal.
- D. Water: Potable and complying with ASTM C94/C94M.

2.5 CURING AND SEALING MATERIALS

- A. Curing Paper: Nonstaining, waterproof paper, consisting of two layers of kraft paper cemented together and reinforced with fiber, and complying with ASTM C171.
- B. Vapor Retarding Membrane: 10 mil reinforced polyethylene.
- C. Curing Materials: As recommended by integral color concrete manufacturer for compatibility.
- D. Sealer: The Bomanite Company Hydrolock water-based, single component, penetrating concrete sealer installed per manufacturer recommendations and specifications.
- E. Slip-Resistance-Enhancing Additive: The Bomanite Company Sure Trac polymeric grit coating additive installed per manufacturer recommendations and specifications.

2.6 RELATED MATERIALS

- A. Joint Fillers: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D8139, semirigid, closed-cell polypropylene foam in preformed strips.
- B. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

- C. Epoxy-Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
 - 1. Types I and II, nonload bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- D. Polyethylene Film: ASTM D4397, 1 mil thick, clear.

2.7 CONCRETE MIXTURES

- A. Obtain each color, size, type, and variety of concrete mixture from single manufacturer with resources to provide concrete of consistent quality in appearance and physical properties.
- B. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
- C. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent. Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 - 1. Fly Ash or Pozzolan: 25 percent.
 - 2. Slag Cement: 50 percent.
 - 3. Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 25 percent.
- D. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
 - 1. Air Content:
 - a. 5-1/2 4-1/2 2-1/2 percent plus or minus 1.5 percent for 1-1/2-inch nominal maximum aggregate size.
 - b. 6 4-1/2 3 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.
 - c. 6 5 3-1/2 percent plus or minus 1.5 percent for 3/4-inch nominal maximum aggregate size.
- E. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 0.30 percent by weight of cement.

- F. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing admixture water-reducing and retarding admixture water-reducing and accelerating 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.
- G. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.
- H. Concrete Mixtures: Normal-weight concrete.
 - 1. Compressive Strength (28 Days): 4000 psi.
 - 2. Maximum W/C Ratio at Point of Placement: 0.50.
 - 3. Slump Limit: Minimum of 3 to maximum of 5 inches.

2.8 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Furnish batch certificates for each batch discharged and used in the Work.
 - 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.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.
 - 1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
 - 2. For concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
 - 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below decorative concrete paving to identify soft pockets and areas of excess yielding.
 - 1. Completely proof-roll subbase. Limit vehicle speed to 3 mph.
 - 2. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 312000 "Earth Moving."
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.
- B. Protect adjacent construction from discoloration and spillage during application of color hardeners, release agents, stains, curing compounds, and sealers.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
 - 1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
 2. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 3. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
 4. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
 2. Extend joint fillers full width and depth of joint.
 3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
 5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
 - a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.
 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 developing random contraction cracks.

- a. Tolerance: Ensure that sawed joints are within 3 inches in both directions from centers of dowels.
3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

3.5 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
- B. Remove snow, ice, or frost from subbase surface before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
- F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels and joint devices.
- H. Screed paving surface with a straightedge and strike off.
- I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.6 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

3.7 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to 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.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Compound: Apply immediately after final finishing. 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.
 - 1. Cure integrally colored concrete with curing compound.
 - 2. Cure concrete finished with pigmented mineral dry-shake hardener with a curing compound.
- F. Curing and Sealing 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. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

- G. Curing Paper: Cure with unwrinkled curing paper in pieces large enough to cover the entire width and edges of slab. Do not lap sheets. Fold curing paper down over paving edges and secure with continuous banks of earth to prevent displacement or billowing due to wind. Immediately repair holes or tears in paper.

3.8 SEALER APPLICATION

- A. Sealer: Apply uniformly in two coats in continuous operations according to manufacturer's written instructions. Allow first coat to dry before applying second coat, at 90 degrees to the direction of the first coat, using same application methods and rates.
 - 1. Begin sealing dry surface per manufacturer recommended timeframe after concrete placement.
 - 2. Allow stained concrete surfaces to dry before applying sealer.
 - 3. Thoroughly mix slip-resistance-enhancing additive into sealer before applying sealer according to manufacturer's written instructions. Stir sealer occasionally during application to maintain even distribution of additive.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Field inspection and testing will be performed under provisions of Section 014000.
- C. Prepare test and inspection reports. Maintain records of placed concrete items. Record date, location of pour, quality, air temperature, and test samples taken.

3.10 REPAIR AND PROTECTION

- A. Remove and replace decorative concrete paving that is broken or damaged or does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Detailing: Grind concrete "squeeze" left from tool placement. Color ground areas with slurry of color hardener mixed with water and bonding agent. Remove excess release agent with high-velocity blower.

- C. Protect decorative concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain decorative concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 32 1373 - CONCRETE PAVING JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Cold-applied joint sealants.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of joint sealant and accessory.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.

1.6 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS, 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.
 1. Primers: Product recommended in writing by joint sealant manufacturer for adhesion of sealant to joint substrates indicated, as determined from sealant compatibility and adhesion tests and prior experience.
- B. Colors of Exposed Joint Sealants: As selected by the Landscape Architect from manufacturer's full range for this characteristic. Submit color samples for review and approval.
- C. Joint-Sealant Backer Materials: Non-staining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint sealant manufacturer based on field experience and laboratory testing.
 1. Backer Strips for Cold - Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depths, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.
 2. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depths and prevent bottom-side adhesion of sealant.

2.2 COLD-APPLIED JOINT SEALANTS

- A. Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.
 1. Products: Subject to compliance with requirements, provide one of the following:

- a. Meadows, W.R., Inc.; Pourthane NS.
 - b. Dow Corning.
 - c. Pecora Corporation; Urexpan NR-200.
 - d. Sonneborn Building Products Div., ChemRex Inc.; SL2.
 - e. L.M. Scofield Company, Lithoseal Trafficalk-3g.
2. Color:
- a. Gray Concrete – Dow Corning, 888 grey silicone, as approved by Landscape Architect.
 - b. Color concrete areas – as selected by Landscape Architect from full range of manufacturer's standard colors.

2.3 JOINT-SEALANT BACKER MATERIALS

- A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.
- 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 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.

2.4 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

- A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
- B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions.
- C. 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.
- D. 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.

- E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
 - 1. 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.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING AND PROTECTION

- A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.
- B. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

END OF SECTION

SECTION 321400 - UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete pavers.
2. Curbs and edge restraints.

B. Related Requirements:

1. Section 321313 "Concrete Paving-Site" for concrete base under unit pavers.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For materials other than water and aggregates.
2. For the following:
 - a. Pavers.
 - b. Bituminous setting materials.
 - c. Mortar and grout materials.
 - d. Edge restraints.
 - e. Precast concrete curbs.
 - f. Granite curbs.

B. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C136.

C. Samples for Initial Selection: For each type of unit paver indicated[.][and the following:]

1. Joint materials involving color selection.
2. Exposed edge restraints involving color selection.
3. Precast concrete curbs.
4. Granite curbs.

D. Samples for Verification: For full-size units of each type of unit paver indicated.[Assemble no fewer than five Samples of each type of unit on suitable backing and grout joints.][Include Samples of the following:]

1. Joint materials.

2. Exposed edge restraints.
3. Precast concrete curbs.
4. Granite curbs.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Adhesion and Compatibility Test Reports: From latex-additive manufacturer for mortar and grout containing latex additives.
- C. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.
- D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.
 1. For solid interlocking paving units, include test data for freezing and thawing according to ASTM C67.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified unit paving installer. Installer's [field supervisor] [personnel assigned to the Work] must have Concrete Paver Installer Certification from the Interlocking Concrete Pavement Institute (ICPI) with [one of] [both of] the following designations:
 1. Residential Paver Technician Designation.
 2. Commercial Paver Technician Designation.
- 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. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 PRECONSTRUCTION TESTING

- A. Preconstruction Adhesion and Compatibility Testing: Submit to latex-additive manufacturer, for testing as indicated below, Samples of flooring materials that will contact or affect mortar and grout that contain latex additives.

1. Use manufacturer's standard test methods to determine whether mortar and grout materials will obtain optimal adhesion with, and will be nonstaining to, installed brick and other materials constituting brick flooring installation.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Store liquids in tightly closed containers protected from freezing.
- E. Store asphalt cement and other bituminous materials in tightly closed containers.

1.7 FIELD CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- B. Weather Limitations for Bituminous Setting Bed:
 1. Install bituminous setting bed only when ambient temperature is above 40 deg F and when base is dry.
 2. Apply asphalt adhesive only when ambient temperature is above 50 deg F and when temperature has not been below 35 deg F for 12 hours immediately before application. Do not apply when setting bed is wet or contains excess moisture.
- C. Weather Limitations for Mortar and Grout:
 1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
 2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and higher.

- a. When ambient temperature exceeds 100 deg F, or when wind velocity exceeds 8 mph and ambient temperature exceeds 90 deg F, set pavers within 1 minute of spreading setting-bed mortar.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 CONCRETE PAVERS

- A. Concrete Pavers, Solid Interlocking Paving Units: Complying with ASTM C936/C936M and resistant to freezing and thawing when tested according to ASTM C67, made from normal-weight aggregates.
 1. Thickness: 2-3/8 inches 3-1/8 inches Insert dimension.
 2. Face Size and Shape:
 - a. 3-7/8 inches 4-7/16 inches 8-7/8 inches 9 inches square.
 - b. 3-7/8-by-7-7/8-inch 4-by-8-inch 4-7/16-by-8-7/8-inch rectangle.
 - c. 5-1/2-inch octagon with attached 3-1/2-inch square 4-1/2-by-9-inch rectangle with saw-tooth edges 4-3/4-inch rectangular and trapezoidal units arranged in semicircular courses to produce fan-shaped pattern As indicated Insert dimensions and shape.
 3. Color: As indicated by manufacturer's designations Match Architect's sample As selected by Architect from manufacturer's full range Insert color.
- B. Concrete Pavers, Solid Paving Units, Normal-Weight Concrete: Solid paving units made from normal-weight concrete with a compressive strength not less than 5000 psi 6000 psi Insert value, water absorption not more than 5 percent according to ASTM C140, and no breakage and not more than 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C67.
 1. Thickness: 1-5/8 inches 1-3/4 inches 2 inches.
 2. Face Size and Shape:
 - a. 8-7/8 inches 9 inches 12 inches 18 inches 24 inches square.
 - b. 9-by-18-inch 12-by-24-inch rectangle.
 - c. As indicated Insert dimensions and shape.

3. Color: As indicated by manufacturer's designations Match Architect's sample As selected by Architect from manufacturer's full range Insert color.
- C. Concrete Pavers, Solid Paving Units, Lightweight Concrete: Solid paving units complying with ASTM C1491, made from lightweight concrete.
1. Thickness: 1-5/8 inches 1-3/4 inches 2 inches Insert dimension.
 2. Face Size and Shape: 9 inches square 12 inches square 18 inches square As indicated Insert dimensions and shape.
 3. Color: As indicated by manufacturer's designations Match Architect's sample As selected by Architect from manufacturer's full range Insert color.

2.3 CURBS AND EDGE RESTRAINTS

- A. Job-Built Concrete Edge Restraints: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 3000 psi.

2.4 ACCESSORIES

- A. Cork Joint Filler: Preformed strips complying with ASTM D1752, Type II.
- B. Compressible Foam Filler: Preformed strips complying with ASTM D1056, Grade 2A1.

2.5 AGGREGATE SETTING-BED MATERIALS

- A. Graded Aggregate for Subbase: Sound, crushed stone or gravel complying with ASTM D448 for Size No. 57 ASTM D2940/D2940M, subbase material requirements in Section 312000 "Earth Moving" for subbase material.
- B. Graded Aggregate for Base: Sound, crushed stone or gravel complying with ASTM D448 for Size No. 8 ASTM D2940/D2940M, base material requirements in Section 312000 "Earth Moving" for base course.
- C. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33/C33M for fine aggregate.
- D. Stone Screenings for Leveling Course: Sound stone screenings complying with ASTM D448 for Size No. 10.
- E. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 sieve.

1. Provide sand of color needed to produce required joint color.
- F. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
1. Survivability: Class 2, AASHTO M 288.
 2. Apparent Opening Size: No. 60 sieve, maximum; ASTM D4751.
 3. Permittivity: 0.02 per second, minimum; ASTM D4491.
 4. UV Stability: 50 percent after 500 hours' exposure, ASTM D4355.
- G. Drainage Geotextile: Nonwoven needle-punched geotextile fabric, 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 per test methods referenced:
1. Survivability: Class 2, AASHTO M 288.
 2. Apparent Opening Size: No. 40 sieve, maximum; ASTM D4751.
 3. Permittivity: 0.5 per second, minimum; ASTM D4491.
 4. UV Stability: 50 percent after 500 hours' exposure, ASTM D4355.
- H. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

2.6 BITUMINOUS SETTING-BED MATERIALS

- A. Primer for Base: ASTM D2028/D2028M, cutback asphalt, grade as recommended by unit paver manufacturer.
- B. Fine Aggregate for Setting Bed: ASTM D1073, No. 2 or No. 3.
- C. Asphalt Cement: ASTM D3381/D3381M, Viscosity Grade AC-10 or Grade AC-20.
- D. Neoprene-Modified Asphalt Adhesive: Paving manufacturer's standard adhesive consisting of oxidized asphalt combined with 2 percent neoprene and 10 percent long-fibered mineral fibers containing no asbestos.
- E. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 sieve.
1. Provide sand of color needed to produce required joint color.

2.7 MORTAR SETTING-BED MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or Type II.

- B. Hydrated Lime: ASTM C207, Type S.
- C. Sand: ASTM C144.
- D. Latex Additive: Manufacturer's standard acrylic resin styrene-butadiene-rubber water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.
- E. Thin-Set Mortar for Bond Coat: Latex-portland cement mortar complying with ANSI A118.4.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ARDEX Americas.
 - b. Boiardi Products Corporation; a QEP company.
 - c. Bostik, Inc.
 - d. C-Cure.
 - e. Custom Building Products.
 - f. H.B. Fuller Construction Products Inc. / TEC.
 - g. Jamo Inc.
 - h. Laticrete International, Inc.
 - i. MAPEI Corporation.
 - j. Parex USA, Inc.
 - k. ProSpec; H.B. Fuller Construction Products Inc.
 - l. Sakrete; CRH Americas, Oldcastle APG.
 - m. Southern Grouts & Mortars, Inc.
 - n. Summitville Tiles, Inc.
 - 2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
 - 3. Provide prepackaged, dry-mortar mix combined with acrylic resin styrene-butadiene-rubber liquid-latex additive at Project site.
 - 4. Provide product that is approved by manufacturer for application thickness of 5/8 inch.
- F. Water: Potable.
- G. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2 by 2 inches by 0.062 inch in diameter; comply with ASTM A1064/A1064M except for minimum wire size.

2.8 GROUT MATERIALS

- A. Sand-Portland Cement Grout: ANSI A108.10, made of white or gray cement and white or colored aggregate as required to produce color indicated.
 - 1. Colored Mortar Pigments for Grout: Natural and synthetic iron and chromium oxides, compounded for use in mortar and grout mixes. Use only pigments that have proved, through testing and experience, to be satisfactory for use in portland cement grout.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Davis Colors.
 - 2) Lanxess Corporation.
 - 3) Solomon Colors Inc.
- B. Standard Cement Grout: ANSI A118.6, sanded.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Boiardi Products Corporation; a QEP company.
 - b. Bostik, Inc.
 - c. C-Cure.
 - d. Custom Building Products.
 - e. H.B. Fuller Construction Products Inc. / TEC.
 - f. Jamo Inc.
 - g. Laticrete International, Inc.
 - h. MAPEI Corporation.
 - i. Parex USA, Inc.
 - j. ProSpec; H.B. Fuller Construction Products Inc.
 - k. Sakrete; CRH Americas, Oldcastle APG.
 - l. Southern Grouts & Mortars, Inc.
 - m. Summitville Tiles, Inc.
 - 2. Polymer Type:
 - a. Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.
 - b. Acrylic resin styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix.
- C. Grout Colors: As indicated by manufacturer's designations Match Architect's samples As selected by Architect from manufacturer's full range Insert color.
- D. Water: Potable.

2.9 BITUMINOUS SETTING-BED MIX

- A. Mix bituminous setting-bed materials at an asphalt plant in approximate proportion, by weight, of 7 percent asphalt cement to 93 percent fine aggregate unless otherwise indicated. Heat mixture to 300 deg F.

2.10 MORTAR AND GROUT MIXES

- A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimal performance characteristics. Discard mortars and grout if they have reached their initial set before being used.
- B. Mortar-Bed Bond Coat: Mix neat cement and latex additive water to a creamy consistency.
- C. Portland Cement-Lime Setting-Bed Mortar: Type M complying with ASTM C270, Proportion Specification.
- D. Latex-Modified, Portland Cement Bond Coat: Proportion and mix portland cement, aggregate, and liquid latex for bond coat to comply with written instructions of liquid-latex manufacturer.
- E. Job-Mixed Portland Cement Grout: Proportion and mix job-mixed portland cement and aggregate grout to match setting-bed mortar except omit hydrated lime and use enough water to produce a pourable mixture.
 - 1. Pigmented Grout: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1 to 10, by weight.
- F. Packaged Grout: Proportion and mix according to grout manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces indicated to receive unit paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

- B. Where unit paving is to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations, including areas where waterproofing system is turned up or flashed against vertical surfaces.
- C. Proceed with installation only after unsatisfactory conditions have been corrected and waterproofing protection is in place.

3.2 PREPARATION

- A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.
- B. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.
- C. Proof-roll prepared subgrade according to requirements in Section 312000 "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive subbase course for unit pavers.

3.3 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.
- B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- C. Cut unit pavers with motor-driven masonry saw equipment 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.
 - 1. For concrete pavers, a block splitter may be used.
- D. Handle protective-coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.
- E. Joint Pattern: As indicated on plans.
- F. Pavers over Waterproofing: Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.

1. Provide joint filler at waterproofing that is turned up on vertical surfaces.

G. Tolerances:

1. Do not exceed 1/32-inch unit-to-unit offset from flush (lippage) or 1/8 inch in 10 feet from level, or indicated slope, for finished surface of paving.
2. Do not exceed 1/16-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches and 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.

H. Expansion and Control Joints:

1. Provide for sealant-filled joints at locations and of widths indicated. Provide compressible foam filler as backing for sealant-filled joints unless otherwise indicated; where unfilled joints are indicated, provide temporary filler until paver installation is complete. Install joint filler before setting pavers. Sealant materials and installation are specified in Section 079200 "Joint Sealants."
2. Provide cork joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.

I. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
2. For metal edge restraints with top edge exposed, drive stakes at least 1 inch below top edge.
3. Install job-built concrete edge restraints to comply with requirements in Section 033000 "Cast-in-Place Concrete."
4. Where pavers set in mortar bed are indicated as edge restraints for pavers set in aggregate setting bed, install pavers set in mortar and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.
5. Where pavers embedded in concrete are indicated as edge restraints for pavers set in aggregate setting bed, install pavers embedded in concrete and allow concrete to cure before placing aggregate setting bed and remainder of pavers. Hold top of concrete below aggregate setting bed.

