

Project Manual

DATE: November 1, 2024



DAYTON

CITY OF DAYTON

NEW POLICE STATION – WEST PATROL DISTRICT

10 Abbey Avenue

Dayton, Ohio 45417

BUILDING PACKAGE



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PROJECT NUMBER: 4205.00

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*SITE PACKAGE	SUBMITTED 8/24/2024	APPROVED 10/25/2024
**FOUNDATION PACKAGE	SUBMITTED 10/03/2024	APPROVED (TBD)

END OF DRAWING SHEET INDEX

DOCUMENT 00 3132
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 DHDC Engineering Consulting Services, Inc., dated July 16, 2024, 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 DOCUMENT 00 3132

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**GEOTECHNICAL INVESTIGATION REPORT
JOINT FIRE AND POLICE STATION
SEC OF THE INTERSECTION OF ABBEY AVENUE & WEST THIRD STREET
DAYTON, MONTGOMERY COUNTY, OHIO
DHDC PROJECT NUMBER: C24-100**

For:

**App Architecture
615 Woodside Drive
Englewood, Ohio 45322**

Submitted by:

**DHDC Engineering Consulting Services, Inc.
2390 Advanced Business Center Drive
Columbus, Ohio 43228**

Date:

July 16, 2024



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July 16, 2024

Timothy J. Bement, AIA
Principal
App Architecture
615 Woodside Drive
Englewood, Ohio 45322
O: 937.836.8898


RE: Geotechnical Investigation Report
Joint Fire and Police Station
Southeast Corner of the Intersection of Abbey Avenue & West Third Street
Dayton, Montgomery County, Ohio
DHDC Project Number: C24-100

Dear Mr. Bement:

In compliance with your request, DHDC Engineering Consulting Services, Inc. (DHDC) has completed a subsurface exploration and geotechnical evaluation for the above referenced project. We appreciate the opportunity to be of service to you on this project. If you have any questions regarding our report or if we may be of further service, please contact us at your earliest convenience.

Respectfully submitted,

DHDC Engineering Consulting Services, Inc.


Mohammed O. Haque, P.E.
Geotechnical Engineer




Savvas P. Sophocleous
Project Manager

Attachment



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1.0 INTRODUCTION

The site of the proposed Joint Fire and Police Station building structure is located at the southeast corner of the intersection of Abbey Avenue and West Third Street in Dayton, Montgomery County, Ohio. The purpose of this investigation was to determine the general types of subsoils present at the proposed site, to make an evaluation of their likely impact on the proposed development, and to make comments and recommendations relative to the design and construction of earthwork and building foundations for this project.

The scope of this investigation included a review of available geologic and soils data for the project area, a subsurface investigation consisting of six (6) standard soil test borings, field and laboratory soil testing, and an engineering analysis and evaluation of the subsurface conditions encountered at this site.

2.0 PROJECT AND SITE CHARACTERISTICS

The proposed building will be a single-story tall slab-on-grade type of structure and will involve load-bearing masonry walls. The footprint of the proposed building will be about 9,000 square feet. It is DHDC's understanding that the proposed building will house equipment room and offices. Parking and paved areas will surround the proposed facility.

Structural loads have not been provided; however, it has been assumed that maximum column loads will not exceed 100 kips, the maximum wall loads will not exceed 5 kips per linear foot and the maximum floor slab loads will not exceed about 200 pounds per sq. ft.

The topography of the proposed site can be described as relatively flat. No site grading plan and finished floor elevation of the proposed structure is available at this time. However, based on the exposed grade it appears that very minimal cuts and/or fill will be required (no more than 2 to 3± feet) to bring the site to the desired finished subgrade elevation.

3.0 INVESTIGATIVE PROCEDURES

DHDC performed four (4) soil Borings B-1 through B-4 within the footprint of the proposed building structure and two (2) soil Borings P-1 and P-2 within the proposed pavement areas. Based on the site plan DHDC staked the boring locations. The building borings were advanced to a depth of about 25 feet and the pavement borings to a depth of 15.0 feet below the exposed grade. The test borings were performed in accordance with geotechnical investigative procedures outlined in American Society for Testing and Materials (ASTM) Standards D 1452 and D 5434. The test borings were performed utilizing 3¼-inch inside diameter hollow-stem augers. Soil samples were collected at 2.5-foot intervals to a depth of 10.0 feet and 5.0 feet thereafter to the maximum depth explored.

Split-spoon samples were obtained by the Standard Penetration Test (SPT) Method (ASTM D 1586), which consists of driving a 2.5-inch outside diameter split-spoon sampler into the soil with a 140-pound weight falling freely through a distance of 30 inches. The sampler was driven in three successive 6-inch increments with the number of blows per increment being recorded. The sum of the number of blows required to advance the sampler the second and third 6-inch increments is termed the Standard Penetration Resistance (N-value) and is presented on the Logs of Test Borings attached to this report. The split-spoon samples were sealed in jars and transported to our laboratory for further classification and testing.

Soil conditions encountered in the test borings are presented in the Logs of Test Borings, along with information related to sample data, SPT results, water conditions observed in the borings, and laboratory test data. It should be noted that these logs have been prepared on the basis of laboratory classification and testing as well as on field logs of the encountered soils.

All samples of the subsoils were visually or manually classified using the Unified Group Soil Classification System (ASTM D-2487 and D-2488). All soil samples were tested in the laboratory for moisture content (ASTM-D 2216) and intact cohesive soil samples for Pocket Penetrometer tests. Atterberg Limit tests were performed on few selected soil samples. The results of these tests are presented on the soil boring logs attached to this report.

4.0 GENERAL SUBSURFACE CONDITIONS

4.1 Site Geologic Conditions

Various topographic, geologic and county soil and groundwater availability maps published by the Ohio Department of Natural Resources (ODNR) and the United States Department of Agriculture (USDA) were reviewed as part of this investigation. The results of the review are summarized in the paragraphs below.

The site is located in the Southern Ohio Loamy Till Plain regional physiographic province. The soils at the site are primarily fine-grained, low plasticity soils formed by weathering of the underlying loess and glacial till. Deep deposits of Late Wisconsinan-aged glacial till ground moraine cover the area to various depths. Glacial till soil consists of silts, silty clays, sandy clays, and clays with variable sand and gravel components. Interbedded thin to thick layers of sand and gravel are also encountered within the cohesive glacial till soil. These interbedded thick layers of cohesionless soils are mostly glacial outwash. The bedrock geology consists Ordovician-aged Drakes, Whitewater, and Liberty Formations. Geological and bedrock maps of Ohio are attached in Appendix of this report.

4.2 Soil Profile

Fill

Man-made fill material was encountered in all six (6) borings drilled for this investigation. Based on the soil borings information, it appears that the bottom of the man-made fill material at this site ranged from about 2.0 to 6.5 feet below the exposed grade. The man-made fill materials consisted of both cohesive and cohesionless soils. The upper layer of fill material in most of the borings consisted of a mixture of silty sand, gravel, and rock fragments. The thickness of this fill material ranged from about 2.0 to about 5.5 feet. The deeper depth fill material consisted of cohesive silty clay containing trace amounts of sand. The silty clay fill material in Boring B-2 contained organic odor.

The Standard Penetration Test N-values within the cohesionless fill material ranged from 10 to more than 50 blows per foot (bpf) and the moisture content ranged from 3 to 4 percent. The N-values within the cohesive fill material ranged from 8 to 11 bpf and the moisture content ranged from 10 to 27 percent.

Possible Fill Material

Below the man-made fill material, a thin layer of brown sandy clay possible fill material was encountered in Boring P-1. The bottom of the possible fill material is about 4.0 feet below the exposed grade.

Naturally Occurring Soil

Cohesive Soil

Below the fill material, naturally occurring native cohesive silty clay soil was encountered in most of the boring locations. The thickness of the silty clay soil ranged from about 1.5 to 4.0 feet. The silty clay soil is glacial till material. Trace amounts of sand and gravel were encountered within the cohesive silty clay soil. The N-values within the silty clay soils ranged from 3 to 7 bpf, indicating soft to medium stiff soil consistency. Natural moisture content of the silty clay cohesive soils ranged from 22 to 28 percent. Pocket Penetrometer value which is the approximate Unconfined Compressive Strength ranged from 1.0 to 2.5 tons per square foot (tsf). Atterberg Limit tests performed on representative samples from this stratum indicated Liquid Limits in the range of 38 to 39 percent and Plasticity Indices of 19 percent, indicating a classification of CL according to the Unified Soil Classification System (USCS).

The deeper depth cohesive soil consisted of silty sandy clay glacial till. All six (6) borings were discontinued in silty sandy clay soil to the maximum depth explored of 10.0 to 25.0 feet below the exposed grade. Coarse gravel and/or cobble were encountered within the silty sandy clay soil in silty sandy clay soil matrix in Boring B-3. Interbedded silty sand and gravel layers were observed within the silty sandy clay soil matrix in Boring B-2.