3.4 AGGREGATE SETTING-BED APPLICATIONS

- A. Compact soil subgrade uniformly to at least 95 percent of ASTM D698 laboratory density.

- B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- C. Place separation geotextile over prepared subgrade, overlapping ends and edges at least 12 inches.
- D. Place aggregate subbase and base, compact by tamping with plate vibrator, and screed to depth indicated.
- E. Place aggregate base, compact to 100 percent of ASTM D1557 maximum laboratory density, and screed to depth indicated.
- F. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches.
- G. Place leveling course and screed to a thickness of 1 to 1-1/2 inches, taking care that moisture content remains constant and density is loose and uniform until pavers are set and compacted.
- H. Treat leveling course with herbicide to inhibit growth of grass and weeds.
- I. Set pavers with a minimum joint width of 1/16 inch and a maximum of 1/8 inch, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch with pieces cut to fit from full-size unit pavers.
 - 1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.
- J. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.
 - 1. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches of uncompacted pavers adjacent to temporary edges.
 - 2. Before ending each day's work, compact installed concrete pavers except for 36-inch width of uncompacted pavers adjacent to temporary edges (laying faces).
 - 3. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches of laying face.

4. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.
- K. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.
- L. Do not allow traffic on installed pavers until sand has been vibrated into joints.
- M. Repeat joint-filling process 30 days later.

3.5 BITUMINOUS SETTING-BED APPLICATIONS

- A. Apply primer to concrete slab or binder course immediately before placing setting bed.
- B. Prepare for setting-bed placement by locating 3/4-inch- deep control bars approximately 11 feet apart and parallel to one another, to serve as guides for striking board. Adjust bars to subgrades required for accurate setting of paving units to finished grades indicated.
- C. Place bituminous setting bed where indicated, in panels, by spreading bituminous material between control bars. Spread mix at a minimum temperature of 250 deg F. Strike setting bed smooth, firm, even, and not less than 3/4 inch thick. Add fresh bituminous material to low, porous spots after each pass of striking board. After each panel is completed, advance first control bar to next position in readiness for striking adjacent panels. Carefully fill depressions that remain after removing depth-control bars.
 1. Roll setting bed with power roller to a nominal depth of 3/4 inch. Adjust thickness as necessary to allow accurate setting of unit pavers to finished grades indicated. Complete rolling before mix temperature cools to 185 deg F.
- D. Apply neoprene-modified asphalt adhesive to cold setting bed by squeegeeing or troweling to a uniform thickness of 1/16 inch. Proceed with setting of paving units only after adhesive is tacky and surface is dry to touch.

- E. Place pavers carefully by hand in straight courses, maintaining accurate alignment and uniform top surface. Protect newly laid pavers with plywood panels on which workers can stand. Advance protective panels as work progresses, but maintain protection in areas subject to continued movement of materials and equipment to avoid creating depressions or disrupting alignment of pavers. If additional leveling of paving is required, and before treating joints, roll paving with power roller after sufficient heat has built up in the surface from several days of hot weather.
- F. Joint Treatment: Place unit pavers with hand-tight joints. Fill joints by sweeping sand over paved surface until joints are filled. Remove excess sand after joints are filled.

3.6 MORTAR SETTING-BED APPLICATIONS

- A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
- B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Do not exceed 1/16-inch thickness for bond coat. Limit area of bond coat to avoid its drying out before placing setting bed.
- C. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
- D. Place reinforcing wire over concrete subbase, lapped at joints by at least one full mesh and supported so mesh becomes embedded in the middle of mortar bed. Hold edges back from vertical surfaces approximately 1/2 inch.
- E. Place mortar bed with reinforcing wire fully embedded in middle of mortar bed. Spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
- F. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.
- G. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16-inch- thick bond coat to mortar bed or to back of each paver with a flat trowel.
- H. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.

- I. Spaced Joint Widths: Provide [3/8-inch] [1/2-inch] [3/4-inch] nominal joint width with variations not exceeding plus or minus [1/16 inch] [1/8 inch] [3/16 inch].
- J. Grouted Joints: Grout paver joints complying with ANSI A108.10.
- K. Grout joints as soon as possible after initial set of setting bed.
 - 1. Force grout into joints, taking care not to smear grout on adjoining surfaces.
 - 2. Clean pavers as grouting progresses by dry brushing or rubbing with dry burlap to remove smears before tooling joints.
 - 3. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
 - 4. If tooling squeezes grout from joints, remove excess grout and smears by dry brushing or rubbing with dry burlap and tool joints again to produce a uniform appearance.
- L. Cure grout by maintaining in a damp condition for seven days unless otherwise recommended by grout or liquid-latex manufacturer.

3.7 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace unit 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.
- B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.
- C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.
 - 1. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to paver and grout manufacturers.
 - 2. Do not allow protective coating to enter floor drains. Trap, collect, and remove coating material.

END OF SECTION

SECTION 321813 - SYNTHETIC TURF SYSTEM SURFACING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, equipment, and materials to install synthetic turf and infill onto the project areas as indicated on the Drawings and in this specification. Work shall include but is not limited to:
 - 1. Review installation of Dynamic Stone base finish surface and survey certification documents provided to the Owner by the Base Contractor prior to commencing work in this specification section.
 - 2. Install synthetic turf surface including all seams and related finish work.
 - 3. Attach turf at perimeter nailer as indicated on the drawings and recommended by Manufacturer/vendor.
 - 4. Provide (8) year warranty for all Synthetic Turf components and installation.
 - 5. Provide Owner with turf maintenance training.
 - 6. Post Construction Testing / observation / maintenance

1.2 RELATED WORK

- A. Examine Contract Documents for Specification Sections that affect work of this Section.
 - 1. 033000 – Cast-in-Place Concrete
 - 2. 321823 – Synthetic Turf Subsurface and Drainage System

1.3 REFERENCES

- A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirement shall govern. Unless otherwise noted or specified, all work under this Section shall conform to the latest edition as applicable.
 - 1. Organizations and Governing Bodies
 - a. American Association of State Highway and Transportation Officials (AASHTO):
 - b. Occupational Safety and Health Administration (OSHA)
 - c. Department of Transportation Standard Specifications
 - d. American Society for Testing and Materials (ASTM)
 - e. Consumer Products Safety Commission (CPSC)

- f. Synthetic Turf Council (STC)
- g. American Sports Builders Association (ASBA)

2. ASTM Standard Test Methods

- a. D1577 – Standard Test Method for Linear Density of Textile Fiber
- b. D5848 – Standard Test Method for Mass Per Unit Area of Pile Yarn Floor Covering
- c. D418 – Standard Test Method for Testing Pile Yarn Floor Covering Construction
- d. D1338 – Standard Test Method for Tuft Bind of Pile Yarn Floor Coverings
- e. D1682 – Standard Method of Test for Breaking Load and Elongation of Textile Fabrics
- f. D5034 – Standard Test Method of Breaking Strength and Elongation of Textile Fabrics (Grab Test)
- g. F1015 – Standard Test Method for Relative Abrasiveness of Synthetic Turf Playing Surfaces
- h. F1551 – Standard Test Methods for Water Permeability
- i. D2859 – Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials
- j. F355 – Standard Test Method for Shock-Absorbing Properties of Playing Surfaces
- k. F1936 – Standard Test Method for Shock-Absorbing Properties of North American Football Field Playing Systems as Measured in the Field
- l. D1557 – Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.

1.4 DEFINITIONS

- A. Dynamic Stone Base & Topping Stone: Materials applied as part of the drainage system / base below the Synthetic Turf Surface System.
- B. Base Contractor – The contractor who shall complete the preparation, construction and installation of the turf area finish subgrade, sub-drainage, turf perimeter nailer, dynamic base stone and finishing stone.
- C. Synthetic Turf Vendor – The synthetic turf company/manufacturer who will provide all the materials and the warranty over the final product.
- D. Synthetic Turf Contractor – The Company working for the Vendor who shall oversee the installation of the turf area surface and infill.
- E. Synthetic Turf Installer/Foreman/Superintendent – The individual who will be on-site installing and overseeing the actual turf area installation.

1.5 SUBMITTALS

A. Synthetic Turf Vendor Product Data and Certifications:

1. Submit the fiber manufacturer's name, type of fiber and composition of fiber
2. Submit manufacturer's specifications, installation instructions and care requirements for the synthetic turf, seaming system, glues, and infill materials.
3. Submit letter and specifications sheet certifying that the products of this specification Section meet or exceed specified requirements.

B. Synthetic Turf Vendor Material Samples and Test Reports:

1. Synthetic Turf

- a. Submit (3) samples of each product specified in this section with backing, approximately 7" x 11". Color and turf sample to be approved by Owner and or its representatives.

2. Seams

- a. Submit glued seam per manufacturers' recommendation.
- b. Submit adhesives technical specification.
- c. Submit (3) samples 11" long seaming tape.

3. Certified copies of independent (third-party) ASTM laboratory reports (New/current) including but not limited to the following:

- a. Impact Attenuation, Gmax - F-355/F1936, Procedure A (system)
- b. Average Tuft Height – D5823
- c. Total Fabric Weight without infill - D5848
- d. Average Pile Yarn Weight D5848
- e. Pile Height, Face Width and Total Fabric Weight D5848 or D418
- f. Primary & Secondary Backing Weights – D5848 or D418
- g. Tuft Bind without infill – D1335
- h. Grab Tear Strength – D5034
- i. Fiber Breaking Strength, Elongation - Glued Seam Turf Sample D5034
- j. Machine Gauge, Stitches per 3 inches – D5793
- k. Infiltration Rate – BS7044 Method 4
- l. Water Permeability with infill D4491
- m. Yarn Denier – ASTM D1907-07
- n. Fiber Thickness – D3218
- o. Total Lead Content F2765-09
- p. Accessibility of Surface F1951

C. References / Successful Installations

1. Certified list of successful existing installations, including Owner representative and telephone number, attesting compliance with quality assurance information.
- D. Quality assurance information
 1. Submit to Owner for approval as delineated in Quality Assurance below in this Specification section.
- E. Qualifications Statements
 1. Submit experience requirements as described in the Quality Assurance portion of this specification.
- F. Supplier List
 1. Submit list of procured and contracted suppliers of all materials required for the Synthetic Turf System.
- G. Turf Vendor / Turf Contractor Review
 1. Turf Contractor to submit signed written statement on company letterhead, stating that the Drawings and Specifications have been reviewed by qualified representatives of the materials manufacturer, and that they are in agreement that the materials and system to be used for synthetic area surfacing are proper and adequate for the applications shown.
- H. Statement of Supervision
 1. Upon completion of the Work, Synthetic Turf Vendor to submit a signed written statement on company letterhead stating that the turf area supervision by the manufacturer's representative (Turf Contractor) was sufficient to ensure proper application of the complete system and materials, that the Work was installed in accordance with the Contract Documents, and that the installation is acceptable to the manufacturer.
- I. Synthetic Turf Product Safety Statement
 1. The Turf Vendor/Manufacturer shall submit a signed statement on company letterhead that provides certification through an independent testing source that the product being installed on the project complies with the United States Consumer Product Safety Commission's most stringent requirement for lead content (below 100 ppm) and is safe for use by all ages and to the environment.
- J. Warranty

1. Turf Vendor shall provide a sample written full labor and full materials warranty for the time duration and in compliance with the requirements of the Warranty/Guarantee section of this specification for the synthetic turf and infill.

K. Delivery Slips

1. The Turf Contractor to submit all delivery slips during construction for infill materials to assure that the proper ratio of sand is in general acceptance of the project requirements.

L. Owner's Manual and Training

1. Submit OM Manual as described in this specification.
2. Include record document(s) showing actual locations of seams, drains or other pertinent information.
3. Submit on a thumb drive a digital copy of the filmed Owner training.

1.6 QUALITY ASSURANCE

A. Experience

1. The experienced Synthetic Turf Installer shall have the following qualifications;
 - a. Minimum experience of at least 5 years, actively selling, installing and maintaining in-fill synthetic turf project of similar size.
 - b. Must have previously installed at least Fifteen (15) successful outdoor full sized (35,000 square feet or larger) synthetic turf infilled fields, play areas of similar material and infill within the past three (3) years.
 - c. Shall be an established, insured installation firm experienced as a premium, manufacturer certified turf installer with suitable equipment and supervisory personnel, with a minimum of 5 years' experience with 15-foot-wide tufted materials.
 - d. Shall be trained and certified, in writing, by the turf manufacturer, as competent in the installation of the specified material, including seaming and proper installation of the infill mixture.
2. Synthetic turf shall be installed by only certified crews approved by the Synthetic Turf Manufacturer/Vendor and employed by the General Contractor, (if different) in strict accordance with manufacturer's recommendations and instructions including but not limited to fabric, adhesives, seaming and abutting or attaching to adjacent materials.
3. The synthetic turf installer superintendent shall have supervised the installation of at least ten (10) outdoor systems of similar to this specified project within the last three (3) year period. This foreman shall be directly employed by the Turf Installer/Contractor.
 - a. Include a listing of other on-site personnel and their experience.
4. The Contractor shall not replace the named individuals for the duration of the contract unless the substitute individuals have equivalent qualifications as approved by the Owner.
5. The Synthetic Turf Contractor and the Synthetic Turf Manufacturer/Supplier must have been in business under the same ownership for at least three years and shall have been installing similar turf areas for that entire period.

1.7 QUALITY CONTROL

A. Source

1. Obtain Synthetic Turf product including tufted or woven synthetic turf yarn, carpet backings and infill materials from a single Synthetic Turf Manufacturer.

2. Provide additional system components including anchoring materials, seaming products, binders and adhesives, and resilient underlayment meeting the criteria of this Specification Section from single sources.
- B. During Construction: Submit samples of each of the following during mass production of gravel materials for performance testing and prior to shipping.
1. Infill Materials:
 - a. Random samples may be pulled from bulk packages or piles on-site at the discretion of the Owner or its representatives. Number of samples at the Owners discretion. The samples shall be tagged and marked from the packages for future reference after testing is complete. Sieve analysis testing results shall be compared to Vendor's previously submitted analysis for the infill materials for approval. Packages that do not meet approval shall be removed from site. Initial testing shall be paid for by the Contractor. Retesting shall be at the Contractors expense. Additional screening of materials by Contractor to remove fines may be required at Owners sole discretion at no additional cost to Owner.
 2. Environmental Conditions
 - a. Install synthetic turf surfacing only when ambient air temperature is 40 degrees F or above and the relative humidity is below 35% or as specified by the product manufacturer. Installation will not proceed if rain is imminent.
 - b. Install product only when prepared base is suitably free of dirt, dust, and petroleum products, is moisture free and sufficiently secured to prevent unwanted pedestrian and vehicular access.
 3. Inspection / Acceptance
 - a. Installation of synthetic turf surfacing shall be done only after dynamic stone base, ground boxes, drainage, perimeter anchor, fencing and or other structures or construction work which might injure it has been completed. Damage caused to stone base finish grade or to the turf installation during construction shall be repaired prior to acceptance/Substantial Completion to the satisfaction of the Owner.
 4. Protection
 - a. The Synthetic Turf Contractor shall be responsible for the protection of the synthetic turf surface and product after its' installation through Substantial Completion.

1.8 DELIVERY, STORAGE AND HANDLING

- A. All materials shall be delivered and stored within the Contractor's work limits or in an area approved by the Owner. Materials shall be inspected for damage immediately upon delivery.
- B. All material shall be stored in strict accordance with the manufacturer's recommendations.
- C. Special care shall be exercised during delivery and storage to avoid damage to the products.
- D. Packaged Materials:
 - 1. Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery, and while stored at site.

1.9 PROJECT CONDITIONS

- A. Adhesives should not be applied within 12 hours after rainfall, or when rainfall is forecast.
- B. No part of the construction shall be conducted during a rainfall or when rainfall is imminent, or unless both ambient and materials temperatures are at least 40 degrees F and rising.

1.10 COMPLETION AND FINAL ACCEPTANCE

- A. Refer to 321823 - Synthetic Turf Subsurface and Drainage System for Base Work completion items prior to commencement of Synthetic Turf Surface installation.
- B. General: Synthetic Turf area completion shall be separated into 2 phases, "Preliminary Completion" and "Substantial Completion."
- C. Preliminary Completion: Scheduled date for preliminary completion shall be at least 10 calendar days before Substantial Completion. Notify Owner and its representatives in writing, 7 days prior to scheduled date for observation for "Preliminary Completion." To be considered "Preliminarily Complete" the following items shall be provided and achieved:
 - 1. Items as previously installed and approved in Section 321823 - Synthetic Turf Subsurface and Drainage System
 - a. Turf Installer also accepted this work as part of commencement of work scope in this specification section.
 - 2. Synthetic turf installed.

3. Smooth, level playing surface level to grading tolerances.
4. In ground accessories adjusted and set to finish grade.
 - a. Coordinated with Base Installer. Base Installer to adjust.

D. Substantial Completion: After "Preliminary Completion" observation, the Landscape Architect/Engineer and Owner shall prepare and submit to the Contractor, a punch list of items to be completed to achieve "Substantial Completion". Contractor shall notify the Landscape Architect /Engineer and Owner in writing, 5 days prior to a requested date for a site observation to meet "Substantial Completion." To be considered "Substantially Complete" or "Playable" the following items shall be jointly provided by the Base Installer / Turf Installer / Turf Manufacturer:

1. All "Preliminary Completion" punch list items are complete.
2. Submit five (5) copies of written operating and maintenance instructions. Provide format and contents as directed by the Engineer. This should include all necessary instructions for the proper care and preventative maintenance of the synthetic turf system, including painting and markings. Also address remedial measures for graffiti removal.
3. Submit (5) copies of all vendors and products used including websites, phone numbers and contacts.
4. Submit (5) copies of all certified surveys performed during construction for Quality Control.
5. Written warranties/guarantees with documentation that applicable forms have been completed in Owner's name and registered with the Manufacturer.
6. Stockpiling or storage of required "attic stock" materials.
7. Upon completion of the synthetic turf system surface, the contractor shall provide the Owner with 2 hours of maintenance training that shall be recorded on a video tape and supplied to the Owner. Instruct the Team or Owner's personnel in the operation of the water and other systems.

1.11 WARRANTY/GUARANTEE – SYNTHETIC TURF SURFACE SYSTEM

- A. General: Warranties / Guarantees specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and are in addition to and run concurrent with other warranties/guarantees made by the Contractor under requirements of the Contract Documents.
- B. Installer/Manufacturer Guarantee: The President(s) of both the synthetic turf contractor and the synthetic turf manufacturer (if different) shall sign this document and it shall include the following:
 1. The turf product and its infill materials (defined as the turf system) shall be free from defects of material and workmanship for a period of fifteen (15) years from date of Substantial Completion. Defects shall include, but not be limited to ultraviolet ray fading, degradation, or excessive wear of fiber.