The N-values in silty sandy clay soil ranged from 8 to 49 bpf. It is most likely that the high N-values are due to the presence of coarse gravel or cobble within the soil matrix. Natural moisture content of the silty sandy clay soils ranged from 9 to 12 percent. Pocket Penetrometer values within these materials ranged from 2.0 to more than 4.5 tsf. Liquid Limit on representative samples from this stratum was 36 percent and the Plasticity Indices 15 to 16 percent, indicating a classification of CL according to the USCS.

Cohesionless Soil

Interbedded thin to thick layers of silty sand and sandy silt were encountered in glacial till soil matrix. The N-values within the cohesionless soils ranged from 4 to 33 bpf, indicating loose to dense relative density. The cohesionless soils sandwiched between less permeable glacial till soil usually hold perched or trapped groundwater.

4.3 Groundwater Conditions

Ground water observations were made during the drilling operations (by noting the depth of water on the drilling tools) and in the open holes following the withdrawal of the drilling augers. Groundwater was encountered in all but Boring P-2. The following table shows the depth of groundwater encountered in the soil borings:

Boring No.	Boring Depth (ft.)	Groundwater at the Time of Drilling (ft.)	Groundwater at End of Drilling (ft.)
B-1	25.0	10.0	11.3
B-2	25.0	9.0	10.2
B-3	25.0	9.0	10.2
B-4	25.0	17.0	None
B-5	10.0	10.0	None
B-6	10.0	None	None

Groundwater was encountered in all building borings and in pavement Boring P-1. Groundwater will be encountered within the cohesionless soils sandwiched between less permeable cohesive soils. Upon withdrawal of the augers Boring B-4, P-1, and P-2 stayed open (not caved) and other borings caved at depths ranging from 19.7 to 22.7 feet below the exposed grade.

Based on the soil borings information it appears that groundwater can be encountered as high as 9.0 to 10.0 feet below the exposed grade. Although these groundwater depths are not the reliable groundwater depths, it is possible that some perched or trapped groundwater can be encountered at any depths within the sand and gravel seam or layers in the glacial till soil matrix.

Seasonal influences typically cause a rise and fall in groundwater levels. Groundwater conditions should be anticipated to fluctuate depending on variations in precipitation, surface runoff, infiltration, site topography, and drainage. Fluctuation of the groundwater table can only be determined by installation of a monitoring well. Construction of monitoring well was beyond the scope of this investigation.

4.4 Seismic Site Classification

The Ohio Building Code (OBC) follows International Building Code (IBC) with regards to seismic guidelines. As part of the OBC code, the seismic properties of the overburden soils and bedrock are utilized to determine the site seismic classification. The Seismic Site Class is determined by evaluation of the shear wave velocities of the overburden soil and bedrock to a depth of 100 feet.

Based on the boring findings, review of geological information, and in accordance with the Ohio Building Code – Site Class Definitions, we estimate the site as a Site Class D - stiff soil profile. Table 20.3-1 of the International Building Code shows the various Site Class.

TABLE 20.3-1 SITE CLASSIFICATION

Site Class	v_s	\bar{N} or \bar{N}_{ch}	\bar{s}_u
A. Hard rock	>5,000 ft/s	NA	NA
B. Rock	2,500 to 5,000 ft/s	NA	NA
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the following characteristics: - Plasticity index $PI > 20$, - Moisture content $w \geq 40\%$, and - Undrained shear strength $\bar{s}_u < 500$ psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1 ft/s = 0.3048 m/s 1 lb/ft² = 0.0479 kN/m²

5.0 GEOTECHNICAL CONCLUSIONS AND RECOMMENDATIONS

Based upon our analysis of the soil conditions and the preliminary design details supplied for this project by the client as previously outlined, the following conclusions were reached, and the following recommendations were developed.

5.1 Important Information and Findings

- Building Borings B-1 through B-4 revealed approximately 5.5 to 6.5 feet of man-made fill material. The fill materials are not compacted engineered fill. The fill material contained various types of foreign materials.
- Below the man-made fill material, possible fill material was encountered in Boring P-1 to a depth of about 4.0 feet below the exposed grade.
- A thin layer of soft silty clay soil was encountered below the fill material in Boring B-2. Wet silty sand was encountered just below the soft silty clay soil. Loose silty sand was encountered below the silty clay soil in Boring P-2.
- Other than the soft and loose soil mentioned above in Boeings B-2 and P-2, the naturally occurring native soil encountered below the fill material consisted of medium stiff to very stiff silty to silty sandy clay glacial till soil.
- Groundwater can be encountered at about 9.0 to 10.0 feet below the exposed grade.

5.2 Building Foundation Recommendations

DHDC recommends complete removal of all existing fill material from the footprint of the proposed building structure footprint area and to a distance of at least 10.0 feet beyond the exterior building line and backfilling the undercut areas with compacted engineered fill. Based on the soil borings information it appears that the bottom of excavation will vary from about 5.5 to 6.5 feet below the exposed surface. However, the actual depth of undercut will be determined during the earth excavation. Provided all existing fill materials are removed as recommended above and the undercut areas backfilled with compacted engineered fill, the floor slab will rest on compacted engineered fill.

Once the foundation areas are prepared as recommended above, conventional shallow spread footing may be used to support the proposed building additions. Continuous (wall) footings, isolated (column) footings, or a combination of both may be utilized to transmit the structural loading to the bearing strata. DHDC recommends that the building footings be designed for a maximum net allowable bearing pressure of 3,000 pounds per square foot (psf) for both column (square) and wall (strip) footings.

This recommended soil bearing value should be considered the upper limit, and any value less than that listed above would be acceptable for the foundation system. It is strongly recommended that careful observation of the undercut excavation as well as all foundation excavations be carried out by a representative of DHDC to identify existing fill and other unsuitable materials and to recommend appropriate remedial actions as necessary.

In using net pressure, the weight of the footing and backfill over the footing including the weight of the floor slab need not be considered; hence, only loads applied at or above the finished floor need to be used for dimensioning the footings. Furthermore, wall footings and isolated column footings should be at least 18 inches wide and 24 inches square, respectively (or as per applicable building code requirements, whichever is larger) for protection against a punching shear type of failure.

Provided that the footings are designed as prescribed herein and inspected, it is estimated that the post construction total and differential foundation settlements will not exceed approximately 1 inch and $\frac{3}{4}$ inches, respectively. Careful field control will contribute substantially to minimizing the settlements.

Uplift forces on footings due to wind load can be resisted by the weight of the footings and the soil material that is placed over the footings. It is recommended that the soil weight be limited to that immediately above and within the perimeter of the footings (unless a much higher factor of safety is used). A total soil unit weight of 115 pounds/cubic foot can be used for the backfill material adjacent to and above the footings, provided it is compacted as recommended. It is also recommended that a factor of safety of at least 1.2 be used for calculating uplift resistance from the footings (provided only the weight of the footing and the soil immediately above it are used to resist uplift forces).

Lateral forces on a shallow spread footing can be resisted by the passive lateral earth pressure against the side of the footing and by friction between the subgrade soil and the base of the footing. A uniform allowable passive pressure of 500 pounds/square foot can be used for that portion of the footing that is below a depth of 3.0 feet below the final exterior grade (no portion of the footing above this depth should be used for lateral resistance). An allowable coefficient of friction (between the base of the footing and the underlying soil) of 0.20 can be used in conjunction with the minimum downward load on the base of the footing.

The footings should be taken to at least 3.0 feet below the final exterior grade for frost protection. All foundation bearing surfaces should be protected against freezing, surface water and undue disturbance as the cohesive soils will tend to soften and increase settlements in such cases. If possible, the footing concrete should be placed the same day that the excavation takes place. If this is not feasible, proper protection of the footing excavations should be provided. All footing excavations should be observed by a representative of DHDC to assure that adequate bearing is achieved before placing concrete for the foundations.

5.3 Floor Slab

Undercutting of existing fill materials and backfilling the undercut areas have been discussed in Sections 5.1 and 5.2 of this report. Since the site will be prepared as per the recommendations of Sections 5.1 and 5.2 of this report, the floor slab will rest on compacted engineered fill. DHDC recommends that the floor slab subgrade areas be proofrolled prior to the placement of the granular subbase material.

Particular attention should be paid to the placement of backfill against the foundation and beneath the slab as inadequate compaction at these locations may cause cracking of the slab edges and corners due to subsidence of the backfill. The slab should be “free floating”, i.e., not structurally attached to adjacent walls or foundations.

It is DHDC’s recommendation that the floor slabs be supported on a minimum six (6) inch thickness of clean, compacted granular material (ODOT Item No. 304 stone), to help distribute concentrated loads and to allow equalization of moisture conditions beneath the slab. Provided that the above granular cushion is in place, a modulus of subgrade reaction (k_{30}) of 120 pounds per sq. inch per inch can be used for design of the floor slabs.

A vapor barrier may not be required beneath the floor slabs unless the floors are covered with moisture sensitive flooring. It should be noted that vapor barrier can have adverse effects on concrete curing and performance. If used, the vapor barrier should be installed in accordance with the recommendations contained in the ACI Manual of Concrete Practice 302.1 R, Guide for Concrete Floor and Slab Construction, and should be placed below the crushed stone layer. If the vapor barrier is placed immediately below the concrete slab, a coefficient of friction between the slab-on-grade concrete floor and the vapor barrier of 0.15 should be used.

5.4 Pavement Design

The borings revealed 2.0 to as much as 6.5 feet of fill at this site. Provided that the existing fill material passes the proofroll test and there will be at least 2.0 feet of compacted engineered fill below the finish subgrade elevation, the existing fill material can stay in place. Failed proofrolled subgrade areas will require stabilization or undercutting.

Minimizing the infiltration of water into the subgrade and rapid removal of any subsurface water will be essential in assuring successful long-term performance of pavements. Both the subgrade and the pavement surface should have a minimum slope of one-quarter (1/4) inch per foot to promote drainage. A means of water outlet should be provided at the pavement edges by extending the aggregate base course through to daylight or to surface drainage features such as storm inlets.



California Bearing Ratio (CBR) test was not performed for this project. DHDC recommends CBR value of 5 for design. The following paragraphs summarize pavement thicknesses for automobile parking areas (light-duty) and heavy truck loading and/or truck turnaround areas. It is important to note that the recommendations for the automobile parking areas assume that these areas will not be subject to any heavy truck traffic. Therefore, in areas where truck traffic cannot be controlled (such as driveways), it is suggested that the thicker pavement section be utilized. The thicknesses were determined by methods developed by the American Association of State Highway and Transportation Officials (AASHTO) based on a ten-year design period.

The following assumptions were made, and the coefficients were used in order to compute a design section:

Regional Factor:	1.5 Roadbed subject to frost, but fairly dry
Terminal Serviceability:	2.5 (2-3 fair)
Soil Support Value:	4 (for CBR value of 5.0)

<u>Traffic Information:</u>	Five (5) semi-trucks per week
	Two (2) garbage trucks per week
	500 cars per day

Flexible Pavement Structural Coefficients:

Items 448 - AC Surface Course:	0.43
Items 302 - AC Base Course:	0.36

Rigid Pavement Design Parameters

Reliability:	90%
Overall Standard Deviation:	0.39
Terminal Serviceability:	2.5
Subgrade Resilient Modulus:	6,000 psi (Satisfactorily Proofrolled Subgrade Soil)

Based on the above traffic numbers and the assumptions, DHDC is recommending the following pavement sections:

Option 1: Flexible Section

Automobile Parking Areas

- 1.5" Asphalt Concrete Surface Course, Item 448, AC Surface Course
- 1.5" Asphalt Concrete base Course, Item 301
- 8" Aggregate Base, ODOT Item No. 304 Stone
- Satisfactorily Proofrolled and Compacted Subgrade

Driveway Areas and Truck Zones

1.5" Asphalt Concrete Surface Course, Item 448, AC Surface Course
3.0" Asphalt Concrete base Course, Item 301
10 Aggregate Base, ODOT Item No. 304 Stone
Satisfactorily Proofrolled and Compacted Subgrade

Option 2: Rigid Section (Driveway Areas and Truck Zones)

8" Non Reinforced Concrete Pavement
10" Aggregate Base, ODOT Item No. 304 Stone
Satisfactorily Proofrolled and Compacted Subgrade

DHDC recommends Tack Coat for Intermediate Course applied at a minimum of 0.05 gallons per square yard. The base aggregate should consist of well-graded crushed stone with a maximum of fourteen (14) percent by weight finer than the number 200 sieve (ODOT item 304 "Aggregate Base"). The pavement should be constructed in accordance with ODOT Standard Specifications.

5.5 Excavation

There will be minimal difficulty experienced in excavating the fill and naturally occurring overburden soil at this site with conventional equipment and methods. All permanent cut slopes shall be no steeper than 3 horizontal to 1 vertical. All temporary excavations for the installation of foundations, utilities, etc., should be properly laid back or braced in accordance with Occupational Safety and Health Administration (OSHA) requirements. For safety purposes, all federal, state, and local safety regulations should be strictly followed. Surface run-off water should be drained away from the excavation and not allowed to pond. The footing excavations should be adequately protected. Some groundwater will be encountered at a depth of about 9.0 to 10.0 feet below the exposed grade. Soft and loose naturally occurring soil can be encountered just below the man-made fill material and at the interface of saturated cohesionless soil.

5.6 Fill

The existing fill materials free of organics and deleterious can be reused as compacted engineered fill. As stated earlier, the upper layer of fill material contained asphalt fragments. Fill material containing asphaltic concrete fragments shouldn't be used as compacted engineered fill. The on-site geotechnical engineer or technician should make the call regarding the usability of the existing man-made fill material as these fill materials are excavated from the site.

DHDC recommends that the structural fills supporting footings, floor slabs, and pavements be compacted to at least 100 percent of the maximum Standard Proctor dry density (ASTM D-698) or 95 percent of the maximum Modified Proctor dry density (ASTM D-11567).

It is DHDC's recommendation that if the moisture content of the existing fill material is higher than the Optimum Moisture Content of such soils at the time of fill material compaction, then tilling, pulverization, and drying will be required to remove the excess moisture. If needed lime modification (about 5.0 percent of the dry weight of these materials) can be performed to bring the existing fill material to the workable condition.

The naturally occurring imported fill material should have a plasticity index value no higher than 25, a liquid limit no higher than 50, organic content less than 5 percent, and a maximum dry density of at least 100 pounds per cubic foot. ODOT Item No. 304 stone or well graded sand and gravel can also be used as compacted engineered fill.

The fill should contain no pieces whose greatest dimension is larger than the thickness of the lift being placed. If fill construction takes place during the winter months, care should be taken so as not to place fill over frozen soil nor should froze materials be used within the fill.

Excavations in excess of 4.0 feet in depth should be sloped or shored according to OSHA regulations. Excavation sidewalls should be inspected and approved by the Soils Engineer. Prior to the commencement of construction, all sheeting, shoring, and bracing of trenches, pits, and excavations should be made the responsibility of the contractor. The following back-slope recommendations are for temporary cut-slopes of 20 feet or less in height:

1. Existing Fill material and Medium Stiff Native Cohesive Soil – OSHA Type B Soil; 1H:1V
2. Granular soil including gravel, and/or stone fragments, submerged soil, or soil from which water is freely seeping soils - OSHA Type C Soil; 1.5H:1V ($\phi = 34^\circ$)



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6.0 QUALIFICATION OF RECOMMENDATIONS

Our evaluation has been based on our understanding of the site and project information and the data obtained during our field investigation. The general subsurface conditions were based on interpretation of the subsurface data at specific boring locations. Regardless of the thoroughness of a subsurface investigation, there is the possibility that conditions will differ from those encountered at the boring locations, that conditions are not as anticipated by the designers, or that the construction process has altered the soil conditions. Therefore, experienced geotechnical engineers should observe construction to confirm that the conditions anticipated in design are noted. Otherwise, DHDC assumes no responsibility for construction compliance with the design concepts, specifications, or recommendations.

The design recommendations in this report have been developed on the basis of the previously described project characteristics and subsurface conditions. If project criteria or locations change, DHDC should be permitted to determine whether the recommendations must be modified. The findings of such a review will be presented in a supplemental report.