2. Synthetic turf product as specified and represented by the Turf manufacturer/vendor.
3. All materials and products as specified.
4. Synthetic turf / infill / backing (turf surface system) shall be guaranteed to have a percolation rate (drain vertically) greater than 6 inches per hour without prolonged accumulation of surface water. If the synthetic turf system does not drain in accordance with this Specification, then punching the carpet backing or any method creating additional holes in the backing other than the designed drainage holes will not be permitted. The removal and replacement of the infill will be permitted given there is not damage to the fibers in the process.
5. The synthetic turf materials shall not fade, (significant loss of color) fail, wrinkle or show excessive wear.
6. The Warranty shall contain no usage limits for warranted turf system.
7. The exposed turf surface shall not decrease more than 10% per year according to ASTM D5848, nor exceed 50% during the warranty period. Portions of the synthetic turf area that fail to meet these standards shall be replaced in both materials and labor by the Contractor.
8. Turf product shall be adaptable to painted lines.
9. Seams shall not separate, become unglued or detached.
10. The entire turf system shall be resistant to weather, insects, rot, mildew and fungus growth and be non-allergenic and non-toxic.
11. The entire turf system shall retain maximum dimensional stability, resist damage and provide normal wear for its designated use.
12. Adhesives used shall be resistant to moisture, bacteria, fungus and resist ultraviolet rays.
13. Guarantee shall include removal and replacement of materials (parts and labor) not performing to the standards described and as required to repair synthetic turf surfacing at no cost to the Owner.
14. Any defects will be remedied on written notice at no additional cost to the Owner.
15. The 8-year warranty shall not be prorated.

1.12 INFRINGEMENT / HOLD HARMLESS

- A. The synthetic turf manufacture and its installer(s) are responsible for ascertaining that means and methods of the products and services which they are providing are not being provided in violation of any patent rights held by their competitors or manufacturers of other products. Their responsibilities are as follows:
 1. The Synthetic Turf Vendor shall provide a signed letter on company letterhead holding the Owner, Owner's Representative and all other project consultants harmless for any violation of patent rights or infringement. The Contractor shall also cover the legal defense costs, turf replacement and any other costs (as applicable) incurred by the Owner and its representatives related to infringement of any current or future patent issued for the synthetic surfacing system.
 2. The Synthetic Turf Vendor shall provide a signed letter on company letterhead holding the Owner, Owner's Representative and all other project consultants

harmless for lawsuits that may occur due to the product manufacture or make up in regard to health and safety.

3. The Synthetic Turf Vendor shall bear any legal, material, service or other costs incurred to the Owner or its representative's due to any patent right infringements.

- B. If any product or services proposed to be provided by the Synthetic Turf Vendor and or its installers are known by them to be subject to any existing claims of infringement, Synthetic Turf Vendor and or its installers shall notify the Owner and the Owner's Representative of such claim and provide evidence of financial ability to perform on the above hold-harmless requirements.

PART 2 - PRODUCTS

2.1 EARTHWORK MATERIALS

- A. Work performed prior to installation of Synthetic Turf Surface.
- B. Earthwork materials shall meet the requirements of Specification "Earth Moving" and "Synthetic Turf Subsurface and Drainage System".

2.2 PERIMETER TURF ANCHOR/NAILER

- A. Work performed prior to installation of Synthetic Turf Surface and consisting of the perimeter turf anchor/nailer, located at the perimeter or turf edges. Turf Contractor to attach synthetic turf product to this perimeter nailer as specified in this specification.

2.3 SYNTHETIC TURF PRODUCT

- A. General:
 1. New outdoor Synthetic Turf System comprised of synthetic turf fibers tufted or woven into a backing, leaving height of exposed fiber per product as recommended and warranted by the manufacturer. The tufted synthetic turf is comprised of either nylon or polyethylene pile sewn into a polyurethane backing.
 2. Selection of these products represents the required minimum performance criteria as outlined herein. The manufacturer's performance criteria and product properties and declarations both physical and chemical are as represented by the manufacturers at the time of this solicitation. Approved equals must be pre-bid approved.
- B. Systems and Manufacturers:
 1. Turf Products

- a. Turf Product Basis of Design: SYNBLUE 949
 - b. Or approved equal
- 2. Turf Manufacturer
 - a. SynLawn:
- C. Appearance/Feel:
 - 1. The finished surface shall appear as mowed grass with no irregularities.
- D. Seams
 - 1. Either sewn or glued seams and as recommended, warranted and approved by the Turf Manufacturer.
 - 2. Glued seams
 - a. Adhesives for bonding tufted synthetic turf shall be as recommended and warranted by the synthetic turf manufacturer. Adhesives shall be one-part moisture cured polyurethane
 - 1) Nordot #34G (Synthetic Surfaces (908) 233-6803), Mapei 2G, or approved equal and as recommended by the Turf Manufacturer / Installer.
 - b. Work in adverse weather is discouraged. If necessary, Turf Installer / Vendor shall recommend amendments to the adhesive that if approved by the Owner and its representatives shall meet all requirements of the warranty and bear no cost implications to the Owner in materials or labor.
- E. Synthetic Turf Products and Physical Properties
 - 1. Turf Product: SynBlue 949 or approved equivalent
 - a. Roll Width: 15 ft
 - b. Grass Zone Yarn/Color: Polyethylene / Olive
 - c. Grass Zone Denier / ends: 9,900/ 9
 - d. Thatch Zone Yarn/Color: polyethylene / field green/beige blend
 - e. Thatch Zone Denier / ends: 5,000/8
 - f. Finished Pile Height: 1-7/8 inch
 - g. Face Weight: 90 oz / sq y
 - h. Total Fabric Weight: 118 oz / sq yd
 - i. Primary Backing Weight: 6oz / sq yd
 - j. Secondary Coating Weight: 22oz / sq yd
 - k. Tuft Bind: >8
 - l. Machine guage: 1/2- inch
 - m. Water Permeability: >400 inches / hr

- n. Other Features: EnviroLoc, Heatblock, DeLuster, UV Stabilizers
- o. Seaming: Micromechanical bonding
- p. Infill: 1 lb. sand psf. required

2.4 SPARE PARTS/ATTIC STOCK

- A. Stockpile Materials: Provide the following additional materials stored as directed by the Owner.
 - 1. Turf: Material may be end of rolls or cutoffs. Minimum size of turf shall be 5 x 15. Provide the following minimum materials for each product and store as directed by the Owner.
 - a. Turf: 100 square feet for each product specified

PART 3 - EXECUTION

3.1 EXAMINATION AND PROTECTION

- A. Verification of Conditions: Examine areas and conditions under which all work of this Section is being performed. Review certified survey submitted to the Owner by the Base Contractor for elevations on the finished topping stone. Use string lines or other procedures to verify uniformity of finish topping stone. Do not proceed with any work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of all areas and conditions.
- B. Protection of Work this Contract: Protect all on-going work, so as not to delay work due to weather or project related construction. This includes but is not limited to the use of tarps, geotextile, plywood and other protective measures.
- C. Protection of Persons and Property: Provide all necessary measures to protect workmen and passersby.
 - 1. Protect adjacent construction throughout the entire operation.
- D. Installation of synthetic surfacing shall be done only after excavation and construction work which might injure it has been completed. Damage caused during construction shall be repaired before acceptance.
- E. The Contractor shall coordinate the installation of the synthetic surface and the surrounding surfaces for optimum interface at all edges.

3.2 STONE BASE ACCEPTANCE

- A. The Turf installer shall submit a written statement of acceptance and acknowledgment of the following;
 - 1. On-site visual observation of the synthetic turf area. Installer should minimally observe overall planarity, overall area compaction, compaction at the turf anchor and perimeter condition.
 - 2. Review of the certified base stone survey(s) of the area submitted previously by the Base Contractor
 - a. Base Stone Tolerance Requirements: The final elevation of the finished stone base is plus or minus one quarter inch at any point on the install area and on a 25 foot by 25-foot grid grade as indicated on the Contract Drawings.
 - b. Finish Stone Base Certification: A certified survey by a State licensed land surveyor with elevations noted on a 25-foot grid to verify required grade and elevation tolerances of the subgrade. The digital survey document indicates spot elevations and tenth of foot contours and was submitted to the Engineer/Owner for review and approval prior to moving to next part of work.
 - 3. Acknowledgement that the stone base and drainage systems appear to be functioning properly prior to beginning work for this section.
- B. Commencement of turf prep and or placement of turf by the Turf Installer indicates acceptance of the stone installation and no claims for extra work based upon these conditions shall be accepted.

3.3 TURF INSTALLATION PREP / DYNAMIC STONE BASE FINISH

- A. General
 - 1. The Synthetic turf installer shall maintain benchmarks, required lines, levels, contours and datum already established by the Base Contractor and only enhancing them to allow for a premier installation of the carpet. Any touch up grading or manipulation of the surface required by the Turf installer is to be coordinated with the Owner and/or it representative and the Base Contractor (if different) and at no additional cost to the Owner.
 - 2. If additional materials are required, only tested and approved stone materials from the original source and specification shall be used. Contract grading tolerances shall be met.

3.4 INSTALLATION OF SYNTHETIC TURF

- A. The installation of the Synthetic Turf product shall be performed in full compliance with the approved Shop Drawings and Manufacturers recommendations. Any variance from these requirements must be accepted in writing, by the Owner, verifying that the changes do not in any way affect the warranty.

- B. The Synthetic Turf Installer shall lay the turf system over the top of the dynamic base / topping stone previously approved and in place.
- C. Synthetic turf shall be installed by crews certified and or employed by the Synthetic Turf manufacturer, in strict accordance with manufacturer's recommendations and instructions including but not limited to, fabric, adhesives, seaming and abutting or attaching to adjacent materials.
- D. The synthetic turf carpet shall be installed with no wrinkles, ripples or bubbles. Shearing of fibers, slits in the fabric or driven spikes or staples to relieve such defects will not be permitted.
- E. Rolls that do not comply with the proper length or conform to the seaming diagram, as approved prior to installation, shall be rejected from the site. No fitted pieces shall be allowed to true alignment.
- F. Turf panel seams shall be glued with an adhesive as recommended by the synthetic turf manufacturer and installed per manufacturer's instructions. All seams shall be flat, tight and permanent with no separation or fraying.
- G. Glued seams shall only be installed in suitable weather conditions as per manufacturer's instructions and or warranty requirements. Any suggested modifications to the adhesive or methods used in unfavorable weather conditions shall be submitted with the full approval of the Turf Vendor to Owner and its representatives. This does not relinquish the responsibility of the Vendor or its installers from any warranty issues or claims throughout the warranty period.
- H. The turf installer shall glue/nail the turf edges to the perimeter anchor system at the edge of the install area as well as to all collars around other in ground boxes or structures.

3.5 CLEAN UP

- A. Remove from the Owners property all surplus excavated material not required for filling and backfilling, trash, and debris and dispose of it properly at Contractor's expense.
- B. At the end of each day, remove all scraps and other debris created by the synthetic turf installation from the install area.
- C. At end of turf installation and just prior to punch list, contractor to use magnetic device/equipment to remove all metallic materials on install area caused by construction.

3.6 TRAINING

- A. As part of Substantial Completion, The Turf Vendor / Turf Contractor shall provide the Owner with synthetic turf maintenance training as required in this Specification Section.

3.7 FINAL SUBMITTALS

- A. Refer to "Completion and Final Acceptance" Section in this Specification Section

END OF SECTION 321813

SECTION 321823 - SYNTHETIC TURF SUBSURFACE AND DRAINAGE SYSTEM

PART 1 - GENERAL

1.1 WORK NOT INCLUDED

- A. The area for this installation is located on the top of a building structure and as part of an outdoor courtyard surrounded by a residential building. The concrete structure and the fill materials used to achieve subgrade (elevation below the turf system finish stone base) is being performed by others and prior to commencement of the synthetic turf system as described in this specification section and the synthetic turf system surface specification section.

1.2 WORK INCLUDED

- A. Provide all labor, equipment and materials, and do work necessary to construct the finish Dynamic Stone Base onto the synthetic turf areas as indicated on the Drawings and per this specification. Work shall include but is not be limited to:

- 1. Drainage System Requirements

- a. Gravel drainage trench fill material.
- b. Panel drain pipe, collector pipe and fittings
- c. Dynamic Stone Base and Finish Stone
- d. Clean outs and inline structures/manholes Dynamic Stone Base and Finish Stone
- e. Certified grade elevation survey of dynamic stone base installation

- 2. Synthetic Turf Area Water System Requirements

- a. Refer to Landscape Irrigation System

- 3. Perimeter Anchor / Turf Edge Attachment

- a. Refer to Cast-in-place concrete curbing and Drawings

- 4. Synthetic Turf System Surfacing Installation

- a. Refer to Synthetic Turf System Surface Specification

1.3 RELATED WORK

A. Examine Contract Documents for requirements that affect work of this Section.

1. 325250 - Cast-in-Place Concrete Curbing
2. 321813 - Synthetic Turf System Surface

1.4 REFERENCES

A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirement shall govern. Unless otherwise noted or specified, all work under this Section shall conform to the latest edition as applicable.

1. Organizations and Governing Bodies

- a. American Association of State Highway and Transportation Officials (AASHTO):
- b. Occupational Safety and Health Administration (OSHA)
- c. American Public Works Association (APWA) for Earthwork Requirements
- d. American Society for Testing and Materials (ASTM):
- e. Synthetic Turf Council (STC)
- f. American Sports Builders Association (ASBA)
- g. American Wood Preservers' Association (AWPA):
 - 1) C2 Lumber, Timbers, Bridge Ties and Mine Ties
 - 2) Preservation Treatment by Pressure Processes

2. ASTM Standard Test Methods

- a. F 405 - Corrugated Polyethylene (PE) Tubing and Fittings
- b. F 449 - Subsurface Installation for Agricultural Drainage or Water Table Control
- c. F 667 - 8, 10, 12 and 15-inch Corrugated Polyethylene Tubing and Fittings

1.5 DEFINITIONS

- A. Finish sub-grade: Final elevations and grading modifications to be performed by others and prior to the work in this specification section. Approved and certified finish sub-grade must be met prior to Synthetic Turf system surface installation.
- B. Gravel Drainage material: Stone material that may be used by others to achieve finish subgrade below the dynamic stone base. This material should bridge with the dynamic stone base as described herein.
- C. Dynamic Stone Base: Approved stone material with the sizing and performance characteristics described herein. This stone material is installed immediately on top of the finished subgrade surface.

- D. Topping Stone: Approved stone material with the sizing and performance characteristics described herein. This stone material is installed immediately on top of the dynamic stone base to create a smooth surface for the placement of the synthetic turf system as well as to aid in achieving finish grade tolerances of the synthetic turf area subsurface.
- E. Turf Base Contractor – A specialty contractor who shall complete the preparation, construction and installation of the synthetic turf sub-drainage, turf anchor, dynamic base stone and finishing stone.
- F. Synthetic Turf Contractor – The Company working for the Turf Vendor who shall oversee the turf surface installation for the synthetic turf areas.

1.6 SUBMITTALS

- A. Manufacturer's Product Data: Submit manufacturer's specifications, test reports and installation instructions for all products in this specification section, including certifications and other data as may be required to show compliance with the Contract Documents. Included but not limited to the following; drainage pipe material, panel drains, perimeter turf anchoring system.
- B. Material samples. Submit three samples each of the following:
 - 1. Panel drain product approximately 6 inches in length, full width
 - 2. Gravel Materials
 - a. 1-gallon samples of dynamic stone, topping stone, and gravel trench stone (if proposed).
 - b. See Section 1.7, "Quality Control"
 - c. Stone Base Source List / Approvals / Certifications
- C. Schedule
 - 1. Work schedule for all work described in this specification section. The Contractor shall update the schedule at a minimum of 2-week intervals thru substantial completion
- D. References / Successful Installations
 - 1. Certified list of successful existing installations, including Owner representative and telephone number, attesting compliance with quality assurance information.
- E. Quality assurance information
 - 1. Submit to Owner for approval as delineated in Quality Assurance below in this Specification section.
- F. Supplier List

1. Submit list of procured and contracted suppliers of all materials required for this part of the Work

G. Qualifications Statements

1. Submit experience requirements as described in the Quality Assurance portion of this specification.

H. Turf Base Contractor Reference List (Refer to Quality Assurance)

I. Turf Base Contractor Job Superintendent/Foreman Resume (Refer to Quality Assurance)

J. Delivery Slips

1. The Turf Base Contractor to submit all delivery slips during construction for stone materials to assure their previous approval prior to shipping and source location.

[SEP]

K. Manufacturer's Review

1. Submit written statement, signed by Base Contractor and synthetic turf surfacing installer/contractor stating that the Drawings and Specifications have been reviewed by qualified representatives of the materials manufacturer, and that they are in agreement that the materials and system to be used for synthetic turf surfacing are proper and adequate for the applications shown

L. Site Acceptance Statements (Refer to Quality Assurance)

M. Photographic Documentation

1. Contractor to provide Owner and its representative's digital pictures of in progress work documenting work described in this Specification section

1.7 QUALITY ASSURANCE

A. Experience

1. The Turf Base Contractor performing the work in this specification section shall be a firm meeting the following criteria:
 - a. A minimum of ten (10) successful synthetic turf fields in the last three (3) years on projects comparable to this Scope of Work. Submit complete list of projects, including project description, date of completion, and contact information. Comparable projects shall minimally include but not be exclusive to the following Scope of Work;

- 1) Full field installations (75,000 sf or larger)
 - 2) Laser grading (not GPS) experience for subgrade, gravel and finished surface meeting the requirements for finish grade elevations required in this Contract
 - 3) Synthetic Turf field finish subgrade installation
 - 4) Synthetic Turf Field drainage system installation
 - 5) Synthetic Turf Field dynamic stone base installation and finished surface tolerances comparable to this project.
 - 6) Experience with testing protocols for dynamic stone base and finish course.
- b. Firms must have been in business under the same Ownership for at least three years and shall have been installing similar sports fields for that entire period.
2. The resume of the Turf Base Contractor's superintendent/foreman who will be on-site during the installation shall be provided showing a list of (5) successful projects for which he/she was responsible.
3. The Contractor shall not replace the named individuals for the duration of the contract unless the substitute individuals have equivalent qualifications as approved by the Owner.
4. The Base Contractor shall be responsible for the protection of the finish stone surface thru its acceptance and when installation work begins on the synthetic turf surface.
- B. All piping and appurtenances shall be new, clean and in accordance with material specifications, unless specifically noted on the plans.
- C. Size and classification shall be shown on the plans or as specified herein.
- D. Site Acceptance Statements:
 1. Prior to Base Contractor beginning Work on subgrade of synthetic turf areas:
 - a. Submit a written statement signed by the Synthetic Turf Base Contractor noting that the site has been reviewed and that documents showing compaction and certified elevations/planarity by others have been reviewed on the subgrade. Note all discrepancies, conflicts or other issues. If none are found this should be noted in the statement. Upon acceptance, Work shall begin with the assurance that all work shall be warranted for the period as specified in these Documents.
 2. Prior to Turf Contractor beginning work on Base installation:
 - a. Inspection and Acceptance: The Turf Base Contractor and the Synthetic Turf Contractor shall inspect the subgrade and drainage system to verify their

acceptance of installation and condition and shall confirm acceptance in writing. Commencement of subsequent installation in a given work area indicates acceptance of underlying substrates and systems.