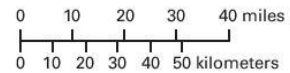
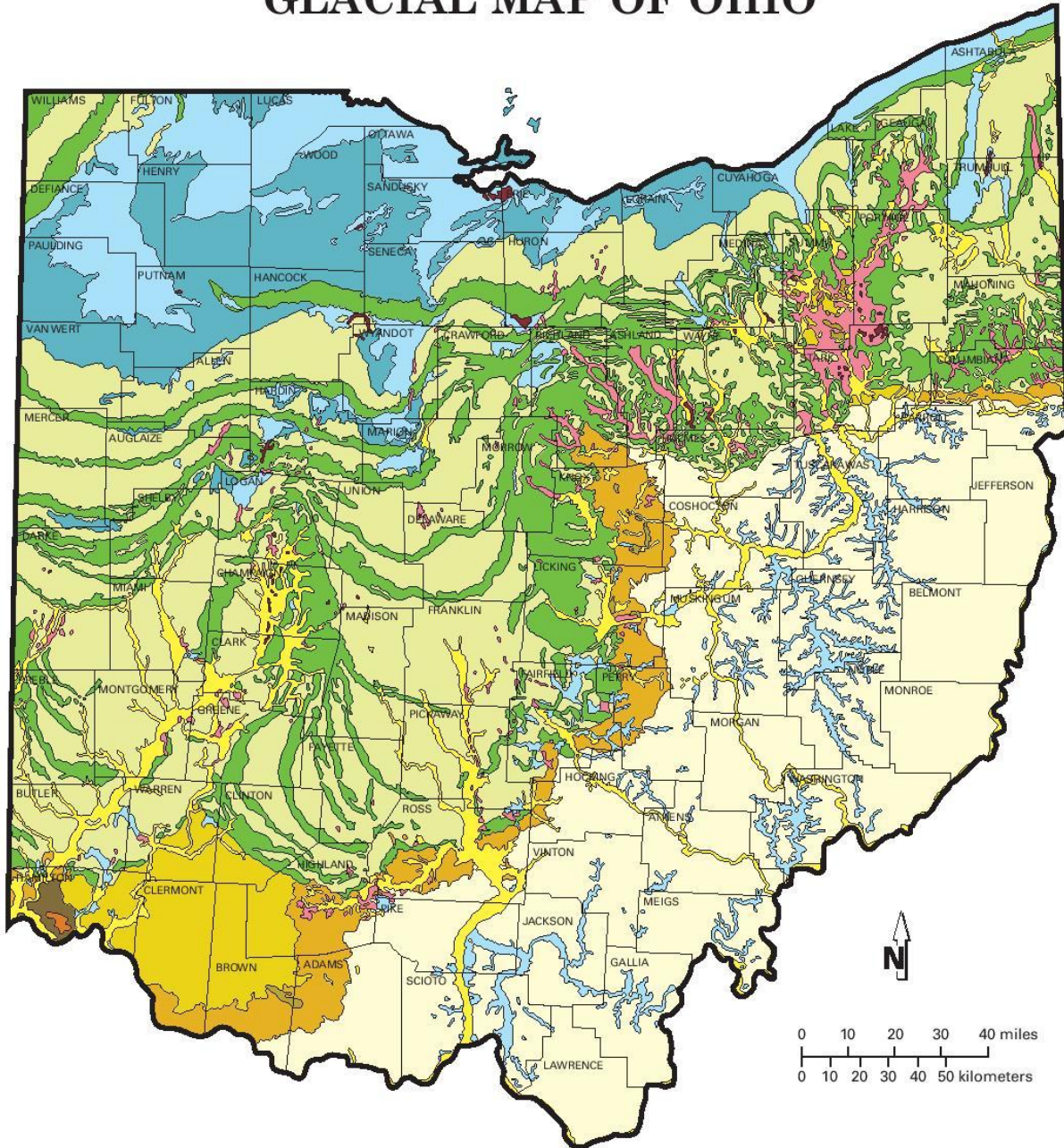
Our professional services have been performed, our findings derived, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied. DHDC is not responsible for the conclusions, opinions, or recommendations of others based on this data.
















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APPENDIX: GEOLOGICAL MAPS

GLACIAL MAP OF OHIO



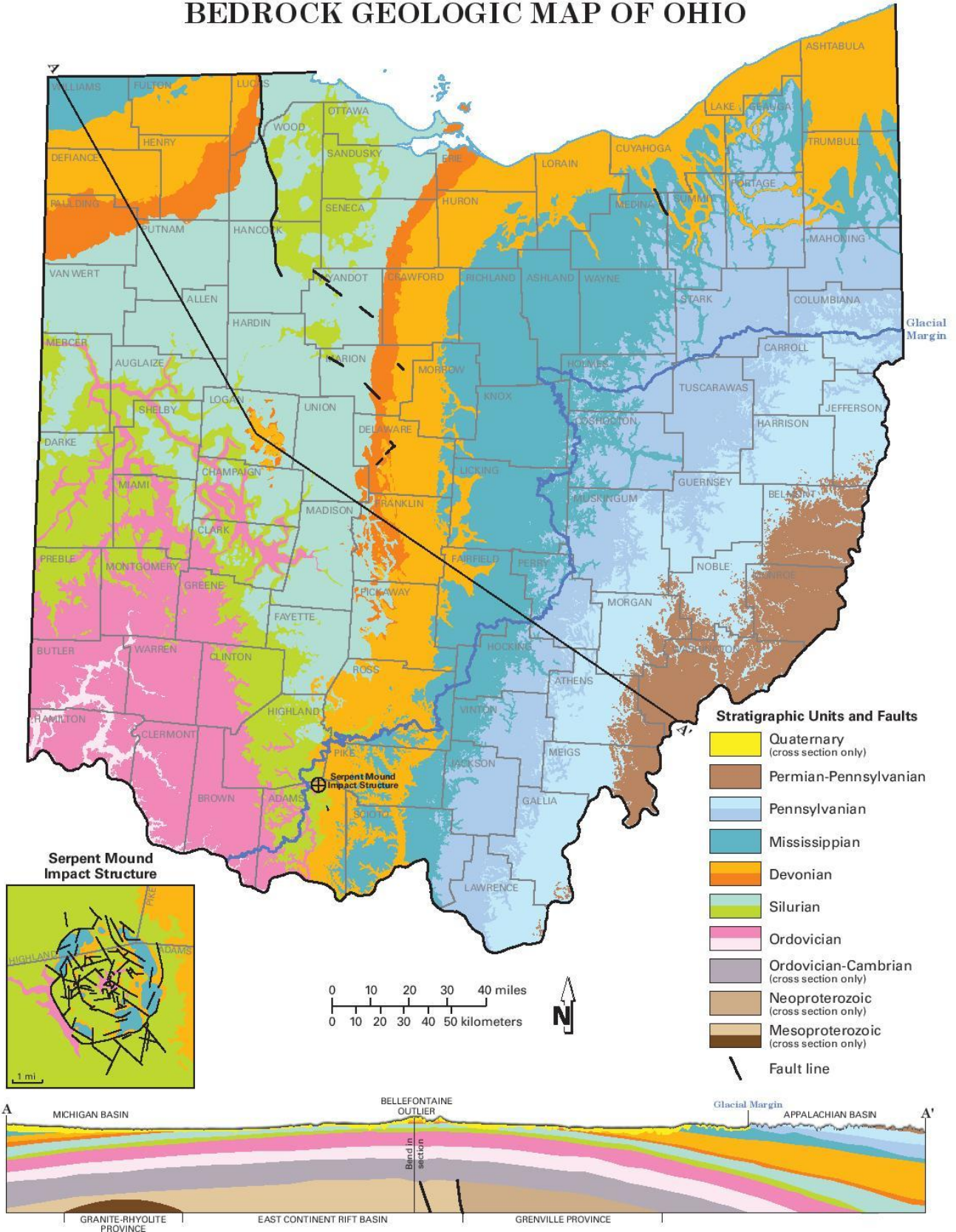
WISCONSINAN (14,000 to 24,000 years old)		ILLINOIAN (130,000 to 300,000 years old)		PRE-ILLINOIAN (older than 300,000 years)			
	Ground moraine		Ground moraine		Ground moraine		Kames and eskers
	Wave-planed ground moraine		Dissected ground moraine		Dissected ground moraine		Outwash
	Ridge moraine		Hummocky moraine				Lake deposits
							Peat
							Colluvium



Recommended citation: Ohio Division of Geological Survey, 2005, Glacial map of Ohio: Ohio Department of Natural Resources, Division of Geological Survey, page-size map with text, 2 p., scale 1:2,000,000.