- 1) The Base Contractor shall remain on site for the initial layout of the turf product by the Turf Contractor to verify that the work of the Base Contractor is not being damaged or altered in a way that would jeopardize conformance to the documents.
- 2) The intent and requirements of this Contract is that these two entities shall agree that base work prior to installation of the synthetic turf and just after installation of the turf conforms to the documents and to the standards of the Turf Manufacturer so that Warranty/Guarantee will be honored in full force by both parties.

- E. Grade Certifications: A certified survey by a State Licensed land surveyor shall be made at the top of the Finish Subgrade and at the top of the installed Dynamic Stone/Finishing Stone base to verify conformance to specified final elevations. GPS survey laser equipment shall not be used for any finish elevation determination. Equipment mounted laser and hub or similar are required for turf area grading operations. Survey shall include spots at a 25-foot grid for entire turf area and shall show tenth foot contours. Survey shall be set up so that spots begin from the exact center of the turf area and symmetrical in both directions. Spots shall include the extent/outer edge of the stone base work and the perimeter curb/turf anchor.

1.8 QUALITY CONTROL

- A. Pre-bid: Materials Inspection and Testing:

1. Bidders are encouraged to:

- a. Pre-test gravel drainage materials with an independent Testing Agent prior to submitting a bid. This does not guarantee that the materials or source will be approved for construction.
- b. Pre-qualify any material deviating from that specified.
- c. All costs associated with pre-bid testing shall be borne by the bidder.

- B. After Bid Award and Prior to construction: Submit samples of each of the following materials to establish Baseline specification and ratios for the remainder of the testing process.

1. Gravel Drainage Material: Provide a one-gallon sample of each gravel drainage source and for each type of gravel material to be used for testing. This could include:
 - a. Dynamic Base Stone
 - b. Topping Stone

- C. During Construction: Submit samples of each of the following during mass production of gravel materials for performance testing and prior to shipping.

1. Gravel Drainage/Dynamic Stone/Topping Stone Material:

- a. A minimum of one-gallon sample for every 500 cubic yards of each material used shall be tested by the Testing Agent for general compliance with the established Baseline specifications.

D. Testing Agent

- a. The Contractor shall hire a testing agent to certify and make recommendations regarding synthetic turf system materials. Turf Base Contractor shall notify the Owner/Construction Manager regarding timing, scheduling and use of these agents.
- b. Agent shall be independent, A2LA accredited, USGA recommended and insured.
- c. The Testing Agent shall perform testing of the turf system material components, including but not limited to dynamic stone and topping stone as well as to certify the capability of the dynamic stone base course to meet permeability and stability requirements before construction.
- d. The Testing Agent is to report/submit test results as they are known and simultaneously to the Turf Base Contractor, the Owner and its representatives.
- e. Potential Agents for Owner Consideration (A2LA Accredited, USGA Recommended)
- 1) Turf and Soil Diagnostics, Sam Ferro, (913) 723-3700
 - 2) Tifton Physical Soil Testing Laboratories, T. Powell Gaines, (229) 382-7292
 - 3) Thomas Turf Services, James Thomas, (979) 774-1600
- f. The Engineer shall recommend for owner approval or rejection based on results of the tests and recommendation of the Testing Agent.


2. The Contractor is required to use a licensed Land Surveyor registered in the State for all layout and engineering work.

1.9 DELIVERY, STORAGE AND HANDLING

- A. All materials shall be delivered and stored within the Contractor's work limits or in an area approved by the Owner.
- B. All material shall be stored in strict accordance with the manufacturer's recommendations.

- C. Special care shall be exercised during delivery and storage to avoid damage to the products.
- D. Products that are damaged will be removed and replaced, unless the product can be repaired in an acceptable manner by the Contractor, at his expense.
- E. Packaged Materials:
 - 1. Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery, and while stored at site. Store out of low lying or drainage areas.
- F. Drainage Gravel and Dynamic Stone Base:
 - 1. Deliver tested and approved lots in clean, washed and covered trucks to eliminate contamination during transportation. Place directly on synthetic turf area. Do not stockpile on site.

1.10 PROJECT CONDITIONS

- A. Do not store drainage system materials or components over wet, frozen, or muddy base.


1.11 BASE WORK COMPLETION PRIOR TO COMMENCEMENT OF SYNTHETIC TURF SURFACE

- A. Refer to 321813 - Synthetic Turf System Surface Specification for Final Submittal and Acceptance Requirements regarding Preliminary and Substantial Completion for the Synthetic Turf areas.
 - 1. Turf Base Contractor to Review these Final Acceptance requirements and submit all pertinent items concurrently with the Turf Installer / Turf Manufacturer as one joint submittal to the Owner and its Representatives.
- B. Base work Completion: The following items are to be complete and operational prior to the installation of the Synthetic Turf and infill. These items will have been systematically observed and approved by the Owner and or its representatives as they are completed in the construction sequence of the Base work. To be considered "Complete" and ready for Turf installation, the following items shall be provided and achieved:
 - 1. Drainage system installed and operational
 - 2. Dynamic stone base in place, compacted and to certified grade elevations
 - 3. Watering system installed and operational. Ground boxes set to finish grade (Refer to and coordinate with Landscape Irrigation documents/Contractor)
 - 4. Perimeter anchor installed and approved

1.12 WARRANTY/GUARANTEE – SYNTHETIC TURF SUBSURFACE DRAINAGE SYSTEM

- A. General: Warranties / Guarantees specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and are in addition to and run concurrent with other warranties/guarantees made by the Contractor under requirements of the Contract Documents.
- B. The following are inclusive of the term "Synthetic Turf System" for provisions of the guarantee:
 - 1. Final grade tolerances to one-quarter inch in the length of 25' of finish grade in any direction.
 - 2. Working functions of the drainage system.
 - 3. All materials and products specified.
 - 4. Water system included with Landscape Irrigation warranty
- C. Synthetic Turf System Installer Guarantee: The President/Principal(s) of both the Synthetic Turf Contractor and the Turf Base Contractor (if different) shall sign this document and it shall include the following:
 - 1. Guarantee shall include removal and replacement of materials (parts and labor) listed in this specification not performing to the standards described to repair synthetic turf system at no cost to the Owner.
- D. Contractor shall not be held liable for incidental or consequential damages.
- E. The Warranty does not cover any defect, failure, damage caused by or connected with abuse, neglect, deliberate acts, acts of God, casualty or loads exceeding the Contractor's recommendations.

PART 2 - PRODUCTS

2.1 SYNTHETIC TURF AREA SUBDRAINAGE SYSTEM MATERIALS

- A. Underdrain Collector Pipe and Fittings
 - 1. General
 - a. Review drawings for locations of perforated and non-perforated piping.
 - b. Solid wall pipe shall be high-density polyethylene pipe (HDPE) and shall conform to the requirements of AASHTO M252 Type S for 4 to 10-inch diameters and AASHTO M294 or ASTM F2306 Type S for 12 to 60-inch diameters.
 - c. Perforated pipe shall be double wall high-density polyethylene pipe (HDPE) and shall conform to the requirements of AASHTO M252 Type SP for 4-inch

to 10-inch diameters and AASHTO M294, Type SP or ASTM F2306 for 12 inch to 60 inch diameters.

- d. HDPE Perforated pipe shall have Class 2 slotted perforations in accordance with AASHTO M252 and M294.
- e. Virgin material for pipe and fitting production shall be high-density polyethylene conforming to the minimum requirements of cell classification 424420C for 4-inch to 10-inch diameters, and 435400C for 12-inch to 60-inch diameters, as defined and described in the latest version of ASTM D3350, except that carbon black content should not exceed 5%.
- f. Provide drainage pipe complete with bends, reducers, adapters, couplings, collars, and joint materials.
- g. Solid wall pipe joints and fittings shall meet the watertight joint performance requirements of AASHTO M252, AASHTO M294, or ASTM F2306. 4-inch through 60-inch shall be watertight according to the requirements of ASTM D3212. Gaskets shall be made of polyisoprene meeting the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly.
- h. Solid wall HDPE 12-inch through 60-inch diameters shall have a reinforced bell with a bell tolerance device. The bell tolerance device shall be installed by the manufacturer.
- i. Provided drainage pipe complete with all fittings such as bends, reducers, adapters, couplings, collars, and joint materials. Fittings and couplers for perforated HDPE pipe shall be split couplings or snap couplings manufactured by the same manufacturer as the corrugated HDPE.
- j. Manufacturer's certification according to AASHTO M252 and M294 shall be submitted to the Engineer prior to installation of the pipe.

2. Products

- a. Advanced Drainage Systems (ADS)
- b. Approved Equivalent

B. Underdrain Panel Drains and Fittings

1. General

- a. Corrugated panel drain shall conform to the requirements for Class B Geocomposite as defined in ASTM D7001-06. This geocomposite product shall be composed of a flat pipe design consisting of a full circumference polyethylene core.
- b. All materials and fittings shall conform to ASTM D7001-06.
- c. The corrugated panel drain shall have a nominal thickness of 1-inch and a nominal width of 12-inch.
- d. The core shall have a minimum compressive strength of 7,500 psf.
- e. Geotextile wrap shall not be used on panel drain.

- f. Provided panel drain complete with all fittings such as bends, reducers, adapters, couplings, collars, and joint materials. All fittings shall be supplied by the same manufacturer as the panel drain.
- 2. Products
 - a. Hydraway Drain 2000
 - b. Approved Equivalent
- C. Clean Out: Provide clean out fittings fabricated from ASHTO-M252 polyethylene pipe that includes threaded polyethylene cap.
- D. Collector Pipe Inline Drainage Structures / clean outs and sized as per drawings:
 - 1. General
 - a. Inline structures only are to be used. Risers with fittings are not allowed.
 - 2. Products:
 - a. Cleanouts
 - 1) Nyloplast Drain Basin
 - 2) Nyloplast Inline Drain
 - b. Grate
 - 1) Solid, Ductile Iron
 - 3. Suppliers
 - a. Nyloplast-ADS
 - 1) www.ads-pipe.com/us
 - b. National Diversified Sales
 - 1) www.ndspro.com
 - c. Approved Equivalent.
- E. Dynamic Stone Base and Top-Dressing Stone
 - 1. The dynamic stone base shall conform to the turf vendor's standard specifications subject to the Engineer's approval and meet the following requirements using ASTM Method C136:
 - 2. All stone shall be angular. Rounded or river stone is not acceptable. Material shall be hard, durable, washed stone free of deleterious materials.

3. In no instance shall multiple quarry sources be used for the project.
4. Top dressing stone shall bridge with selected dynamic base stone to prevent loss of top stone into base. Dynamic base shall also bridge with stone material used by others to achieve subgrade.
5. Bridging Characteristics:
 - a. D85 Top Stone x 5 > D15 Base Stone
 - b. D85 Top Stone / D15 Base Stone <2
6. Drainage Characteristics
 - a. Permeability for base stone shall be greater than 50"/hr.
 - b. Permeability for top dressing stone shall be greater than 30"/hr.
 - c. Porosity for top dressing and base stone shall be greater than 25% when compacted and saturated.
7. Top dressing Stone is allowed for use to level the finished surface of the base stone. Total allowable depth to be in the range of 1/2 to 3/4 inch after installation and finish grade.
8. The dynamic base gravel should meet one or both of the following stability requirements:
 - a. Sulfate Soundness (C-88) (Required)
 - 1) Not to exceed 12% loss
 - 2) This is a long lead item for testing. Contractor shall submit and gain approval to maintain project schedule.
 - b. LA Abrasion (ASTM C131) (Desired, Optional)
 - 1) Not to exceed 40

2.2 SYNTHETIC TURF PERIMETER ANCHOR / TURF EDGE ATTACHMENT

A. Turf Attachment Methods: The Turf shall be attached at the perimeter as follows:

1. Cast in Place Concrete Curb / Wood Nailer Combination
 - a. Wood nailer is attached to the turf area side of the Concrete curb with the top of the wood nailer being recessed below the top of the curb. Turf shall be attached to the wood nailer.
 - b. Top of wood Nailer shall be no greater than 3/4 - 1 inch below curb so that when infill material is placed the infill and top of curb are flush/no tripping will occur in elevation.
 - c. Wood Nailer Board

- 1) YellaWood 2" x 4"
 - 2) Approved equivalent
- d. Anchor Nails
 - 1) Stainless Steel Ramset/RedHead
 - a) Use 4 nails per 8-foot length nailer
 - b) Use 5 nails per 10-foot length nailer
 - c) 4 inches from end of board
 - 2) Approved equivalent
- 2. Cast in Place Concrete curb with formed notch
 - a. This method may be used at the recommendation of Turf Contractor.

2.3 SYNTHETIC TURF AREA WATER SYSTEM MATERIALS

- A. General: Refer to Landscape Irrigation documents.

PART 3 - EXECUTION

3.1 EXAMINATION AND PROTECTION

- A. Verification of Conditions: Examine areas and conditions under which all work of this Section is being performed. Commencement of work implies acceptance of all areas and conditions.
- B. Contractor to Protect and use care in regard to adjacent construction and other surrounding work.
- C. Protection of Work this Contract: Protect all on-going work, so as not to delay work due to weather or project related construction. This includes but is not limited to the use of tarps, geotextile, plywood and other protective measures.
- D. Protection of Persons and Property: Provide all necessary measures to protect workmen and passersby.

3.2 SYNTHETIC TURF AREA SUBGRADE ACCEPTANCE

- A. Synthetic Turf Area Subgrade by others prior to the commencement of this specification section.
- B. Tolerances and Certifications

1. The following will be required for the Contractor performing subgrade work and should be the expected result by the Turf Base Contractor prior to beginning Finish grade.
 - a. Subgrade Tolerance Requirements: The final elevation of the subgrade is plus or minus one inch at any point on the turf area and on a 25-foot grid as indicated on the Contract Drawings.
 - b. Subgrade Elevation Certification: A certified survey by a State licensed land surveyor with elevations noted on a 25-foot grid to verify required grade and elevation tolerances of the subgrade. The digital survey document indicates spot elevations and tenth of foot contours and was submitted to the Engineer/Owner for review and approval prior to moving to next part of work.
 - c. Subgrade mirrors the final finish elevation of the turf area surface in regard to slope except where noted on the drawings.
 - d. Documents showing compaction meets 95% Standard Proctor

- C. Commencement of work in this specification section implies acceptance of the subgrade conditions.

3.3 SYNTHETIC TURF AREA PERIMETER ANCHOR / TURF EDGE ATTACHMENT

- A. Install/form notch at turf edge of curb or install wood nailer to concrete curbing at entire perimeter/edges of turf installation
- B. Coordinate installation with installation of other adjacent construction as shown on the drawings

3.4 SYNTHETIC TURF AREA WATER SYSTEM / CONDUIT INSTALLATION

- A. General: Coordinate installation of turf drainage base and finish subgrade with irrigation lines installed as part of the landscape irrigation system.

3.5 DRAINAGE SYSTEM INSTALLATION

- A. Collector Pipe Trenching:
 1. Contractor to connect synthetic turf drainage system to site storm drainage system and as coordinated with the General Contractor.
 2. Excavate trenches for all piping to a uniform depth and width, sufficiently wide enough to provide ample working room and into the previously installed subgrade material.
 - a. Minimum width of trench to be twice the pipe diameter.

3. Excavate trenches to depth indicated or required to establish indicated slope and invert elevations and to support bottom of pipe
4. Contractor to remove or manipulate spoils from trenching excavation so that integrity of finished grade requirements is maintained

B. Panel Drain Pipe Trenching

1. Only perform trenching, drainage pipe installation and backfilling operations that can be completed in one day
2. Panel trenching to be at a depth so that top of panel is flush with finish subgrade and at a width to comfortably place and install panel.

C. Installation of Collector piping:

1. Lay perforated pipe directly on trench bottom in accordance with pipe manufacturer's recommendations.
2. Provide collars and couplings as required for installation of these lines as well as for connections to drainage structures
3. Install collector as indicated on drawings so that it connects to site structures
 - a. Protect any exposed ends of pipe until connected to detention or storm sewer system by Synthetic Turf Contractor or others
4. Pipe laying work shall commence at the main collector line and shall proceed from low point of system to high point.
 - a. Pipe shall be laid true to line and grade in such a manner as to assure a close concentric joint with the adjoining pipe.
 - b. Protect any exposed ends of the pipe until final connections are made.
 - c. After pipe installation has been observed by the Engineer, drainage material shall be placed around and over the pipe.
5. Install inline structures, drain inlets, catch basins per manufacturer's instructions
6. After pipe installation has been observed by the Landscape Architect/Engineer, approved drainage material shall be placed around and over the pipe to the top of the trench.
 - a. If observation indicates poor alignment, debris, displaced pipe, infiltration or other defects, Contractor to take whatever steps are necessary to correct such defects prior to proceeding
7. Installation of drain lines from in ground accessories
 - a. Install drain lines from in ground boxes installed in the field area. Connect directly to field drainage system

8. Collector pipe Clean Out: A nyloplast or equal structure is to be used for the cleanout. Cap shall be placed flush with finish subgrade as shown on the drawings. Install bolt, washer and nut on cap for metal detection purposes

D. Installation of Panel Drains:

1. Install panel drains per the manufacturer's written instruction.
2. The panel drains are to be installed in shallow trenches minimally equal to the height and 1.5 times the width of the panel drains and directly over the top of the geotextile fabric.
3. Connect panel drains to collector/header piping using panel drain manufacturer provided fittings, per manufacturer instructions and as shown on drawings.
4. Provide 48 hours' notice to the Engineer to inspect the panel drains in place prior to covering.

E. Installation of drain lines from in ground boxes

1. Install drain lines from in ground boxes in the turf area. Connect directly to turf area drainage system or minimally to the gravel perimeter trench.

F. Clean Out/End Cap: Cap shall be recessed below the dynamic stone and flush with finish subgrade elevation. Install bolt, washer and nut on cap for metal detection purposes

3.6 INSTALLATION OF DYNAMIC STONE BASE/TOPPING STONE

A. Install only tested and approved material at a uniform depth.

B. Placement of the dynamic stone base shall proceed from a stable area next to the geotextile fabric and systematically worked outward onto the area.

1. Laser operated equipment, string lines or screed boards shall be utilized.
2. All equipment used in spreading or traveling on the cover layer shall exert low ground pressures and shall be approved by the manufacturer and Engineer.
3. During placement and spreading,
 - a. A minimum depth of 6 inches of granular material shall be maintained at all times between the fabric and wheels of trucks or spreading equipment.
 - b. All equipment traveling on the cover layer shall avoid making sharp turns, quick stops or quick starts.
 - c. Care shall be taken to not disturb, displace or damage the drainage system.
 - d. Contractor shall install dynamic stone layer in such a way as to reduce separation of the fines and larger particles in the stone blend.

C. Placement of the Topping Stone: This stone layer shall be placed over the dynamic stone base at a finished depth as shown on the drawings to produce a level/smooth surface prior to the placement of the synthetic turf. Due to possible drifting of this finish stone material into the dynamic stone layer below, more material may be required than the

finished depth to eventually achieve finished grade elevations at the top of the finish stone layer and shall be considered as part of the overall quantities necessary.

1. Contractor shall install topping stone layer in such a way as to reduce separation of the fines and larger particles in the stone blend.

D. Finish grade for Dynamic Stone Base and Top-Dressing Stone

1. Shall be verified using laser operated survey instrument with a tolerance of +/- one-quarter inch over 25 feet in any direction.

- E. Stone base elevation verification: A survey of the finished elevation for the stone base is to be developed by a State licensed surveyor over the entire surface in a 25-foot grid. The survey shall be certified (signed) and submitted to the Owner and its representatives for approval prior to installing the synthetic turf. The survey shall indicate spot elevations and tenth of foot contours starting from the exact center point of the field, working in both directions and including the field curb and outer extent of the field system perimeter limits.

3.7 INSTALLATION OF SYNTHETIC TURF

- A. Refer to 321813 - Synthetic Turf Surface System Specification. To commence only after acceptance of Base Work performed in this Specification Section.

3.8 CLEAN UP

- A. At the end of each day, remove all scraps and other debris created by the synthetic turf installation from the area.
- B. At end of synthetic turf installation and just prior to punch list, contractor to use magnetic device/equipment to remove all metallic materials on turf or adjacent area caused by turf construction.
- C. Remove all surplus excavated material not required for filling and backfilling, trash, and debris and dispose of it properly off of the Owner's property at Contractor's expense.
- D. Leave the premises and work in clean, satisfactory condition.
- E. Ground boxes (if applicable) to be cleaned of debris and if necessary clean gravel added

3.9 FINAL SUBMITALS

- A. Refer to Completion and Final Acceptance in Synthetic Turf Surface System Specification Section.

- B. Final Spot Elevation Certification documents for all synthetic turf areas.
- C. Warranty/Guarantee Documents as described in this Specification Section.

3.10 PROTECTION

- A. Protection of materials and work shall be the responsibility of the Contractor during installation and thru acceptance/substantial completion. All material damaged prior to acceptance shall be replaced at no cost to the Owner.

END OF SECTION 321823

SECTION 323300 - SITE FURNISHINGS

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. Removable bollard.
 - 2. Planter.
 - 3. Wundercover.
 - 4. Custom wood slat bench.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For site furnishings to include in maintenance manuals.
- B. Warranties.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Manufacturer regularly engaged in manufacture of site furnishings for 10 years.
- B. Product Support: Products are supported with complete engineering drawings and design patents.
- C. Production: Orders are filled within a 40-day schedule.
- D. Facility Operator: Welders and machine operators are certified.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage: Store materials in clean, dry area in accordance with manufacturer's instructions. Keep materials in manufacturer's original, unopened containers and packaging until installation.
- C. Handling: Protect materials and finish during handling and installation to prevent damage.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. As shown on the plans.
- B. Per manufacturer's recommendations and specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Notify Landscape Architect of conditions that would adversely affect installation or subsequent use.

3.2 INSTALLATION

- A. Do not begin installation until unacceptable conditions are corrected.
- B. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
- C. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.

- D. Install site furnishings level, plumb, true, and positioned at locations indicated on Drawings.

3.3 ADJUSTING

- A. Finish Damage: Repair minor damage to finish in accordance with manufacturer's instructions and as approved by Landscape Architect.
- B. Component Damage: Remove and replace damaged components that cannot be successfully repaired as determined by Landscape Architect.

3.4 CLEANING

- A. Clean furnishings promptly after installation in accordance with manufacturer's instructions.
- B. Do not use harsh cleaning materials or methods that could damage finish.

3.5 PROTECTION

- A. Protect installed benches to ensure that, except for normal weathering, furnishings will be without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 328400 - PLANTING IRRIGATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes furnishing all labor, materials, accessories and equipment, and performing all operations necessary for the complete installation of the landscape irrigation system, permits and including items listed below:
 - 1. Piping.
 - 2. Manual valves.
 - 3. Automatic control valves.
 - 4. Automatic drain valves.
 - 5. Spray and rotor heads.
 - 6. Driplines
 - 7. Quick couplers.
 - 8. Controller.
 - 9. Boxes for automatic control valves.
- B. Irrigation Control System
 - 1. The construction includes one (1) satellite controller as shown on the irrigation plans.
 - 2. Power shall be provided to the irrigation controller by electrical contractor. Final connection by irrigation contractor.
- C. All bids should reflect a total "turn-key" installation for the site. This would include all equipment necessary to install satellite controller, central control system, including necessary wiring, communications equipment, electrical service, water supply and lines needed to communicate with the central irrigation control system. Each bid shall include all equipment and labor necessary to provide a "turn-key" installation.
- D. Each proposal shall include the cost to install a combination flow meter and master valve as indicated on the design drawings. This meter and valve shall be connected just past the water meter connection at each site. This meter and valve shall be capable of relaying this information to the central irrigation control system point computer to provide flow information of each valve as it waters. It shall also be capable of detecting any flow that is occurring when no valves are operating, such as a broken main line would create. This flow sensor should then be capable of sending a signal to the central irrigation control system that will then in turn close the master valve. The bid for each flow meter and valve shall include the meter/valve and any other items needed for a "turn-key" installation. The bid price for this meter and valve shall be shown as a separate bid item for this site.
- E. The contractor shall include a projected time frame for installing the system. It should reflect, in calendar days, the anticipated time required from the day of the award to completion of the system in a fully operational mode. This schedule should reflect

anticipated time for ordering and receiving all components, starting and ending times for installation, starting and ending times for training, system start-up, etc.

1.2 PERFORMANCE REQUIREMENTS

- A. Irrigation zone control shall be central control system with automatic operation with controller and automatic control valves.
- B. Location of Sprinklers and Specialties: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards. Maintain 100 percent irrigation coverage of areas indicated.
- C. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties unless otherwise indicated:
 - 1. Irrigation Main Piping: 120 psi
 - 2. Circuit Piping: 60psi

1.3 SEQUENCING/SCHEDULING

- A. Obtain information pertaining to the location of all existing utility lines and equipment prior to irrigation installation.
- B. Install sleeves for all mainline, laterals, and wire that cross roadways, drives, sidewalks, and all other paving surfaces prior to placement of paving. It is the responsibility of the Irrigation Contractor to coordinate timing of sleeve installation and construction procedure with Paving Contractor to ensure proper sequencing.
- C. Give at least seven (7) days notice to the Landscape Architect or his representative prior to all required site visits as indicated herein.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Only materials and items of equipment so approved shall be used.
- B. Wiring Diagrams: For power, signal, and control wiring.
- C. Approvals: Submit documentation of all approvals required by local, municipal, and state jurisdictions.
- D. Grounding and Line Surge Protection Verification: The Irrigation Contractor is to provide written documentation and verification that each grounding device meets the manufacturer's specified requirements for grounding and line surge protection. The tests shall be completed using an approved ground resistance tester. The Rain Bird ASP shall conduct testing.

1.5 INFORMATIONAL SUBMITTALS

- A. Controller Timing Schedule: Indicate timing settings for each automatic controller zone.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operational and Maintenance Data: Submit manufacturer's data in a three-ring binder, labeled and indexed
- B. Record Drawings: Irrigation Contractor shall record and submit an "As-Built Drawing" which records actual installed conditions. The As-Built Drawing shall be submitted in an electronic format. Irrigation Contractor shall submit the As-Built Drawing to the Landscape Architect before work under this contract will be considered for Acceptance.

1.7 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. Manufacturing Qualifications: Provide landscape irrigation system as a complete unit produced by acceptable manufacturers for all portions of work, including heads, valves, piping, controllers, and accessories.
- C. Installer qualification: Contractor shall be a firm specializing in irrigation work with a minimum of 10 years' experience in work of this type. The irrigation contractor shall provide written proof of attendance at a manufacture's supported training program regarding the installation, programming and trouble-shooting for a Rain Bird IQ v4.0 decoder based irrigation control system. These qualifications must be present prior to any work beginning on this project.
- D. Authorized Service Provider requirements: Contractor shall have Authorized Service Provider (ASP) provide Rain Bird IQ Commissioning of central irrigation control system including verification of specified Rain Bird Components, Correct wire and connectors, Grounding of required components, proper installation of communication and software has been set up with proper start-up and initial programming.
 - 1. Approved Rain Bird Authorized Service Provider/Central Control Service Provider
 - a. Irrigation Management Company (IMC) 816-215-1810
- E. Referenced Standards: American Society for Testing and Materials, Annual Book of ASTM Standards, latest edition.
- F. Codes and Standards: Irrigation installation shall comply with all applicable federal, state and local governing agency requirements and to industry standards. Notify Landscape Architect immediately in writing of any discrepancies, inconsistencies, or contradictory

requirements.

- G. Workmanship: Install materials and equipment in a neat and professional manner following manufacturer's recommendations.

1.8 FEES AND PERMITS

- A. Work under this Section shall include all fees, permits, licenses, and required inspections by concerned governing agencies.

1.9 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials and equipment in such a manner as not to damage the parts or decrease the useful life of equipment.
- B. Store materials away from detrimental elements. Coordinate with Owner's Representative, General Contractor, or Landscape Contractor, as appropriate, to secure a safe staging area.
- C. Handle, load, unload, stack, and transport materials carefully to avoid damage. Handle pipe in accordance with manufacturer's recommendations.

1.10 JOB CONDITIONS

- A. Prior to commencing any work required under the Contract, the Contractor shall locate all utilities, subsurface drainage, and underground construction so that proper precautions may be taken not to disturb or damage any subsurface improvements. Damage to any of the above mentioned items or other shall be promptly repaired by the contractor at no additional cost to the owner.
- B. Water service and electric service will be supplied by the General Contractor as indicated on the plans for the purpose of the automatic irrigation system.
- C. Irrigation System is to operate under the water pressure and flow rates prevailing at the project site. Irrigation Contractor shall be responsible for determining these parameters, and shall design the irrigation system in accordance with the existing or anticipated conditions.
- D. Insurance on irrigation materials or equipment stored or installed is the responsibility of the Irrigation Contractor. Such insurance shall cover fire, theft, and vandalism. Should the Irrigation Contractor elect not to provide such insurance the Owner shall in no way be responsible for any losses incurred by the aforementioned acts. The Irrigation Contractor is responsible for all costs incurred in replacing damaged or stolen materials or equipment prior to Substantial Completion of the Work.
- E. Obtain all required permits and pay all required fees at no additional cost to the Owner. Any penalties imposed due to failure to obtain permits or pay fees are the responsibility of the Irrigation Contractor.

- F. Provide and maintain all passageways, guard fences, warning lights, and other protection devices required by local authorities or others having jurisdiction.
- G. Irrigation Contractor shall adequately protect adjacent property as provided by law and the Contract Documents.
- H. Existing Site Improvements: Perform Work in a manner that avoids damage to existing site improvements. The Irrigation Contractor is responsible for any damage of mechanical nature as well as damage resulting from leaks in the irrigation system whether due to negligence or otherwise.
- I. Test water conditions: Irrigation System is to operate under the water pressure and flow indicated on the irrigation plan. It shall be the responsibility of the Irrigation Contractor to measure or analyze the existing or anticipated water supply at the tap. Notify the Landscape Architect if conditions vary from plans.

1.11 WARRANTY AND SUBSTANTIAL COMPLETION

- A. Substantial Completion
 - 1. At the completion of the installation of the irrigation system components, and at the direction of the Owner, the Landscape Architect shall observe the conditions of the project for the purpose of verifying compliance with plans, details and specifications. A written report will be provided to the Owner listing any deviations or omissions. These issues will be resolved and verified by the Landscape Architect prior to the issuance of a Letter of Substantial Completion.
 - 2. Contractor shall provide Landscape Architect with written notification from Rain Bird ASP stating that all installation, testing and training of the Central Control System has been completed and approved. Notification shall be received prior to substantial completion.
- B. All irrigation equipment including central irrigation control system, controller(s), control valves, sprinklers, rotors, and accessories shall have a five (5) year manufacturer's warranty. All other irrigation equipment, workmanship, and, supplies shall be warranted for one (1) year from date of issuance of the letter of substantial completion. All warranties shall be turned over to the Owner.

1.12 TRAINING

- A. A minimum of 2 hours of training, as determined by Rain Bird, for up to two (2) users determined by Owner and Landscape Architect shall be conducted by the ASP on site, with installed system, after completion of project. The contractor is to schedule, coordinate, and attend the training session. Training shall include an overview of system operations as well as detailed one-on-one training for selected individuals for both software and hardware operation.
- B. The control system manufacturer is to provide toll-free phone-in support to the Owner at no cost for a period of one (1) year within the initial purchase price of the system.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Specific requirements concerning the various materials and the arrangements in which they are to be installed are outlined in this Specification.
- B. Quality and Size
 - 1. Material specified by name and / or model number in the Specifications, on the site, or detailed drawings are used for the purpose of identification of materials and to ensure specific use of that material in the construction of the system. No substitutions will be permitted without approval.
 - 2. All materials used in the system must be new and without flaws or defects of any type and be the best quality available.

2.2 ACCEPTABLE MANUFACTURERS

- A. Manufacturer: Contractor materials shall comply with all requirements and provide irrigation equipment products from only the following:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products not listed within this section may be incorporated into the Work.
 - 2. Irrigation equipment including spray heads, rotors, nozzles, control valves, quick couplers, master valves, irrigation controller, rain sensors, low volume irrigation equipment, drip tubing and drip fittings including pressure regulators, filters, air relief valves, tree root watering devices, pipe fittings including swing assemblies, swing joints, barbed fittings, swing pipe and compression fittings shall be manufactured by the Rain Bird Corporation.
 - a. Or approved equal
 - 3. Decoder based irrigation control system equipment including, field decoders, line surge protection devices, sensors decoder and field transmitters shall be manufactured by the Rain Bird Corporation.
 - a. Or approved equal
 - 4. IQ™ v4.0 Central Irrigation Control System equipment, software, modules, and system hardware interface shall be manufactured by the Rain Bird Corporation. Contact John Miller 913-333-9127
 - a. Or approved equal
 - 5. Decoder control wire shall be manufactured by Rain Bird Corporation.
 - a. Or approved equal
 - 6. Wire connectors shall be manufactured by 3M Corporation.
 - a. Or approved equal

2.3 DELIVERY, STORAGE AND HANDLING

- A. Manufactured materials shall be delivered in original containers with brand and maker's names marked thereon. Materials in broken containers or showing evidence of damage will be rejected and must be immediately removed from the work.
- B. Store plastic pipe on flat pallets and protect from sunlight.

2.4 PIPES, TUBES, AND FITTINGS

- A. Main Irrigation supply line for potable water. PVC plastic pipe, ASTM D 2241 Class 200 SDR 21.
 - 1. All PVC pipe from sizes three (3) inches and above shall, unplasticized rigid polyvinylchloride (PVC) pipe with integral bell and rubber ring gasket unless otherwise specified.
 - 2. All PVC pipe from sizes two and one - half (2 1/2) to one (1) inch shall be Class 200, solvent weld PVC pipe.
 - 3. All pipe shall be supplied in standard twenty (20) foot lengths.
 - 4. Polyethylene pipe will not be accepted unless prior written approval is obtained by the landscape architect.
- B. Circuit Pipe for potable water (downstream from circuit valves): PVC plastic pipe, ASTM D 2241 Class 200 SDR 21.
 - 1. All PVC pipe from sizes three (3) inches and above shall, unplasticized rigid polyvinylchloride (PVC) pipe with integral bell and rubber ring gasket unless otherwise specified.
 - 2. All PVC pipe from sizes two and one - half (2 1/2) to one (1) inch shall be Class 200, solvent weld PVC pipe.
 - 3. All pipe shall be supplied in standard twenty (20) foot lengths.
 - 4. Polyethylene pipe will not be accepted unless prior written approval is obtained by the landscape architect.
- C. All pipe that is exposed or not below grade shall be Schedule 80 PVC or HDPE. Seamless Copper Pipe: ASTM B88, Type M, drawn temper.
- D. Sleeving Pipe for Potable Water Irrigation Supply Line: PVC plastic pipe, Schedule 40, ASTM D 1785 and D 1784, PS 21-70.
- E. Fittings:
 - 1. For PVC plastic pipe,
 - a. All pipe fittings size four (4) inches and greater shall be ductile iron.
 - b. 3" fittings shall be bell and rubber gasket.
 - c. Fittings 2-1/2" and under shall be Schedule 40 solvent weld PVC. ASTM D 2466 socket fittings with ASTM A 2564 solvent cement.
 - 2. Metallic: Cast bronze with standard iron pipe thread; 125 bl. class rating in conformance with ANSI B16.15.

3. Copper: ANSI B16.22 wrought copper or cast brass, recessed solder joint type fittings.

F. Nipples:

1. Metallic: Schedule 40 red brass (35% copper, 15% zinc) pipe: threaded both ends. Pipe shall be in accordance with ASTM B43.
2. Plastic: Factory-threaded Schedule 80, Type 1, Grade 1 polyvinyl chloride (PVC) pipe, threaded both ends. Pipe shall be in conformance with ASTM D1784 and D1785. Color: grey.

G. Pipe Connection Materials: Solvent, primer and lubricants as recommended by the manufacturer.

1. Joint compound for threaded connections is Teflon or approved equal tape; UL listed.
2. No thinning of solvent or primer is allowed in any manner whatsoever.

2.5 WATER METER

- A. Water meter shall be sized as needed, and shall be provided per City specifications. Ref: Building MEP Plans.

2.6 BACKFLOW PREVENTER

- A. Back Backflow preventer shall be of the type required by the local water supplier and local codes. Backflow preventer shall be sized to meet flow and pressure requirements of the plans; Ref: Building MEP Plans.

2.7 IRRIGATION CONTROL SYSTEM SLEEVING

- A. Install separate sleeve beneath paved areas to route each run of wiring. Any existing sleeving is not to be used without the consent of the owner's representative.
- B. Sleeving material beneath pedestrian pavements shall be PVC Class 200 pipe with solvent welded joints.
- C. Sleeving beneath drives and streets shall be PVC Schedule 40 pipe with solvent welded joints.
- D. Sleeving diameter shall be equal to twice the diameter of the wiring bundle.

2.8 VALVES

- A. Manufacturer's Standard, of type and size required, and as follows:
- B. Furnish valves with plastic bodies, glass filled nylon or red brass, unless otherwise indicated.