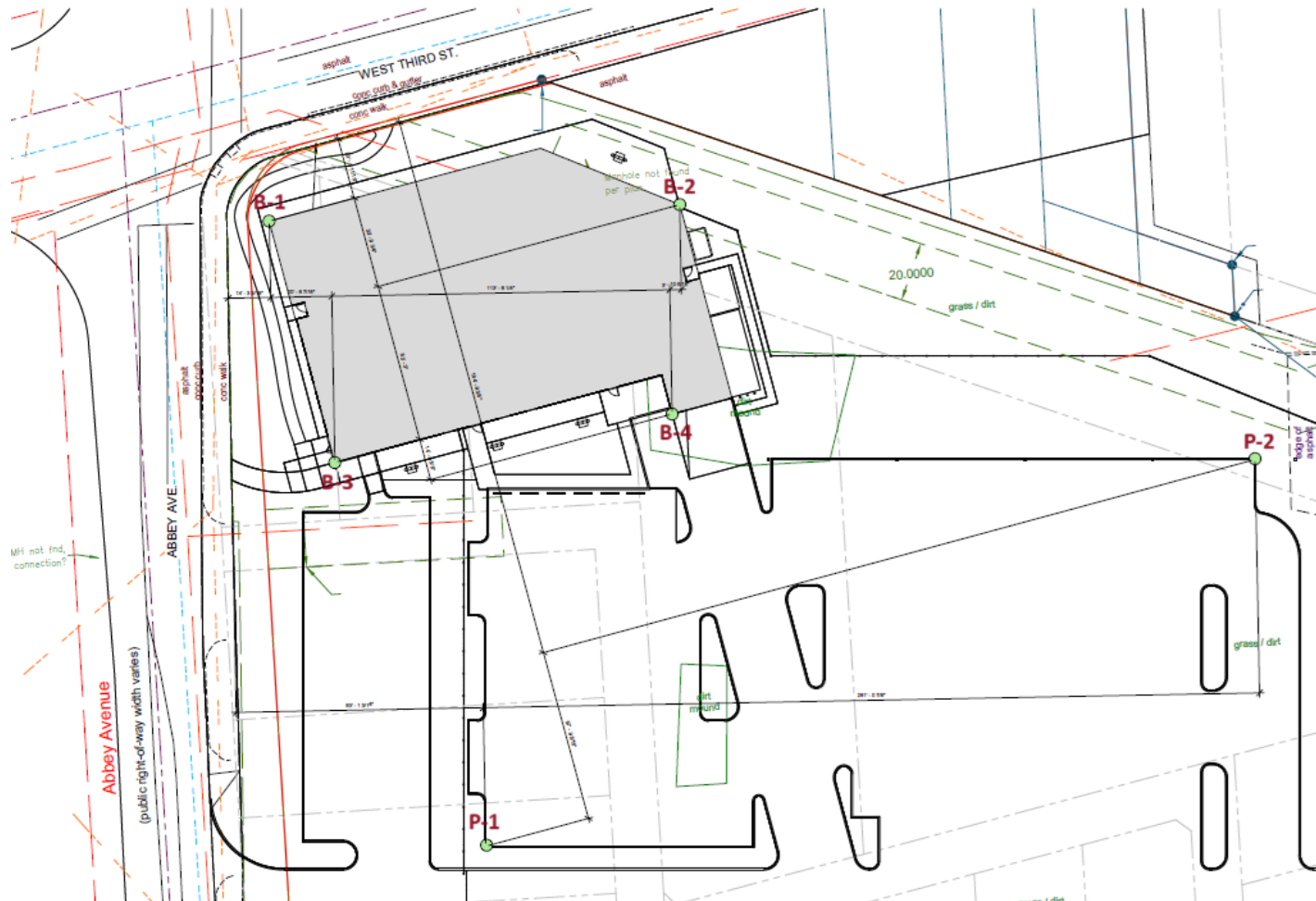
BEDROCK GEOLOGIC MAP OF OHIO





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APPENDIX: BORING LOCATION PLAN



BORING LOCATION PLAN



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APPENDIX: SOIL TERMS

DESCRIPTION OF SOIL TERMS

The following terminology was used to describe soils throughout this report and is generally adapted from ASTM 2487/2488 and ODOT Geotechnical Specifications.

GRANULAR SOILS – The relative compactness of granular soils is described as:

<u>Description</u>	<u>Blows per foot – SPT (N)</u>		
Very Loose	2	–	4
Loose	5	–	10
Medium Dense	11	–	30
Dense	31	–	50
Very Dense	Over	–	50

COHESIVE SOILS – The relative consistency of cohesive soils is described as:

<u>Description</u>	<u>Blows per foot – SPT (N)</u>			<u>Unconfined UCS (ksf)</u>		
Very Soft	Below	–	2	Less Than	–	0.50
Soft	2	–	5	0.50	–	1.00
Medium Stiff	6	–	10	1.00	–	2.00
Stiff	11	–	15	2.00	–	4.00
Very Stiff	16	–	30	4.00	–	8.00
Hard		–	Over 30	Over	–	8.00

GRADATION – The following size related denominations are used to describe soils:

<u>Soil Fraction</u>	<u>USCS Size</u>	<u>ODOT Size</u>
Boulders	Larger than 12"	Larger than 12"
Cobbles	12" to 3"	12" to 3"
Gravel – Coarse	3" to 3/4"	3" to 3/4"
Gravel – Fine	3/4" to 4.75 mm	3/4" to 2.0 mm (#10)
Sand – Coarse	4.75 mm to 2.0 mm	2.0 mm to 0.42 mm (#40)
Sand – Medium	2.0 mm to 0.42 mm	
Sand – Fine	0.42 mm to 0.074 mm	0.42 mm to 0.074 mm (#200)
Silt	0.074 mm to 0.005 mm	0.074 mm to 0.005 mm
Clay	< 0.005 mm	< 0.005 mm

MODIFIERS OF COMPONENTS – Modifiers of components are as follows:

<u>Term</u>	<u>Range</u>		
Trace	0%	–	10%
Little	11%	–	20%
Some	21%	–	35%
And	36%	–	50%



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APPENDIX: BORING LOGS (6)



CLIENT APP Architecture
 PROJECT NUMBER C24-100
 DATE STARTED 6/27/24 COMPLETED 6/27/24
 DRILLING CONTRACTOR DHDC
 DRILLING METHOD Hollow Stem Auger
 LOGGED BY Brian CHECKED BY M.O.H.
 NOTES _____

PROJECT NAME Joint Fire & Police Station
 PROJECT LOCATION Dayton, Ohio
 GROUND ELEVATION _____ HOLE SIZE _____ inches
 GROUND WATER LEVELS:
 ▽ AT TIME OF DRILLING 10.00 ft
 ▼ AT END OF DRILLING 11.30 ft
 AFTER DRILLING ---

GEOTECH BH COLUMNS - GINT STD US LAB.GDT - 7/15/24 20:53 - C:\USERS\UNDE\DROPBOX\FAMILY ROOM\SUNDEEP\GINT FILES\JOINT FIRE & POLICE STATION_C24-100.GPJ

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0		Fill: Brown to Blackish Brown, SILTY CLAY , little sand, trace gravel, Moist		SS 1	44	4-6-6 (12)			13				
		Fill: Dark Brown, SILTY CLAY , trace to little sand, trace gravel, Moist		SS 2	67	4-5-5 (10)			10				
		Medium Stiff, Dark Brown and Gray, SILTY CLAY (CL) , trace sand, trace gravel [Glacial Till], Moist		SS 3	72	3-3-4 (7)	2.5		24	39	20	19	
		▽ Medium Dense, Brown, SILTY SAND (SM) , little gravel, Wet		SS 4	56	2-4-7 (11)			16				
		▼ Medium Dense, Brown, fine SANDY SILT (ML) , Wet											
		Hard, Gray, SILTY SANDY CLAY (CL) , little gravel [Glacial Till], Wet		SS 5	100	6-12-23 (35)	4.5+		9				
		Medium Dense, Gray, SILTY SAND (SM) , little gravel, Wet		SS 6	100	5-7-10 (17)			17				
		Very Stiff, Gray, SILTY SANDY CLAY (CL) , little gravel [Glacial Till], Wet		SS 7	33	4-7-10 (17)			11				

Boring discontinued at 25.0 feet depth
 Boring caved at 21.6 feet

CLIENT APP Architecture
PROJECT NUMBER C24-100
DATE STARTED 6/27/24 **COMPLETED** 6/27/24
DRILLING CONTRACTOR DHDC
DRILLING METHOD Hollow Stem Auger
LOGGED BY Brian **CHECKED BY** M.O.H.
NOTES

PROJECT NAME Joint Fire & Police Station
PROJECT LOCATION Dayton, Ohio
GROUND ELEVATION _____ **HOLE SIZE** inches
GROUND WATER LEVELS:
 ∇ **AT TIME OF DRILLING** 9.00 ft
 ▼ **AT END OF DRILLING** 10.20 ft
AFTER DRILLING ---

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DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0		Fill: Black, A mixture of SILTY SAND , GRAVEL , ASPHALT , and ROCK fragments, Moist											
		Fill: Black, SILTY CLAY , trace sand, Moist ---Organic odor---		SS 1	72	7-11-6 (17)			25				
5		Soft, Brown with trace Gray, SILTY CLAY (CL) , trace sand, trace gravel, Moist		SS 2	67	2-3-5 (8)			27				
		Medium Dense, Brown, SILTY SAND (SM) , little to some gravel, Wet ∇ ---Coarse GRAVEL/COBBLE within the soil matrix---		SS 3	22	1-1-2 (3)	1.0		28				
10		Medium Dense, Brown, SILTY SAND (SM) , Wet		SS 4	44	3-9-10 (19)			12				
15		Medium Dense, Brown, SILTY SAND (SM) , Wet		SS 5	78	9-9-12 (21)			15				
20		Very Stiff to Stiff, Gray, SILTY SANDY CLAY (CL) , little gravel [Glacial Till], Wet ---Interbedded SILTY SAND and GRAVEL layers---		SS 6	100	7-12-12 (24)			12				
25				SS 7	83	3-6-9 (15)			11				

Boring discontinued at 25.0 feet depth
 Boring caved at 19.7 feet



CLIENT APP Architecture
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 NOTES _____

PROJECT NAME Joint Fire & Police Station
 PROJECT LOCATION Dayton, Ohio
 GROUND ELEVATION _____ HOLE SIZE _____ inches
 GROUND WATER LEVELS:
 ▽ AT TIME OF DRILLING 9.00 ft
 ▼ AT END OF DRILLING 10.20 ft
 AFTER DRILLING ---

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DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0		Fill: A mixture of Brown, SILTY SAND , GRAVEL , and ROCK fragments, Moist											
		Fill: Blackish Brown, SILTY CLAY , trace sand, trace gravel, Moist		SS 1	44	4-6-6 (12)			18				
		Possible Fill: Dark Brown, SILTY CLAY , trace sand, trace gravel, Moist		SS 2	39	5-5-6 (11)			23				
5		Medium Stiff, Mottled Brown and Gray, SILTY CLAY (CL) , trace sand, trace gravel [Glacial Till], Moist		SS 3	39	2-2-3 (5)	1.5		22	38	19	19	
		Dense, Brown and Gray, SILTY SAND (SM) , little to some gravel, Wet		SS 4	83	10-13-20 (33)			23				
		---Coarse GRAVEL/COBBLE within the soil matrix---											
		Very Stiff to Hard, Gray, SILTY SANDY CLAY (CL) , little gravel [Glacial Till], Wet		SS 5	89	7-12-17 (29)	4.0		10				
		---Coarse GRAVEL/COBBLE within the soil matrix---											
20				SS 6	100	6-7-10 (17)	3.5		9				
25				SS 7	100	8-16-33 (49)			10				

Boring discontinued at 25.0 feet depth
 Boring caved at 22.7 feet



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 DRILLING CONTRACTOR DHDC
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 LOGGED BY Brian CHECKED BY M.O.H.
 NOTES _____

PROJECT NAME Joint Fire & Police Station
 PROJECT LOCATION Dayton, Ohio
 GROUND ELEVATION _____ HOLE SIZE _____ inches
 GROUND WATER LEVELS:
 ∇ AT TIME OF DRILLING 17.00 ft
 AT END OF DRILLING ---
 AFTER DRILLING ---

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DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0		Fill: A mixture of Brown, SILTY SAND, GRAVEL , and ROCK fragments, Moist											
3				SS 1	72	30-21-34 (55)			3				
4				SS 2	60	50/5"			4				
5		Very Stiff, Mottled Brown and Gray, SILTY SANDY CLAY (CL), little gravel [Glacial Till], Moist		SS 3	100	9-9-11 (20)	4.0		11	36	21	15	
8				SS 4	100	8-8-8 (16)	3.0		12				
15		Very Stiff, Gray, SILTY SANDY CLAY (CL), little gravel [Glacial Till], Wet		SS 5	100	7-9-19 (28)	4.0		11				
17		∇											
20		Medium Stiff, Gray, SILTY SANDY CLAY (CL), little gravel [Glacial Till], Wet		SS 6	100	4-4-4 (8)			12				
24				SS 7	100	2-4-4 (8)			12				

Boring discontinued at 25.0 feet depth
 Boring didn't caved



CLIENT APP Architecture
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 DRILLING CONTRACTOR DHDC
 DRILLING METHOD Hollow Stem Auger
 LOGGED BY Brian CHECKED BY M.O.H.
 NOTES _____

PROJECT NAME Joint Fire & Police Station
 PROJECT LOCATION Dayton, Ohio
 GROUND ELEVATION _____ HOLE SIZE _____ inches
 GROUND WATER LEVELS:
 ∇ AT TIME OF DRILLING 10.00 ft
 AT END OF DRILLING ---
 AFTER DRILLING ---

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DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0		Fill: A mixture of Brown, SILTY SAND , GRAVEL , and ROCK fragments, Moist		SS 1	17	8-12-8 (20)			4				
		Possible Fill: Brown, SANDY CLAY (CL) , little gravel, Moist											
		Medium Dense, Brown, SILTY SAND (SM) , some gravel, Moist		SS 2	67	11-13-10 (23)			12				
5		Stiff to Very Stiff, Mottled Brown and Gray, SILTY SANDY CLAY (CL) , little gravel [Glacial Till], Moist		SS 3	67	6-4-6 (10)	3.0		8	36	20	16	
				SS 4	100	5-9-9 (18)	4.0		11				
10													
15		Stiff, Gray, SILTY SANDY CLAY (CL) , little gravel [Glacial Till], Wet		SS 5	100	3-4-7 (11)	2.0		11				

Boring discontinued at 15.0 feet depth
 Boring didn't caved



CLIENT APP Architecture
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 DRILLING CONTRACTOR DHDC
 DRILLING METHOD Hollow Stem Auger
 LOGGED BY Brian CHECKED BY M.O.H.
 NOTES _____

PROJECT NAME Joint Fire & Police Station
 PROJECT LOCATION Dayton, Ohio
 GROUND ELEVATION _____ HOLE SIZE _____ inches
 GROUND WATER LEVELS:
 AT TIME OF DRILLING ---
 AT END OF DRILLING ---
 AFTER DRILLING ---

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DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION (ft)	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
										LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0		Fill: A mixture of Brown, SILTY SAND, GRAVEL , and ROCK fragments, Moist											
		Stiff, Dark Brown, SILTY CLAY , trace sand, Moist		SS 1	67	13-5-5 (10)	2.0		20				
		Loose, Brown, SILTY SAND (SM) , some gravel, Moist ---Sample #3 is coarse GRAVEL/COBBLE fragments---		SS 2	44	5-2-2 (4)			13				
5				SS 3	17	5-8-7 (15)			10				
		Stiff, Brown, SILTY SANDY CLAY (CL) , little gravel [Glacial Till], Moist		SS 4	100	2-4-6 (10)	2.5		12				
10													
		Very Stiff, Gray, SILTY SANDY CLAY (CL) , little gravel [Glacial Till], Moist		SS 5	100	5-8-12 (20)	4.0		9				
15													

Boring discontinued at 15.0 feet depth
 Boring didn't caved
 No groundwater



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APPENDIX: LABORATORY TEST RESULTS

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SECTION 01 1000
SUMMARY

PART 1 GENERAL

1.01 PROJECT

1.01.A. Project Name: 4205.00 City of Dayton New Police Station - West Patrol District

1.01.B. Owner's Name: City of Dayton.

1.01.C. Architect's Name: App Architecture, Inc.

1.01.D. Construction Manager's Name: Brumbaugh Construction, Inc.

1.01.E. The Project consists of the construction of a new Police Station and other Work indicated in the Contract Documents to include, but not limited to, civil, architectural, structural, fire protection, plumbing, heating, ventilation and air conditioning, electrical, data and communications, safety and security.

1.02 CONTRACT DESCRIPTION

1.02.A. Contract Type: Project will be constructed under a Construction Manager at Risk contract with subcontracts contracted to CMaR.

1.03 WORK BY OWNER

1.03.A. Items noted NIC (Not in Contract) will be supplied and installed by Owner before Date of Substantial Completion. Some items include:

1. Furnishings.
2. Small equipment, including but not limited to fitness equipment.
3. Refer to construction documents for additional items.

1.03.B. Owner will supply and install the following:

1. Refer to the matrices located on the drawings.

1.03.C. Owner will supply the following for installation by Contractor:

1. Refer to the matrices located on the drawings.

1.04 OWNER OCCUPANCY

1.04.A. Owner intends to occupy the Project upon Substantial Completion.

1.04.B. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.

1.04.C. Schedule the Work to accommodate Owner occupancy.

1.05 CONTRACTOR USE OF SITE AND PREMISES

- 1.05.A. Construction Operations: Limited to areas noted on Drawings.
1. Locate and conduct construction activities in ways that will limit disturbance to site.
- 1.05.B. Arrange use of site and premises to allow:
1. Work by Others.
 2. Work by Owner.
- 1.05.C. Provide access to and from site as required by law and by Owner:
1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
 2. Do not obstruct roadways, sidewalks, or other public ways without permit.
- 1.05.D. Time Restrictions:
1. Limit conduct of the hours of 7:00 a.m. to 5:00 p.m.
 2. Weekend Hours: As approved by Owner.
 3. Early Morning Hours: As approved by Owner.

END OF SECTION 01 1000

SECTION 01 2100
ALLOWANCES

PART 1 GENERAL

1.01 SECTION INCLUDES

1.01.A. Contingency allowance.

1.02 RELATED REQUIREMENTS

1.03 CONTINGENCY ALLOWANCE

1.03.A. Contractor's costs for products, delivery, installation, labor, insurance, payroll, taxes, bonding, equipment rental, overhead and profit will be included in Change Orders authorizing expenditure of funds from this Contingency Allowance.

1.03.B. Funds will be drawn from the Contingency Allowance only by Change Order.

1.03.C. At closeout of Contract, funds remaining in Contingency Allowance will be credited to Owner by Change Order.