- C. Pressure Reducing Valve: If required, standard capacity water pressure reducing valve with integral strainer, Watts U5 series or equal.
- D. Master Valve.
 - 1. Globe valve shall be normally closed 24 VAC 50/60 cycle solenoid actuated with a pressure rating of not less than 200 psi.
 - 2. The valve body and bonnet shall be constructed of heavy cast red brass; diaphragm shall be of nylon reinforced nitrile rubber. All other internal parts shall be made of bronze, brass and stainless steel.
 - 3. The valve shall have both internal and external manual open/close control to manual open and close the valve without electrically energizing the solenoid. The valve shall house a fully-encapsulated one piece solenoid.
 - 4. The valve shall have a stainless steel flow control stem and cross handle for regulating or shutting off flow of water. The valve must open or close in less than one minute at 200psi.
 - 5. The valve shall be sized to meet flow requirements shown on plans.
 - a. Potable irrigation system: Rain Bird EFB-CP IVM Series 2" valve
- E. Zone Control Valves for potable irrigation system.
 - 1. Globe valve shall be normally closed 24 VAC 50/60 cycle solenoid actuated with a pressure rating of not less than 200 psi.
 - 2. The valve body and bonnet shall be constructed of heavy duty glass filled UV-resistant nylon and have stainless steel studs and flange nuts with a nylon reinforced nitrile rubber diaphragm.
 - 3. The valve shall have both internal and external manual open/close control to manual open and close the valve without electrically energizing the solenoid. The valve shall house a fully-encapsulated one piece solenoid.
 - 4. The valve shall have a brass flow control stem for accurate manual regulation and/or shut off of outlet flow.
 - 5. The valves shall be sized to meet flow requirements shown on plans.
 - a. Potable irrigation system: Rain Bird PE-IVM series valves
- F. Drip Zone Control Valve.
 - 1. Preassembled Zone Control Valve Assembly designed specifically for drip irrigation applications. The Zone Control Kit shall consist of a valve, ball valve, pressure regulator and 200 mesh filter.
 - 2. Globe configuration valve shall be normally closed 24 VAC 50/60 cycle solenoid actuated with a pressure rating of not less than 150 psi.
 - 3. The valve body and bonnet shall be constructed of high impact, weather resistant plastic, stainless steel and other chemical / UV resistant materials.
 - 4. The valve shall have a one unit diaphragm constructed of durable Buna-N rubber material with a clog resistant metering orifice and a double knife seal. The valve shall have one 90 mesh pilot filter attached to the diaphragm.
 - 5. The valve shall have one fully encapsulated solenoid with captured plunger. The valve shall have one 90-mesh filter attached to the solenoid base.
 - 6. The valve shall be capable of on/off control by turning the solenoid ¼ turn. The valve shall provide a flush mode that is manually activated by ½ turn of the bleed screw where external port is permissible.

7. The pressure regulating filter body shall be constructed of heavy duty, glass filled, UV resistant plastic material with a pressure rating of not less than 150 psi. The filter element shall be constructed of a durable polyester fabric attached to a propylene frame and shall be serviceable for cleaning by unscrewing the cap from the body.
 8. The pressure regulator shall have a preset outlet pressure of approximately 40 psi in the 1" size and will accommodate an inlet pressure of not less than 150psi.
 9. The valves shall be sized to meet flow requirements shown on plans.
 - a. Potable irrigation system: Rain Bird XCZ-100-IVM-Q series valves
- G. Pressure Regulating Module for regulating outlet pressure at control valve from 15 – 100 psi.
1. The pressure regulating module shall be a two-piece devise consisting of a glass filled UV resistant nylon housing and dial cartridge. The regulator shall have visible pressure indication scale ranging from 0-100psi and an adjustable knob to provide fine tune adjustments in 1/3 psi increments.
 2. The regulator shall have a Schrader valve to accommodate a pressure hose gauge. The regulator shall be waterproof and provide regulation if the valve is manually internal bled or electronically activated.
 3. The Pressure Regulating Module shall be Rain Bird PRS-D.
- H. Quick Coupling Valve: Brass, Single piece construction, one inch female iron pipe size connection; vinyl covered brass hinged locking cover.
1. Potable irrigation system: Yellow cap Rain Bird 44RC
- I. Manual Gate Valves (Isolation Valves): Non-rising stem, 125 lbs. brass body and parts with wedge disc filled for key operation, as supplied by Crane or equal.
- J. Pressure Relief Valves: As manufactured by Waterman, or equal.
- K. Valve Box Cover and Frame:
1. Manufactures:
 - a. Rain Bird VB Series, manufactured by Rain Bird Corporation
 - b. Ametek plastic valve boxes, manufactured by Plymouth Products
 - c. or equal.
 2. Potable water irrigation system:
 - a. Turf Areas: Green Cover
 - b. Landscape Beds: Black Cover/Brown Cover
 3. Sizes:
 - a. 12" Standard; Rain Bird VB-STD

- L. Drainage Pit Backfill: Cleaned gravel or crushed stone, graded from 2" maximum to 3/4" minimum. AB3 or equivalent is not acceptable backfill material.

2.9 AUTOMATIC DRAIN VALVES

- A. Description: Spring-loaded-ball type of corrosion-resistant construction and designed to open for drainage if line pressure drops below 2-1/2 to 3 psig.

2.10 SPRINKLER HEADS

- A. Manufacturer's standard unit designed to provide uniform coverage over entire area of spray shown on drawings at available water pressure.
 - 1. Pop-up spray heads, 6" for turf: Rain Bird 1800 Series with plastic body, co-molded wiper seal, precision controlled flush at pop-down, built-in pressure regulator (PRS) built in the stem to maintain constant outlet pressure of 30 psi, designed for use with Rain Bird matched precipitation rate (MPR) plastic nozzles and high efficiency variable arc nozzles (HEVAN) in odd angle locations, installed using Rain Bird SA series swing assemblies. All pop-up spray heads are to have the built-in Seal-A-Matic (SAM) check valve.

2.11 TURF ROTORS

- A. Manufacturer's standard unit to provide uniform coverage over entire area of spray shown on drawings at designated water pressure.
 - 1. 6" Pop-up gear driven turf rotor: Rain Bird 5000 plus series with flow shut off device, an integral pressure regulator to reduce operating pressure to 45PSI and top arc adjustment using flat bladed screwdriver of 40-360 degrees, pressure activated multi functional wiper seal, designed for use with the MPR nozzle set providing matched precipitation from 25' to 35' using Rain Curtain technology installed using Rain Bird TSJ series swing joints. Rotors located in low elevation areas and will be susceptible to lateral pipe drain down as designated by Landscape Architect are to have a spring loaded Seal-A-Matic (SAM) device in the base of the case.

2.12 LANDSCAPE DRIPLINE

- A. Flexible In-Line Drip Tubing
 - 1. Polyethylene tubing with factory installed, pressure compensating emitters with a spacing and consistent flow as listed on the plans.
 - 2. Pressure compensation will be accomplished through effective lengthening of the emitter flow path resulting with superior clog resistance.
 - 3. In-line emitter drip line shall have dual outlet ports to ensure direct contact with the ground.
 - 4. All drip tube to be staked in place using 12 gauge galvanized steel staples at 24"-36" OC.

5. Rain Bird Easy Fit Compression Fitting System shall be used to connecting all drip tubing.
6. In-line drip tubing shall be Rain Bird Landscape Dripline.
 - a. Potable water irrigation system XFD-06-18 in shrub beds
 - b. Potable water irrigation system XFD-09-12 in planters

2.13 AUTOMATIC CONTROL SYSTEM

- A. The irrigation controller shall be a Rain Bird ESP-LXIVM controller.
 1. The controller shall be housed in a wall-mountable, plastic locking cabinet suitable for either indoor or outdoor installation. The controller shall be capable of supporting up to 60 stations.
 2. The controller shall support up to 5 independently managed flow sensors interfaced with sensor decoders. The controller shall support up to five flow zones.
 3. The controller shall incorporate a FloManager feature that shall provide real-time flow, power, and station management. FloWatch shall compare the current real-time flow rate to the learned rates and take user defined actions if problem is detected. FloWatch shall automatically determine the location of the flow problem and isolate the problem by turning off the affected station or master valve.
 4. The controller shall be compatible with the IQ v4.0 Central Control System utilizing IQ-NCC Network Communication Cartridges providing remote computer control of the controller via a variety of communication options (Direct Connect Cable, Phone, GPRS/Cellular, Ethernet, WiFi, Radio, and IQNet Communication Cable).
 5. Shall have the dimensions of:
 - a. Width: 14.32 in. (36.4 cm)
 - b. Height: 12.69 in. (32.2 cm)
 - c. Depth: 5.50 in. (14.0 cm)
- B. Surge Protection: Rain Bird Line Surge Protector IVM-SD (built in surge protection), required every 500' along two-wire path.
 1. Output power: Adjustable from controller – Inrush and holding current valves adjustable at controller.
 2. Encapsulation: Fully waterproof
 - a. Address: Pre-coded from factory Electrical Input: Nominal voltage: 34Vpp (24V AC) from two-wire line. Minimum voltage: 21 Vpp (15V AC). Maximum Voltage: 36 Vpp (25V AC)
 3. Electrical Output:
 - a. Max. voltage: 36 Vpp

4. Maximum Cable Runs: 14 gauge – Star Pattern: 2.4 miles; Loop Pattern: 9.6 miles

Maximum Critical Path Lengths for 2-Wire Paths					
Nominal Wire Size	Ohms per 1000' or Ohms per Km (per conductor) Miles	Max. Length For Critical Path			
		Star		Loop	
		Km	Miles	Km	Miles
2.5 mm2	7.5 Ohms/Km	3.00	1.86	12.00	7.46
14 AWG	2.58 Ohms/1000'	2.66	1.65	10.63	6.61
12 AWG	1.62 Ohms/1000'	4.23	2.63	16.93	10.52

5. Decoder/Solenoid Wires - Electrical Resistance: Max. 3 ohms
6. Max. Distance Decoder/Solenoids: Cable length: 14 gauge: 456 feet
7. Wiring: Paige special direct burial irrigation control cable,
8. Environment: Working range: 32° to 122° F (0° to 50° C); storage range: -4° to 158° F (-20 to 70° C); Humidity: 100%
9. Surge Protection: 40 V, 1.5 kW transil

2.14 ELECTRIC WIRING

- A. 120 Volt AC Wiring: 120 volt service to controller shall consist of three wires: one black, one white, and one ground. Electrical service is to be provided by the General Contractor unless otherwise directed by Owner's Representative.
- B. Provide junction box, flush-mounted and gasketed per code as required.
- C. 2-Wire Control Wiring shall be dual core, tin-coated, double insulated special irrigation control wire. Minimum wire size shall be fourteen (14) gauge. Wire to be Maxi-cable as manufactured by Rain Bird® Corporation, Azusa, California or approved equal.
- D. Splices in controller wiring shall be waterproof direct bury application. Use Rain Bird-DBY T or R wire connectors. No substitutions will be allowed.

2.15 SURGE PROTECTION FOR THE TWO-WIRE PATH

- A. An IVM-SD shall be installed on the 2-wire communication path at each ESP-LXIVM controller location.
 1. The Rain Bird™ IVM-SD Line Surge Protector decoder specifications include but are not limited to:
 - a. The line surge protector decoder shall be grounded on a two-wire path every 500 feet (150 meters) or every 15 valves, whichever is smaller.
 - b. Install one (1) within controller cabinet.
 - c. The IVM-SD Line Surge Protector decoder shall be placed on a two-wire path.

- d. The IVM-SD Line Surge Protector decoder shall be used for surge protection only, and shall not have a decoder address.
- e. The IVM-SD Line Surge Protector decoder shall protect against 40V, 1.5kW transil.

2.16 GROUNDING

- A. Controller, decoders and ancillary products used on a two-wire path shall be connected to a grounding system with a ground resistance of ten (10) ohms or less.

2.17 FLOW SENSOR

- A. The flow sensor shall be an in-line type with a nonmagnetic, spinning impeller (paddle wheel) as the only moving part. The electronics housing shall have two, ethylenepropylene O-Rings and shall be easily removed from the meter body. The sensor electronics will be potted in an epoxy compound designed for prolonged immersion. Electrical connections shall be 2 single conductor 18 AWG leads 48 inches (1,2 meters) long. Insulation shall be direct burial "UF" type colored red for the positive lead and black for the negative lead. The sensor shall be capable of operating in line pressures up to 400 psi (27,5 bars) and liquid temperatures up to 220° F, and operating in flows of ½ foot per second to 15 feet per second with linearity of ±1% and repeatability of ±1%. The meter body shall be cast 85-5-5-5 bronze, in 1" and 1½", female iron pipe thread sizes. This flow sensor shall be Rain Bird Model FS200P series

2.18 RAIN SENSOR

- A. Provide and install a wired Rain Bird Rain Sensor (RSD-BEx) capable of turning off the irrigation system if adequate rainfall is received.
- B. Contractor to install per Rain Bird's recommendations and specifications. Location to be approved by Landscape Architect.
- C. Rain sensor shall employ an electro-mechanical actuating mechanism designed to cause a circuit interrupt if programmable low temperature or rainfall set points are satisfied.
- D. The device shall be used with 24VAC controllers and shall be of sufficient capacity to be used with a maximum of six 24VAC 7VA solenoids plus an additional master valve that does not exceed 53VA.

2.19 EQUIPMENT

- A. The following list of items shall be submitted to the Owner prior to the final inspection of the irrigation system.
 - 1. 2 quick coupler valve keys, Rain Bird 44-K
 - 2. 2 hose swivel (1" x 3/4"), Rain Bird SH-2
 - 3. 2 gate valve keys (48")

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall install all irrigation system components in accordance with the Irrigation and Landscape Plans, Details and these Specifications.
- B. Schedule of Work: The Irrigation Contractor shall be responsible for the installation of the piping and equipment in a manner that will effect the earliest completion of the work in conformance with the construction progress schedules of other Contractors and Trades, and these Specifications.
- C. Observations: In addition to normal progress inspection, the Contractor shall give at least 48 hours notice to the Landscape Architect for inspection as follows:
 - 1. Layout of the system.
 - 2. Pressure tests.
 - 3. Coverage adjustment; Automatic operation.
 - 4. Punch list inspection.
- D. Quick Coupler Valves: Locate quick coupler valves on mainline runs only, near pavement surfaces, and adjacent to annual planting beds. Space quick coupler valves at maximum 100' intervals near parking lots, islands, building entries, sidewalks, entry monuments, and annual planting beds. Space quick coupler valves at maximum 200' interval for large turf areas.

3.2 PROTECTION

- A. The Contractor shall be responsible for storage of materials and any damage to the work covered by these Specifications before the final acceptance of the work.
- B. Protect work and materials from damage during construction. Storage of polyvinyl chloride (PVC) pipe and fittings shall be protected from direct sunlight. Beds on which materials are stored must be the full length of the pipe to avoid damage. Any pipe that has been damaged or dented shall not be used in the work.
- C. Any existing structures, equipment, utilities, pavement, landscaping, etc., damaged by Irrigation Contractor during the course of the work, including any damage caused by leakage or settling of piping systems being or having been installed by them, shall be restored at Contractor's expense and to the Owner's satisfaction.
- D. Securely cover openings into the system and cover apparatus, equipment, and appliances, both before and after being set in place, to prevent obstruction in the pipes and the breakage, misuse or disfigurement of the apparatus, equipment or appliances.

3.3 LAYOUT AND VERIFICATION

- A. The Contractor shall stakeout the locations of all piping, quick coupling valves, spray heads, rotors, and emitters in accordance with the irrigation design drawings. The

Contractor shall check and verify dimensions of layout and report variations to the Landscape Architect before proceeding. Layout work as accurately as possible to the drawings.

- B. Minor changes in locations to the above from locations shown shall be made as necessary to avoid existing or proposed planting, piping, utilities, structures, etc., at the Contractor's expense, or when directed by the Landscape Architect, providing such change is ordered before such items or work directly connected to same are installed, and providing no additional materials are required.
- C. The Contractor will be held responsible for the relocating of any items without first obtaining the Landscape Architect's approval. The Contractor shall remove and relocate such items, at his expense; if so directed by the Landscape Architect.
- D. Before starting work on irrigation system, carefully check all grades to determine that work may safely proceed, keeping within the specified material depths. The Contractor shall be aware of the fact that the drawings are horizontal dimensions. Actual measurements taken along the slope of a bank will differ from those shown on the drawings.
- E. No fittings shall be installed on pipe underneath pavement or walls except where noted on the irrigation drawings. If such a need should occur, the Contractor shall bring it to the attention of the Landscape Architect.
- F. Exact sprinkler head placement is based on and shall be coordinated with actual planting layout and shall be verified by the Landscape Architect.
- G. All changes shall be recorded daily on the Record Drawings.

3.4 TRENCHING AND BACKFILLING

- A. Provide a minimum of 24" cover over top of PVC main line for potable irrigation systems, or per city code.
- B. Provide a minimum of 12" cover over top of PVC lateral piping for potable irrigation systems, or per city code.
- C. Backfill for irrigation lateral lines shall be with clean material from excavation. Remove organic material as well as rock and debris larger than 1" diameter. Irrigation piping shall have no rock or debris touching at any point along its length. A minimum of 6" clearance is required around all piping from all immovable obstructions. Place acceptable backfill material in 6" lifts, compacting each lift. Compact within 90% of the maximum density of the material used as determined by ASTM D-698 (Standard).
- D. Backfill trench to within 6" of finished grade. Continue fill with acceptable topsoil and compact to bring even with existing grade. Thorough compaction at each sprinkler head, valve, and piping will be required. Repair all settled areas.
 - 1. Under pavement areas contractor shall meet compaction requirements of pavement section plans and geotechnical report. Include flowable fill as required.

- E. Boring underneath existing pavement may be required. PVC sleeving for irrigation main line shall be installed underneath all pavements.
- F. Unless otherwise indicated, comply with requirements of the Uniform Plumbing code, city specifications, and all state or local codes.

3.5 TAPPING AND SUPPLY

- A. Verify meter and backflow preventer have been installed in building. Ref: Building MEP plans.
- B. Install irrigation mainline tap at stub out provided by building MEP. Coordinate with site contractor.

3.6 MASTER VALVE AND FLOW SENSOR

- A. Install master valve, flow sensor and pulse transmitter as per manufacturer's directions.
- B. Master valve and flow meter shall be installed in locking valve box per specification on detail sheets.

3.7 SLEEVING AND BORING

- A. Install sleeving at a depth which permits the encased wiring to remain at the specified depth.
- B. Extend the sleeve ends 6" beyond the edge of the paved surface. Cover pipe ends and mark with stakes.
- C. Install separate sleeve beneath paved areas to route each run of wiring. Any existing sleeving is not to be used without the consent of the Owner's Representative.
- D. Sleeving material beneath pedestrian pavements shall be PVC Class 200 pipe with solvent welded joints.
- E. Sleeving beneath drives and streets shall be PVC Sch. 40 pipe with solvent welded joints.
- F. Sleeving diameter shall be equal to twice the diameter of the wiring bundle.

3.8 CIRCUIT VALVES

- A. All valves shall be connected to main irrigation line in a plumb position. Each valve shall be installed in a valve box so that all parts of valve can be serviced. Valve boxes shall be installed over 6" of drainage gravel and shall be set so that the cover is flush with finish grade. Thorough compaction at valve boxes is required to bring the top of valve box 1" for turf and 2" for shrubs above finished grade after compaction and settlement has occurred. All settled valve boxes shall be raised prior to establishment acceptance.