1.04 ALLOWANCES SCHEDULE

1.04.A. CMAA Contingency Allowance: Include a stipulated sum agreed upon per the contract requirements for the CMAA's use upon Owner's approval during construction.

1.04.B. Owner Contingency Allowance: Include a stipulated sum / price of \$100,000 for the Owner's use for potential additional scope items during construction.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 2100

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SECTION 01 2300
ALTERNATES

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Description of Alternates.
- 1.01.B. Procedures for pricing Alternates.
- 1.01.C. Documentation of changes to Contract Price and Contract Time.

1.02 RELATED REQUIREMENTS

- 1.02.A. Document 00 2113 - Instructions to Bidders: Instructions for preparation of pricing for Alternates.

1.03 ACCEPTANCE OF Alternates

- 1.03.A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at Owner's option. Accepted Alternates will be identified in the Owner-Contractor Agreement.
- 1.03.B. Coordinate related work and modify surrounding work to integrate the Work of each Alternate.

1.04 SCHEDULE OF Alternates

1.04.A. Alternate H1:

Provide add/deduct pricing to provide the basis of design Mitsubishi VRF System and Mitsubishi DOAS unit. A price of \$0.00 indicates the Mitsubishi equipment is provided in the contractors base bid package.

1.04.B. Alternate E1:

Price to provide solar array package. This includes all items indicated on 'PV' series drawings, and miscellaneous items indicated on Division 23 HVAC and Division 26 Electrical drawings for the complete installation of the solar carport and array.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 2300

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SECTION 01 2500
SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

1.01.A. Procedural requirements for proposed substitutions.

1.02 RELATED REQUIREMENTS

1.02.A. Section 00 2113 - Instructions to Bidders: Restrictions on timing of substitution requests.

1.02.B. Section 01 3000 - Administrative Requirements: Submittal procedures, coordination.

1.02.C. Section 01 6000 - Product Requirements: Fundamental product requirements, product options, delivery, storage, and handling.

1.03 DEFINITIONS

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

1. Substitutions for Cause: Proposed due to changed Project circumstances beyond Contractor's control.
 - a. Unavailability.
 - b. Regulatory changes.
 - c. Unavailability of required warranty terms.
2. Substitutions for Convenience: Proposed due to possibility of offering substantial advantage to the Project.
 - a. Substitution requests offering advantages solely to the Contractor will not be considered.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

3.01.A. A Substitution Request for products, assemblies, materials, and equipment constitutes a representation that the submitter:

1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.

2. Agrees to provide the same warranty for the substitution as for the specified product.
 3. Agrees to provide same or equivalent maintenance service and source of replacement parts, as applicable.
 4. Agrees to coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to Owner.
 5. Waives claims for additional costs or time extension that may subsequently become apparent.
 6. Agrees to reimburse Owner and Architect for review or redesign services associated with re-approval by authorities.
- 3.01.B. A Substitution Request for specified installer constitutes a representation that the submitter:
1. Has acted in good faith to obtain services of specified installer, but was unable to come to commercial, or other terms.
- 3.01.C. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Burden of proof is on proposer.
1. Note explicitly any non-compliant characteristics.
- 3.01.D. Content: Include information necessary for tracking the status of each Substitution Request, and information necessary to provide an actionable response.
1. No specific form is required. Contractor's Substitution Request documentation must include the following:
 - a. Project Information:
 - 1) Official project name and number, and any additional required identifiers established in Contract Documents.
 - 2) Owner's, Architect's, and Contractor's names.
 - b. Substitution Request Information:
 - 1) Discrete and consecutive Substitution Request number, and descriptive subject/title.
 - 2) Indication of whether the substitution is for cause or convenience.
 - 3) Issue date.
 - 4) Reference to particular Contract Document(s) specification section number, title, and article/paragraph(s).
 - 5) Description of Substitution.
 - 6) Reason why the specified item cannot be provided.
 - 7) Differences between proposed substitution and specified item.
 - c. Attached Comparative Data: Provide point-by-point, side-by-side comparison addressing essential attributes specified, as appropriate and relevant for the item:
 - 1) Physical characteristics.
 - 2) In-service performance.
 - 3) Expected durability.
 - 4) Visual effect.

- 5) Warranties.
- 6) Other salient features and requirements.
- 7) Include, as appropriate or requested, the following types of documentation:
 - a) Product Data:
 - b) Samples.
 - c) Certificates, test, reports or similar qualification data.
 - d) Drawings, when required to show impact on adjacent construction elements.
- d. Impact of Substitution:
 - 1) Savings to Owner for accepting substitution.
 - 2) Change to Contract Time due to accepting substitution.

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

1. Submit an electronic document, combining the request form with supporting data into single document.

3.02 SUBSTITUTION PROCEDURES DURING PROCUREMENT

3.02.A. Submittal Time Restrictions:

1. Section 00 2113 - Instructions to Bidders specifies time restrictions and the documents required for submitting substitution requests during the bidding period.

3.03 SUBSTITUTION PROCEDURES DURING CONSTRUCTION

3.03.A. Architect will consider requests for substitutions only within 15 days after date of Agreement.

3.03.B. 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.

3.03.C. 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. Document means of coordinating of substitution item with other portions of the work, including work by affected subcontractors.
3. Bear the costs engendered by proposed substitution of:
 - a. Owner's compensation to the Architect for any required redesign, time spent processing and evaluating the request.
 - b. Other construction by Owner.
 - c. Other unanticipated project considerations.

3.03.D. Substitutions will not be considered under one or more of the following circumstances:

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

3.04 RESOLUTION

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

3.04.B. Architect will notify Contractor in writing of decision to accept or reject request.

1. Architect's decision following review of proposed substitution will be noted on the submitted form cover sheet.

3.05 ACCEPTANCE

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

3.06 CLOSEOUT ACTIVITIES

3.06.A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

3.07 ATTACHMENTS

3.07.A. A facsimile of the Substitution Request Form Cover Sheet (During Construction) required to be used on the Project is included after this section.

END OF SECTION 01 2500

SECTION 01 3000
ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. General administrative requirements.
- 1.01.B. Web-based project software service.
- 1.01.C. Preconstruction meeting.
- 1.01.D. Progress meetings.
- 1.01.E. Construction progress schedule.
- 1.01.F. Contractor's daily reports.
- 1.01.G. Coordination drawings.
- 1.01.H. Submittals for review, information, and project closeout.
- 1.01.I. Number of copies of submittals.
- 1.01.J. Requests for Information (RFI) procedures.
- 1.01.K. Submittal procedures.

1.02 RELATED REQUIREMENTS

- 1.02.A. Section 00 7200 - General Conditions: Duties of the Brumbaugh Construction, Inc.
- 1.02.B. Section 00 7300 - Supplementary Conditions: Duties of the Brumbaugh Construction, Inc.
- 1.02.C. Section 01 6000 - Product Requirements: General product requirements.
- 1.02.D. Section 01 7000 - Execution and Closeout Requirements: Additional coordination requirements.
- 1.02.E. Section 01 7800 - Closeout Submittals: Project record documents; operation and maintenance data; warranties and bonds.
- 1.02.F. Section 01 9113 - General Commissioning Requirements: Additional procedures for submittals relating to commissioning.

1. Where submittals are indicated for review by both Architect and the Commissioning Authority, submit one extra and route to Architect first, for forwarding to the Commissioning Authority.
2. Where submittals are not indicated to be reviewed by Architect, submit directly to the Commissioning Authority; otherwise, the procedures specified in this section apply to commissioning submittals.

1.03 REFERENCE STANDARDS

1.04 PROJECT COORDINATOR

- 1.04.A. Construction Manager.
- 1.04.B. Cooperate with the Project Coordinator in allocation of mobilization areas of site; for field offices and sheds, for access, traffic, and parking facilities.
- 1.04.C. During construction, coordinate use of site and facilities through the Project Coordinator.
- 1.04.D. Comply with Project Coordinator's procedures for intra-project communications; submittals, reports and records, schedules, coordination drawings, and recommendations; and resolution of ambiguities and conflicts.
- 1.04.E. Comply with instructions of the Project Coordinator for use of temporary utilities and construction facilities. Responsibility for providing temporary utilities and construction facilities is identified in Section 01 1000 - Summary.
- 1.04.F. Coordinate field engineering and layout work under instructions of the Project Coordinator.
- 1.04.G. Make the following types of submittals to Architect through the Project Coordinator:
 1. Requests for Information.
 2. Requests for substitution.
 3. Shop drawings, product data, and samples.
 4. Test and inspection reports.
 5. Design data.
 6. Manufacturer's instructions and field reports.
 7. Applications for payment and change order requests.
 8. Progress schedules.
 9. Coordination drawings.
 10. Correction Punch List and Final Correction Punch List for Substantial Completion.
 11. Closeout submittals.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 Web-Based Project Software Service

3.01.A. Web-Based Project Software Service: Construction Manager to provide, administer, and use web-based project software to host and manage project communication and documentation.