- B. Adjust automatic control valves to provide flow rate of rated operating pressure required for each sprinkler circuit.
- C. Provide pressure regulation modules on the control valves for all zones that exceed recommended operating pressure by 5 psi as indicated in the irrigation zone schedule.

3.9 PIPING

- A. Lay pipe in properly excavated trenches.
- B. For all mainline piping, slope to manual drain valve and drainage pit at least 1/2" in 10' of run.
- C. Install PVC pipe in dry weather when temperature is above 40 F in strict accordance with manufacturer's instructions. Allow joints to cure at least 24 hours at temperatures above 40 F (4 C) before testing, unless otherwise recommended by manufacturer.
- D. Manual Drain Valves: Install manual drain valves at all low points in main irrigation supply line. Record location on as-built drawings.
- E. Manual Gate Valves: Install manual gate valves at location shown on plan in main irrigation supply line. Record location on as-built drawings.
- F. Drainage Pits: 3 cu. ft. of clean gravel, minimum 18" deep, 1-1/12" - 2" size, shall be located at all manual and automatic drain valves. Cover drainage pit with a soil separator and backfill to finish grade with excavated soil material.
- G. Sleeves: Install sleeves for all main line, laterals, and wire that cross roadways, drives, sidewalks, and all other paving surfaces. Sleeves shall be a minimum of 4" diameter, and shall be sized to accommodate all equipment necessary. Top of sleeves shall be a minimum of 24" below surface of paving. Sleeves shall extend a minimum of 12" behind back of curb. Permanently mark location of each end of sleeve on back of curb.

3.10 SPRINKLER AND ROTOR HEADS

- A. Flush circuit lines with full head of water and install heads after hydrostatic test is completed.
- B. All sprinkler heads shall be set plumb at the elevation to be flush with finish grade.
- C. Contractor shall adjust, if necessary, the elevation of the sprinkler heads after finish grade and landscape plantings are complete.
- D. Install all sprinkler heads with pre-assembled swing-joints or swing-assemblies. Funny pipe will not be accepted for installation of any kind.

3.11 LANDSCAPE DRIPLINE

- A. Final installation of drip irrigation to occur after the trees, shrubs and other plant material has been installed.
- B. Flexible inline tubing or point source emitter tubing shall be used.
- C. Layout drip and distribution tubing as detailed on the plans to place drip tubing near root zone of the plantings. Install drip tubing at or near the surface of planting soil.
- D. Install one (1) OPERIND drip system operation indicator per drip zone at the furthest point of the drip zone from the remote control valve.
- E. Stake all drip tubing with steel stakes so that no movement of the pipe exists.
- F. Pressurize, flush and cap drip tubing.
- G. Cover drip tubing with specified depth of mulch.

3.12 CONTROLLER

- A. Controller shall be installed in permanent location as shown on plan and verified by Landscape Architect.
- B. Contractor shall properly programmed controllers for this particular job prior to substantial completion of this project.
- C. Control wire of system shall be 2 x 14 gauge, specifically designed for direct burial use. A minimum of 3'-0" of extra wire shall be spooled at each decoder location, at each splice, at each change in direction and at every 500 feet of straight run. At each termination of the mainline, an additional 6'-0" of wire shall be coiled and located within a valve box.
- D. Control wire shall be installed in multiple wire paths as shown on the plans.
- E. Wire shall be placed consistently along one side of the pipe in the trench. Splices and connections shall be watertight and leak proof, use Pin-Tight connections. Multiple wires in the trenches shall be banded together at 20-foot intervals for protection. Wire not along mainline pipe shall be placed within an electrical conduit.
- F. Install monitoring equipment including Weather Station, Flow Meter, and Soil Moisture Sensor. Electrical connections between controller and monitoring equipment shall be installed by contractor per manufacturer's recommendations. Irrigation contractor is responsible for all electrical power connections from power supply point adjacent to weather station.
- G. Install all surge protection as per manufacturer's latest instructions.
- H. Lightning protection: Drive three 8' copper-clad grounds into the soil. If soil conditions prevent proper penetration of the ground rods into the soil, contact the Landscape Architect. Connect controller to grounding rod with AWG No. 10 Solid conductor copper wire. Secure wire to grounding rod with brass or bronze clamp.

- I. Install electrical connections between controller manufacturer's recommendations.
- J. Install all surge protection as per manufacturer's latest instructions.
- K. Lightning protection: Drive three 8' copper-clad grounds into the soil. If soil conditions prevent proper penetration of the ground rods into the soil, contact the Landscape Architect. Connect controller to grounding rod with AWG No. 10 Solid conductor copper wire. Secure wire to grounding rod with brass or bronze clamp.
- L. Irrigation Control Units
 - 1. The locations of the control units depicted on the drawings are approximate; the Owner's Representative, with assistance from the manufacturer's representative and the Landscape Architect, will determine the exact site locations at the system layout review.
 - 2. General Contractor will provide all communication drop location as designated on the plans. The irrigation contractor is responsible for all connections from stubout locations. Coordinate with General Contractor.
 - 3. General Contractor to provide all 120VAC power for control units. Coordinate location of power with Landscape Architect.
 - 4. Install electrical connections between central control unit components and satellite control units per manufacturer's recommendations.
 - 5. Install electrical connections between satellite control units and monitoring equipment per manufacturer's recommendations.
 - 6. Install all surge protection as per manufacturer's latest instructions.
 - 7. Lightning protection: Drive three 8' copper-clad grounds into the soil. If soil conditions prevent proper penetration of the ground rods into the soil, contact the Owner's Representative. Connect controller to grounding rod with AWG No. 10 solid conductor copper wire. Secure wire to grounding rod with brass or bronze clamp.
 - 8. Attach wire markers to the ends of control wires inside the controller unit housing. Label wires with an identification number that consists of the name and station number of the existing controller to which the control wire had been previously connected.
 - 9. Connect control wire to corresponding control unit terminal. Connect wires to the satellite controller in the same order they are connected to the existing controller.
 - 10. Connection to controller per manufacture recommendation.
- M. Irrigation Control System Setup
 - 1. All irrigation schedules and programming shall be set up per manufacture recommendations.
 - 2. Contractor shall set up all modules including connection to all site controllers and sensors.

3.13 HYDROSTATIC TESTING

- A. Contact the Landscape Architect, while the necessary piping system components are exposed. All mainline piping is to be subjected to a hydrostatic test. Subcontractor is to supply all testing equipment including pump and all caps and gauges as required.

- B. Pressure gauges shall be read in PSI. Calibration shall be such that accurate determination of potential pressure loss can be ascertained. Test supply line at a pressure of 120 PSI for minimum of one hour with an allowable loss of 5 PSI.
- C. Re-test as required until the system meets the requirements. During the tests, regardless of the amount of leakage, all detectable leaks are to be stopped and all defects corrected.

3.14 ADJUSTING THE SYSTEM

- A. Adjust alignment and coverage of all sprinklers and rotors if it is determined that adjustments in the irrigation equipment will provide proper and more adequate coverage. Make all necessary changes or make arrangements as directed by Landscape Architect. These changes or adjustments shall be made without additional cost.

3.15 RECORD DRAWINGS

- A. Indicate actual location of all valves and controls including piping. Show dimensions from easily identifiable existing features such as walls, curbs, fences, buildings, or walks. Submit diagram to the Landscape Architect for approval.
- B. Maintain progress drawings on the construction site at all times during installation of the irrigation system. Make a daily record of all work installed each day until completion of the work.
- C. Submit to Owner one (1) electronic version of the irrigation record drawings.
- D. Submit to Owner one (1) 1/2 size reduction of the irrigation record drawing, laminated both sides, for inclusion into the inside of the controller door.
- E. Submit to Owner two (2) full size plan sets of the irrigation record drawings.

3.16 ACCEPTANCE

- A. The ASP shall instruct the owner's designated personnel in the operation of the system pursuant to the training section already outlined in the specifications.
- B. The irrigation control system must be commissioned the ASP prior to final walk through of the system. The ASP shall confirm that the system is installed and grounded per the manufacture's recommendations. The Contractor shall address any system deficiencies found by the ASP prior to substantial completion.

3.17 GUARANTEE AND MAINTENANCE INSTRUCTIONS

- A. The Contractor shall fill and repair all depressions and replace all necessary lawn and planting due to the settlement of irrigation trenches for one year following the completing and acceptance of the job.

- B. The Contractor shall also guarantee all materials, equipment and workmanship furnished by him to be free of all defects of workmanship and materials, and shall agree to replace at his expense, at any time within one year after installation is accepted, any and all defective parts that may be found. Contractor shall transfer all manufacturer material warranties to the Owner. All manufacturer warranties shall be in effect for the period outlined in the manufacturer literature from the date of installation. Contractor shall detail these warranties and provide all necessary information regarding them to the Owner in the record drawing submittals.
- C. The Contractor shall drain the irrigation system in the fall of the first year, and provide start up in the following spring.
- D. After the system is installed and approved, instruct the Owner or Owner's representative as to the complete operation and maintenance.

END OF SECTION 328400

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Seeding.
 - 2. Hydroseeding.
 - 3. Sodding.

1.3 RELATED SECTIONS

- A. Section 328400 – Planting Irrigation
- B. Section 329300 - Plants

1.4 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- C. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See [Section 329113 "Soil Preparation"] [Section 329115 "Soil Preparation (Performance Specification)"] and drawing designations for planting soils.
- D. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.5 INFORMATIONAL SUBMITTALS

- A. Prior to delivery to the job site, contractor shall submit to the Landscape Architect the source and supplier of all grass sod, seed, fertilizer, and other materials along with the type of equipment to be used on this project.
Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
- B. Certification of grass seed.
- C. Certification of each seed mixture for turfgrass sod.
- D. Product Certificates.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.7 QUALITY ASSURANCE

- A. Regulatory Requirements
 - 1. Comply with applicable requirements of Federal, State, and Local laws, regulations and codes having jurisdiction at the project site.
 - 2. Contractor shall be responsible for certificates of inspection of plant material that may be required by Federal and Local authorities to accompany shipments of plants.
- B. Reference Standards
 - 1. "Standardized Plant Names" by the American Joint Committee of Horticultural Nomenclature.
 - 2. American National Standards Institute (ANSI); Publication Z60.1
- C. Coordination
 - 1. Work in conjunction with other trades as directed, taking all reasonable precautions to avoid disturbance or interference with any other operation or installation on the site. Contractors shall be responsible for the cost of replacing any material damaged as a result of his/her negligence.
- D. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
2. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the National Association of Landscape Professionals:
 - a. Landscape Industry Certified Technician - Exterior.
 - b. Landscape Industry Certified Lawn Care Manager.
 - c. Landscape Industry Certified Lawn Care Technician.
3. Pesticide Applicator: State licensed, commercial.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.
- C. Bulk Materials:
 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Accompany each delivery of bulk materials with appropriate certificates.

1.9 JOB CONDITIONS

- A. Examination of Site:
 1. The bidder must acknowledge that he has examined the site, Drawings and Specifications and the submission of a quotation shall be considered evidence that examinations have been made.
- B. Field Conditions:
 1. The Contractor shall verify drawing dimensions with actual field conditions and inspect related work and adjacent surfaces. The Contractor shall report to the Landscape Architect all conditions which prevent proper execution of this work.

- C. The Contractor shall determine the exact location of all existing utilities, structures, and geogrid reinforcement before commencing work. The Contractor shall conduct his work so as to prevent interruption of service or damage to them. The Contractor agrees to be fully responsible for any and all damage which might be occasioned by the Contractor's failure to exactly locate and preserve and all utilities, structures, and geogrid reinforcement.

SEQUENCING AND SCHEDULING

- D. Planting Restrictions: Proceed with and complete planting as rapidly as portions of the site become available, working within seasonal limitations for each kind of landscape work required. Recommended dates for seeding and sodding:
 - 1. Spring Planting: April 1 – June 15.
 - 2. Fall Planting: September 1 – December 15.
- E. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

MATERIALS CLEAN-UP

- A. The Contractor shall keep the premises free from rubbish and all debris associated with their work at all times, and all unused materials and debris shall be removed the site and disposed of in a legal manner.

WARRANTY

- A. All plant material (lawns) shall be warranted for a period of not less than one (1) year from the date of issuance of the letter of Substantial Completion.
- B. All replacement stock shall be subject to the same warranty requirements as the original stock. Any damage due to replacement operations shall be repaired by the Contractor. At the end of the warranty period, inspections shall be made jointly by the Owner, Landscape Architect, and Contractor. All lawn areas not in healthy growing condition shall be removed and replaced with grasses of like kind and size before the close of the next planting season and before issuance of the letter of Final Completion.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species:
 - 1. Quality, State Certified: State-certified seed of grass species as listed below for solar exposure.
 - 2. Quality, Non-State Certified: Seed of grass species as listed below for solar exposure, with not less than 85 Insert number percent germination, not less than 95 Insert number percent pure seed, and not more than 0.5 Insert number percent weed seed:
 - 3. Full Sun, Cool-Season Grass: Kentucky bluegrass (*Poa pratensis*), a minimum of three cultivars.
 - 4. Sun and Partial Shade, Cool-Season Grass: Proportioned by weight as follows:
 - a. 50 percent Kentucky bluegrass (*Poa pratensis*).
 - b. 30 percent chewings red fescue (*Festuca rubra* variety).
 - c. 10 percent perennial ryegrass (*Lolium perenne*).
 - d. 10 percent redtop (*Agrostis alba*).
 - 5. Shade, Cool-Season Grass: Proportioned by weight as follows:
 - a. 50 percent chewings red fescue (*Festuca rubra* variety).
 - b. 35 percent rough bluegrass (*Poa trivialis*).
 - c. 15 percent redtop (*Agrostis alba*).

2.2 TURFGRASS SOD

- A. Turfgrass Sod: Certified Approved Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture that is strongly rooted and capable of vigorous growth and development when planted.
- B. Turfgrass Species, Cool-Season Grass: Sod of grass species as follows, with not less than 85 Insert number percent germination, not less than 95 Insert number percent pure seed, and not more than 0.5 Insert number percent weed seed:
 - 1. Full Sun: Kentucky bluegrass (*Poa pratensis*), a minimum of three cultivars.
 - 2. Sun and Partial Shade: Proportioned by weight as follows:

- a. 50 percent Kentucky bluegrass (*Poa pratensis*).
 - b. 30 percent chewings red fescue (*Festuca rubra* variety).
 - c. 10 percent perennial ryegrass (*Lolium perenne*).
 - d. 10 percent redtop (*Agrostis alba*).
3. Shade: Proportioned by weight as follows:
 - a. 50 percent chewings red fescue (*Festuca rubra* variety).
 - b. 35 percent rough bluegrass (*Poa trivialis*).
 - c. 15 percent redtop (*Agrostis alba*).

2.3 FERTILIZERS

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 1. Composition:
 - a. 1 lb/1000 sq. ft. Insert value of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
 - b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
 1. Composition:
 - a. 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
 - b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.4 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.5 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 3. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect/Engineer and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.

2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Before planting, obtain Landscape Architect's acceptance of finish grading, restore planting areas if eroded or otherwise disturbed after finish grading.

3.3 TURF AREA PREPARATION

- A. General:
 1. Clearing
 - a. All areas of turf establishment are to be cleared by the Contractor.
 - b. Clearing shall consist of the satisfactory removal and disposal of brush, rubbish, and other vegetative growth occurring within all proposed turf areas unless turf is being overseeded. All debris associated with this work shall be gathered and removed from the Project by the Contractor.
 2. Preparation of Planting Mixture
 - a. Mix recommended soil amendments and fertilizers with topsoil at rates recommended by the soil test results. Delay addition of fertilizer if planting mixture will not be used within two (2) days.
 3. Protection of Existing Vegetation
 - a. All areas under drip lines of existing trees shall be kept free of construction equipment, trailers, material storage, and vehicles.
 - b. Exercise extreme care when working around existing trees to remain. No soil scarification or compaction from construction vehicles shall occur under any existing tree dripline.
 - c. In areas of established turf, the surrounding turf area shall be covered in a manner that will provide protection before excavations begin for sodded turf.
- B. Reduce elevation of planting soil to allow for soil thickness of sod.
- C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.4 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 2. Do not use wet seed or seed that is moldy or otherwise damaged.

3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a manufacturer's recommended rate for new lawns.
- C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blanket and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
- F. Protect seeded areas from hot, dry weather or drying winds by applying planting soil within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.5 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, commercial fertilizer slow-release fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
 1. Mix slurry with non-asphaltic tackifier.
 2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
 3. Spray-apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre.

3.6 SODDING

- A. All sod areas indicated on the plans shall have temporary cover removed, fine graded and sodded as specified herein and in strict accordance with standard horticultural practices.
- B. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

- C. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to soil or sod during installation. Tamp and roll lightly to ensure contact with soil, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
 - 1. Lay sod across slopes exceeding 1:3.
 - 2. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.
- D. As sodding is completed in any one section, the entire area shall be rolled or tamped to insure solid contact of roots with the soil surface. Sod shall be watered immediately after rolling and tamping until the underside of the new sod pad and soil surface below the sod are thoroughly moistened. The operations of laying, tamping and watering for any piece of sod shall be completed within eight (8) hours.
- E. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.7 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
 - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 - 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
1. Mow turf-type tall fescue to a height of 2 to 3 inches.
- D. Turf Postfertilization: Apply commercial fertilizer slow-release fertilizer after initial mowing and when grass is dry.
1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.8 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect/Engineer:
1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
 2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.9 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.10 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.
- C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- D. Remove nondegradable erosion-control measures after grass establishment period.

3.11 MAINTENANCE

- A. The Contractor shall maintain sod and seed areas by weeding and mowing as required for healthy growth until issuance of the letter of Substantial Completion for the entire site and scope of work.
- B. The Contractor shall be responsible for watering sod areas until the new irrigation system is completely functional and the letter of Substantial Completion has been issued. Contractor shall be responsible for watering sod areas by hand where irrigation system does not cover. Hand watering of these areas shall continue until letter of Substantial Completion has been issued. Watering shall supplement natural rainfall and shall assure that the sod areas receive a minimum of one (1) inch of water per week. Sod shall be watered daily during the first week and in sufficient quantities to maintain moist soil to a depth of four inches (4"). After the first week sod shall be watered as necessary to maintain adequate moisture.

END OF SECTION

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, and services necessary to install plant material, preparation of soil, fine grading, planting, mulching, guying, pruning, watering, and the proper disposal of any excess earth or debris, all in accordance with the accompanying Drawings and these Specifications.

1.2 SUMMARY

- A. Section Includes:
 - 1. Plants.
 - 2. Mulches.
 - 3. Tree stabilization.
 - 4. Tree-watering devices.
 - 5. Landscape edgings.

1.3 RELATED SECTIONS

- A. Section 328400 – Planting Irrigation
- B. Section 329200 - Turf and Grasses

1.4 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.
- C. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

- D. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

1.5 COORDINATION

- A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
 - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples of each type of mulch.

1.7 INFORMATIONAL SUBMITTALS

- A. Product Certificates
- B. Sample Warranty

1.8 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year.

1.9 QUALITY ASSURANCE

- A. Regulatory Requirements
 - 1. Comply with applicable requirements of Federal, State, and Local laws, regulations and codes having jurisdiction at the project site.
 - 2. Contractor shall be responsible for certificates of inspection of plant material that may be required by Federal and Local authorities to accompany shipments of plants.
- B. Reference Standards
 - 1. "Standardized Plant Names" by the American Joint Committee of Horticultural Nomenclature.
 - 2. "American Standard of Nursery Stock" by the American Association of Nurseryman.
 - 3. American National Standards Institute (ANSI); Publication Z60.1.

C. Substitutions

1. Substitutions of plant material will not be permitted unless authorized in writing by Owner or Landscape Architect. If proof is submitted that any plant specified is not obtainable, a proposal will be considered for use of the nearest equivalent size or variety with corresponding adjustment of Contract Price. Such proof shall be substantiated and submitted in writing to the Owner and Landscape Architect at least thirty (30) days prior to start of the work under this Section. These provisions shall not relieve the Contractor of the responsibility of obtaining specified materials in advance if special growing conditions or other arrangements must be made in order to supply specified materials.

D. Condition and Source of Plants

1. Plants shall be subject to review and approval by the Owner or Landscape Architect upon delivery for conformity to Specifications. Such approvals shall not impair the right of review and rejection during progress of the Work. Submit written request for inspection of plant material at place of growth and quantity of plants to be inspected.

E. Coordination

1. Work in conjunction with other trades as directed, taking all reasonable precautions to avoid disturbance or interference with any other operation or installation on the site. Contractors shall be responsible for the cost of replacing any material damaged as a result of his/her negligence.

F. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

1. Pesticide Applicator: State licensed, commercial.

G. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage of Materials

1. All materials delivered to the job shall be stored so as to keep them in new condition and free from deterioration. Peat moss, fertilizer, etc., shall be stored in temporary sheds off-site at Contractor's expense.

B. Packaged Materials

1. Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

C. Plant Material

1. Plants shall not be delivered to the site until the corresponding beds are fully prepared. All shipments of nursery materials shall be thoroughly protected from the sun and from drying winds during transit. All plants which cannot be planted at once after delivery to the site of the work shall be well protected against the possibility of drying by wind and sun. Balls of earth on B&B plants shall be kept covered with soil or other acceptable material. All materials heeled-in on the property shall be adequately watered.
2. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
3. Handle planting stock by root ball.
4. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.
5. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
6. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
7. Do not remove container-grown stock from containers before time of planting.
8. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.11 JOB CONDITIONS

- A. Examination of Site:
 1. The bidder must acknowledge that he has examined the site, Drawings and Specifications and the submission of a quotation shall be considered evidence that examinations have been made.
- B. Field Conditions: The Contractor shall verify drawing dimensions with actual field conditions and inspect related work and adjacent surfaces. The Contractor shall report to the Landscape Architect all conditions which prevent proper execution of this work.
- C. The Contractor shall determine the exact location of all existing utilities, structures, and geogrid reinforcement before commencing work. The Contractor shall conduct his work so as to prevent interruption of service or damage to them. The Contractor agrees to be fully responsible for any and all damage which might be occasioned by the Contractor's failure to exactly locate and preserve any and all utilities, structures, and geogrid reinforcement.

1.12 SEQUENCING AND SCHEDULING

- A. Planting Time: Proceed with and complete planting as rapidly as portions of the site become available, working within seasonal limitations for each kind of landscape work required.
- B. Planting Dates:
 - 1. Trees, shrubs, and perennials shall be planted only when the ground is not frozen, snow covered, or in an otherwise unsuitable condition for planting. Spring planting shall generally occur between Feb 15 and May 31, and fall planting shall generally occur between September 1 and Dec 15.

1.13 MATERIALS CLEAN-UP

- A. The Contractor shall keep the premises free from rubbish and all debris associated with their work at all times and all unused materials and debris shall be removed from the site.

1.14 WARRANTY

- A. All plant material (trees, shrubs, etc.) and planting supplies (bark mulch, etc.) shall be warranted for a period of not less than one (1) year from the date of issuance of the letter of Substantial Completion.
- B. All replacement stock shall be subject to the same warranty requirements as the original stock. Any damage due to replacement operations shall be repaired by the Contractor. At the end of the warranty period, inspections shall be made jointly by the Owner, Landscape Architect, and Contractor. All plants not in a healthy growing condition shall be removed and replaced with plants of a like kind and size before the close of the next planting season and before issuance of the letter of Final Completion.
- C. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
 - b. Structural failures including plantings falling or blowing over.

PART 2 - PRODUCTS

2.1 TOPSOIL

- A. Topsoil shall be fertile, natural topsoil, typical of the locality. Stockpiled topsoil may be used. It shall be free of subsoil, slag, clay, stones, lumps, sticks, plants or their roots, toxic substances or other extraneous matter that may be harmful to plant growth or would interfere with future maintenance. Topsoil pH range shall be 6.0 to 7.0.
- B. Soil Testing:
 - 1. Onsite Topsoil – The Contractor shall be responsible for having onsite topsoil tested by the Local County Extension Office to determine the amounts of amendments needed to meet the desired pH, nutritional organic levels determined to be adequate for the area by the County Extension Agent. The Contractor shall submit topsoil tests to the Landscape Architect.
 - 2. Offsite Topsoil - The Contractor shall be responsible for having offsite imported topsoil tested by the Local County Extension Office to determine the amounts of amendments needed to meet the desired pH, nutritional organic levels determined to be adequate for the area by the County Extension Agent. The Contractor shall submit topsoil tests to the Landscape Architect.
- C. Soil Conditioners and Amendments:
 - 1. Aluminum sulfate shall be horticultural grade.
 - 2. Peat shall be a natural product of sphagnum peat (peat moss), derived from a fresh-water site conforming to ASTM D 2607 except as otherwise specified. Peat shall be shredded and conditioned in storage piles for at least 6 months after excavation.
 - 3. Sand shall be clean and free of toxic materials.
 - 4. Vermiculite shall be horticultural grade and free of any toxic materials.
 - 5. Rotted manure shall be unleached stable or cattle manure not less than 8 months or more than 2 years old, containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; and containing no chemicals or ingredients harmful to plants. The manure shall be heat treated to kill weed seeds.
 - 6. Rotted sawdust shall have 7.5 pounds of nitrogen added uniformly to each cubic yard and shall be free of chips, stones, sticks, soil, and toxic substances.
 - 7. Gypsum shall be 90 percent pure, free of any toxic materials, and at least 95 percent by weight shall pass a 4-mesh sieve.
 - 8. Other amendments as recommended by County Extension Agent.
- D. Treatment of Saline Soil: Saline soil shall be leached out by a controlled amount of water sufficient enough to leach the salts to a level below the root zone. Water used for this purpose shall have a low salt content.

2.2 PLANTING SOIL MIXTURE

- A. The "topsoil mixture" shall be composed of on-site or off-site topsoil and additional soil amendments appropriate for the location and plantings based on the soil test provided in the appendix.
- B. The "planting soil mixture" for all planting pits shall be 80% topsoil mixture, 10% peatmoss, and 10% well composted manure. Mix thoroughly for uniformity of texture and distribution before placing in pit.
- C. The "planter soil mixture" for all planters shall be 60% topsoil mixture, 10% peatmoss, 10% well composted manure and 20% clean sand. Mix thoroughly for uniformity of texture and distribution before placing in planter.

2.3 PLANT MATERIAL

- A. Plant material shall be first quality stock and shall conform to the code of standards set forth in the current edition of the American Standards of Nursery Stock sponsored by the American Association for Nurserymen, Inc.
- B. Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
- C. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.
- D. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- E. Species and variety as specified on the Drawings and delivered to the site shall be certified true to their genus, species and variety and as defined within the current edition of "Standardized Plant Names" by the American Joint Committee of Horticultural Nomenclature.
- F. The Contractor shall facilitate inspection and identification by labeling of trees, shrubs, and perennials with a durable waterproof label and weather-resistant ink. Labels shall state the correct plant name and size as specified in the plant list of required plants. Labels shall be securely attached to plants and shall be legible for 60 days after delivery to the planting site. Wire identification tags shall not be used. Plants not labeled will be rejected. The Contractor shall remove all tags after the Landscape Architect's acceptance of the installation.

- G. Plants shall be nursery grown and shall be of varieties specified in the plant list bearing botanical names.
- H. Planting stock shall be well-branched and well formed, sound, vigorous, healthy, free from disease, sun-scale, windburn, abrasion, and harmful insects or insect eggs; and shall have healthy, normal unbroken root systems. Deciduous trees and shrubs shall be symmetrically developed, of uniform habit of growth, with straight trunks or stems, and free from objectionable disfigurements. Evergreen trees and shrubs shall have well-developed symmetrical tops with typical spread of branches for each particular species or variety. Evergreen trees and shrubs shall not be sheared. Plants shall have been grown under climatic conditions similar to those in the locality of the project. Deciduous plants shall be dug in a dormant stage only.
- I. Stock Sizes: All stock measurements - caliper, height, branching level, number of canes, ball sizes shall be in strict accordance with the latest edition of the American Standard for Nursery Stock, unless otherwise noted on the plans. Plants used on the project shall meet or exceed all minimum requirements indicated in the size, condition, and remarks sections of the planting legend on the plan sheets.\
- J. All stock shall be balled and burlapped or container grown stock. Bareroot stock of any kind is unacceptable.

2.4 FERTILIZERS

- A. All fertilizers shall be horticultural grade complete formula fertilizers and shall conform to the applicable State Fertilizer Laws.
- B. Plant Stock: Fertilizer shall be "AGRIFORM" slow release fertilizer tablets. To be applied per manufacturer's specifications. Perennials areas: Fertilizer shall be applied at the same rate as the lawn areas.

2.5 MYCORRHIZAL

- A. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.
- B. All mycorrhizal shall be horticultural grade complete formula mycorrhizal and shall conform to the applicable State Mycorrhizal Laws.
- C. MYKE Pro Landscape Granular Mycorrhizal Inoculant
 - 1. Distributor: Subject to compliance with requirements, provide products by the following:
 - 2. Arbor Valley Nursery, Brighton, CO, (303) 654-1682, ArborValleyNursery.com

3. For approved equal, reference specific written instructions from manufacturer

2.6 MULCHES FOR PLANTINGS

- A. Hardwood Mulch: Mulch in all open planting beds labeled as hardwood mulch shall be shredded double ground oak or dark hardwood mulch of its natural color. Cypress, or dyed or colored mulch is unacceptable. Bark shall be of a relative uniform particle size with a median size of one and one-half inches (1-1/2") and shall be free of sticks, stones, leaves and any other debris.

2.7 GEOTEXTILE FILTER FABRIC

- A. Woven Geotextile Filter Fabric: Polypropylene fabric, 3.5 oz to 4.0 oz./sq. yd. minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.

2.8 PESTICIDES

- A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.9 TREE-STABILIZATION MATERIALS

- A. Trunk-Stabilization Materials:
 1. Steel "T" bar fence post, 8' long, painted dark green with the top 6" painted white
- B. Tree tie systems shall be easily adjustable, strong in all weather, and easily attached and removed. Hose and wire are not acceptable for staked trees. Tree tie systems shall be the following or approved equal:
 1. Cinch Ties, J. Lichtenthaler
P.O. Box 938

Cerritos, CA 90701

2. Adj-A-Type
Heavyweight only, plastic chain twist tie
3. A.M. Leonard and Sons
Piqua, Ohio 43356
Plastic Binder Tye, tie with tapered beads that snap lock

2.10 EDGING

- A. Shrub bed edge adjacent to turf areas shall be black powder coat steel 3/16" x 4"x 16' edging as manufactured by Sure-Loc Edging. or approved equal.
1.800.787.3562
- B. Bed edging adjacent to concrete curb, pavement and sidewalk shall be manicured "V" edge per details.

2.11 WATER

- A. Water shall not contain elements toxic to plant life. It shall be the Contractor's responsibility to obtain water to be used for watering of plant material.

2.12 TREE-WATERING DEVICES

- A. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over an extended time period; manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BIO-PLEX, Water-It-Well 18 Gal.
 - b. Spectrum Products, Inc., Treegator Original Slow Release Watering Bag
 2. Color: Green

2.13 MISCELLANEOUS PRODUCTS

- A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.
- B. Burlap: Non-synthetic, biodegradable.

- C. Planter Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTM D448 for Size No. 8 Insert requirements.
- D. Planter Filter Fabric: Woven geotextile manufactured for separation applications and made of polypropylene, polyolefin, or polyester fibers or combination of them.
- E. Trunk Wrapping Material: Tree wrap products shall be two thicknesses of crinkled paper cemented together with a layer of bituminous material. Wrapping material shall be a minimum of 4" inches in width and have a stretch factor of 33 1/3 percent. Twine for tying shall be a grafting cord.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
 - 3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GENERAL PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.
- D. Lay out plants at locations directed by Architect. Stake locations of individual trees and shrubs and outline areas for multiple plantings.
- E. Preparation of Planting Soil Mixture
 - 1. Mix recommended soil amendments and fertilizers with topsoil at rates recommended by the soil test results. Delay addition of fertilizer if planting mixture will not be used within two (2) days.
- F. Protection of Existing Vegetation
 - 1. All areas under drip lines of existing trees shall be kept free of construction equipment, trailers, material storage, and vehicles.
 - 2. Exercise extreme care when working around existing trees to remain. No soil scarification or compaction from construction vehicles shall occur under any existing tree dripline.
 - 3. In areas of established turf, the surrounding turf area shall be covered in a manner that will provide protection before excavations begin.

3.3 PLANTING AREA ESTABLISHMENT

- A. General: Prepare planting area for soil placement and mix planting soil Coordinate
- B. Placing Planting Soil: Place manufactured planting soil over exposed subgrade.
- C. Before planting, restore planting areas if eroded or otherwise disturbed after finish grading.
- D. Application of Mycorrhizal Fungi: At time of planting, apply dry product uniformly over prepared soil at application rate according to manufacturer's written recommendations.

3.4 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits.
 - 1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

2. Excavate approximately three times as wide as ball diameter for balled and burlapped stock.
 3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
 4. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
 5. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
 6. Maintain supervision of excavations during working hours.
 7. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
 8. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.
- B. Backfill Soil: Subsoil may not be used as backfill and the top six (6) inches of topsoil removed from excavations, if free from subsoil, clay, rocks, roots, or other debris, may be utilized in the topsoil mixture as specified.
- C. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
1. Hardpan Layer: Drill 6-inch- diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet, whichever is less, and backfill with free-draining material.
- D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
- E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE, SHRUB, AND VINE PLANTING

- A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Balled and Burlapped and Container-Grown Stock: Balled and burlapped and container grown plants shall be handled and moved only by the ball or container. Container-grown stock shall be removed from containers without damaging plant or root system. Set each plant plumb and in center of planting pit or trench with root flare 2 inches above adjacent finish grades.

1. Backfill: Planting soil as specified.
 2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
 3. Apply Mycorrhizal to root ball according to manufacturer's recommended rates. Inoculant must be physically rubbed onto the root ball thoroughly prior to backfilling planting hole.
 4. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 5. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
 - a. Quantity: Per manufacturer's recommended rates.
 6. Continue backfilling process. Water again after placing and tamping final layer of soil.
- D. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 TREE, SHRUB, AND VINE PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Prune, thin, and shape trees, shrubs, and vines as directed by Landscape Architect.
- C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.
- D. Do not apply pruning paint to wounds.

3.7 TREE STABILIZATION

- A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:
 1. Upright Staking and Tying:

- a. Trees shall be staked and guyed as indicated on plans within 24 hours of planting.
 - b. Stakes shall be driven vertically into the ground to a depth specified in details and in such a manner as to not damage the ball or roots.
 - c. Tree tie systems shall be installed as per manufacturer specifications.
 - d. All trees 2-1/2 inches in caliper or less shall be staked with two stakes. All trees greater than 2-1/2 inches in caliper shall be staked with three stakes, spaced equal distant around the tree.
2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
 3. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

3.8 TREE WRAPPING

- A. Deciduous trees planted in specified fall timeframe shall have their trunks wrapped with 24 hours after planting.
- B. Apply specified tree wrap per manufacturer's recommendations and specifications.

3.9 PLACING SOIL IN PLANTERS

- A. Wrap a layer of drainage gravel at least 4 inches thick in bottom of planter with filter fabric. Secure the filter fabric wrapped drainage gravel with duct tape to prevent soil from migrating into the drainage gravel layer during the soil-filling process.
- B. Fill planter with planting soil. Place soil in lightly compacted layers to an elevation of 1-1/2 inches below top of planter, allowing natural settlement.

3.10 GROUND COVER AND PLANT PLANTING

- A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.
- B. Use specified planting soil for backfill.
- C. Dig holes large enough to allow spreading of roots.
- D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.

- E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.11 PLANTING AREA MULCHING

- A. Prior to installation of mulch, all areas to be covered shall be weed free and treated with the specified pre-emergent herbicide.
- B. Mulching shall take place within 48 hours after planting.
- C. Mulch backfilled surfaces of planting areas and other areas indicated.
 - 1. Trees in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with 36-inch radius around trunks or stems. Do not place mulch within 3 inches of trunks or stems.
 - 2. Organic Mulch in Planting Areas: Apply 3-inch average thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.
 - 3. Mulch shall be kept off walls, sidewalks, light standards, and other structures.
 - 4. The top of all areas covered with mulch shall be 1-inch below the top of adjacent curb, walk, wall, wall cap, or edge of pavement.

3.12 INSTALLATION OF EDGING

- A. Steel Edging: Install steel edging where indicated on the Drawings according to manufacturer's written instructions.

3.13 INSTALLATION OF SLOW-RELEASE WATERING DEVICE

- A. Provide one device for each tree.
- B. Place device on top of the mulch at base of tree stem and fill with water according to manufacturer's written instructions.

3.14 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.
- B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.15 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.
- C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.16 CLEANING AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.
- C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

- E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.17 PLANT MAINTENANCE

- A. The Contractor shall maintain trees, shrub, and other plants by pruning, cultivating, and weeding as required for healthy growth until issuance of the letter of Substantial Completion for the entire site and scope of work. The Contractor shall tighten and repair stake and tree tie systems, reset trees and shrubs to proper grades or vertical position, restore or replace damaged wrappings, and apply herbicide and pesticides to keep trees, shrubs, and other plant material free of insects and disease as required until issuance of the letter of Substantial Completion.
- B. The Contractor shall be responsible for watering trees, shrubs, and other plant material until the new irrigation system is completely functional and the letter of Substantial Completion has been issued. Contractor shall be responsible for watering trees by hand where tree root watering irrigation does not occur. Hand watering of these trees shall continue for 90 days after letter of Substantial Completion has been issued. Watering shall supplement natural rainfall and shall assure that the trees, shrubs, and other plant material receive a minimum of 1-inch of water per week.

END OF SECTION