1. Include, at minimum, the following features:
 - a. Project directory, including Owner, Contractor, subcontractors, Architect, Architect's consultants, and other entities involved in the project. Include names of contact persons and contact information for each entity.
 - b. Access control for each entity and for each workflow process to determine each entity's digital rights to create, modify, view, and print documents.
 - c. Workflow planning, allowing customization of workflow for each project entity.
 - d. Creation, logging, tracking, and notification for project communications required in other Specification Sections, including, but not limited to RFI's, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
 - e. Tracking of project communication statuses in real time, including timestamped response log.
 - f. Procedures for viewing PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
 - g. Processing and tracking of payment applications.
 - h. Processing and tracking of contract modifications.
 - i. Creation and distribution of meeting minutes.
 - j. Document management for drawings, specifications, and coordination drawings, including revision control.
 - k. Management of construction progress photographs.
 - l. Mobile device compatibility.
 - m. Creation of data analytics reports.
 - n. Creation and export of editable logs for software functions. Provide Owner, Architect, and Architect's consultants with rights and ability to download logs when requested.
2. Provide up to 20 user licenses for use by Owner, Architect, Architect's consultants, and other entities involved in the project.
3. Comply with the software service's current published licensing agreements.
4. Training: Provide one-hour, web-based training session for users of software service. Further training is the responsibility of the user.
 - a. Representatives of Owner are scheduled and included in this training.

5. Project Closeout: Provide digital archive in format that is readable by common desktop software applications in format acceptable to Architect. Provide data in locked format to prohibit further changes after completion of the project.
6. Web-Based Project Software Services: Subject to compliance with the requirements use one of the following:

3.02 PRECONSTRUCTION MEETING

3.02.A. Construction Manager will schedule a meeting no later than 10 days after the execution of the Agreement.

3.02.B. Attendance Required:

1. Owner.
2. Architect.
3. Construction Manager.

3.02.C. Agenda:

1. Execution of Owner-Contractor Agreement.
2. Submission of executed bonds and insurance certificates.
3. Distribution of Contract Documents.
4. Submission of list of subcontractors, list of products, schedule of values, and progress schedule.
5. Submission of initial Submittal schedule.
6. Designation of personnel representing the parties to Contract, Construction Manager and Architect.
7. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
8. Scheduling.
9. Scheduling activities of the Special Inspector.

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

3.03 PROGRESS MEETINGS

3.03.A. Schedule and administer meetings throughout progress of the work at maximum bi-weekly intervals.

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

3.03.C. Attendance Required:

1. Construction Manager.
2. Owner.
3. Architect.
4. Contractor's superintendent.

5. Major subcontractors.

3.03.D. Agenda:

1. Review minutes of previous meetings.
2. Review of work progress.
3. Field observations, problems, and decisions.
4. Identification of problems that impede, or will impede, planned progress.
5. Review of submittals schedule and status of submittals.
6. Review of RFIs log and status of responses.
7. Maintenance of progress schedule.
8. Corrective measures to regain projected schedules.
9. Planned progress during succeeding work period.
10. Maintenance of quality and work standards.
11. Effect of proposed changes on progress schedule and coordination.
12. Other business relating to work.

- 3.03.E. Record minutes and distribute copies within two days after meeting to participants, and those affected by decisions made.

3.04 CONSTRUCTION PROGRESS SCHEDULE

- 3.04.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.
- 3.04.B. If preliminary schedule requires revision after review, submit revised schedule within 10 days.
- 3.04.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.
- 3.04.D. Within 10 days after joint review, submit complete schedule.
- 3.04.E. Submit updated schedule with each Application for Payment.

3.05 DAILY CONSTRUCTION REPORTS

- 3.05.A. Include only factual information. Do not include personal remarks or opinions regarding operations and/or personnel.
- 3.05.B. Prepare a daily construction report recording the following information concerning events at Project site and project progress:
1. Date.
 2. High and low temperatures, and general weather conditions.
 3. List of subcontractors at Project site.

4. List of separate contractors at Project site.
5. Approximate count of personnel at Project site.
6. Major equipment at Project site.
7. Material deliveries.
8. Safety, environmental, or industrial relations incidents.
9. Meetings and significant decisions.
10. Unusual events (submit a separate special report).
11. Stoppages, delays, shortages, and losses. Include comparison between scheduled work activities (in Contractor's most recently updated and published schedule) and actual activities. Explain differences, if any. Note days or periods when no work was in progress and explain the reasons why.
12. Testing and/or inspections performed.
13. Signature of Contractor's authorized representative.

3.06 COORDINATION DRAWINGS

- 3.06.A. Provide information required by Project Coordinator for preparation of coordination drawings.
- 3.06.B. Review drawings prior to submission to Architect.
- 3.06.C. Architect and consultants will provide CAD or REVIT files as requested for use in producing coordination drawings. Waiver forms are provided at the end of this section and must be completed and signed as part of any request for digital files.

3.07 REQUESTS FOR INFORMATION (RFI)

- 3.07.A. 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.
 - a. Review, coordinate, and comment on requests originating with subcontractors and/or materials suppliers.
 - b. Do not forward requests which solely require internal coordination between subcontractors.
 2. Prepare in a format and with content acceptable to Architect.
- 3.07.B. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.
 1. Include in each request Contractor's signature attesting to good faith effort to determine from Contract Documents information requiring interpretation.
 2. Unacceptable Uses for RFIs: Do not use RFIs to request the following:
 - a. Approval of submittals (use procedures specified elsewhere in this section).
 - b. Approval of substitutions (see Section - 01 6000 - Product Requirements)

- c. Changes that entail change in Contract Time and Contract Sum (comply with provisions of the Conditions of the Contract).
 - d. Different methods of performing work than those indicated in the Contract Drawings and Specifications (comply with provisions of the Conditions of the Contract).
 - 3. Improper RFIs: Requests not prepared in compliance with requirements of this section, and/or missing key information required to render an actionable response. They will be returned without a response, with an explanatory notation.
 - 4. Frivolous RFIs: Requests regarding information that is clearly indicated on, or reasonably inferable from, Contract Documents, with no additional input required to clarify the question. They will be returned without a response, with an explanatory notation.
 - a. The Owner reserves the right to assess the Contractor for the costs (on time-and-materials basis) incurred by the Architect, and any of its consultants, due to processing of such RFIs.
- 3.07.C. 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 Construction Manager'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.
- 3.07.D. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.
- 3.07.E. RFI Log: Prepare and maintain a tabular log of RFIs for the duration of the project.
 - 1. Indicate current status of every RFI. Update log promptly and on a regular basis.
 - 2. Note dates of when each request is made, and when a response is received.
 - 3. Highlight items requiring priority or expedited response.
 - 4. Highlight items for which a timely response has not been received to date.

- 3.07.F. Review Time: Architect will respond and return RFIs to Contractor within seven calendar 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.
- 3.07.G. Responses: Content of answered RFIs will not constitute in any manner a directive or authorization to perform extra work or delay the project. If in Contractor's belief it is likely to lead to a change to Contract Sum or Contract Time, promptly issue a notice to this effect, and follow up with an appropriate Change Order request to Owner.
1. Response may include a request for additional information, in which case the original RFI will be deemed as having been answered, and an amended one is to be issued forthwith. Identify the amended RFI with an R suffix to the original number.
 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 seven calendar days if an additional or corrected response is required by submitting an amended version of the original RFI, identified as specified above.

3.08 SUBMITTAL SCHEDULE

- 3.08.A. Submit to Architect for review a schedule for submittals in tabular format.
1. Submit at the same time as the preliminary schedule specified in Section 01 3216 - Construction Progress Schedule.
 2. Coordinate with Contractor's construction schedule and schedule of values.
 3. Arrange information to include scheduled date for initial submittal, specification number and title, submittal category (for review or for information), description of item of work covered, and role and name of subcontractor.
 4. Account for time required for preparation, review, manufacturing, fabrication and delivery when establishing submittal delivery and review deadline dates.
 - a. For assemblies, equipment, systems comprised of multiple components and/or requiring detailed coordination with other work, allow for additional time to make corrections or revisions to initial submittals, and time for their review.

3.09 SUBMITTALS FOR REVIEW

- 3.09.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.

- 3.09.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.
- 3.09.C. Samples will be reviewed for aesthetic, color, or finish selection.
- 3.09.D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 01 7800 - Closeout Submittals.

3.10 SUBMITTALS FOR INFORMATION

- 3.10.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.
- 3.10.B. Submit for Architect's knowledge as contract administrator or for Owner.

3.11 SUBMITTALS FOR PROJECT CLOSEOUT

- 3.11.A. Submit Correction Punch List for Substantial Completion.
- 3.11.B. Submit Final Correction Punch List for Substantial Completion.
- 3.11.C. When the following are specified in individual sections, submit them at project closeout in compliance with requirements of Section 01 7800 - Closeout Submittals:
 - 1. Project record documents.
 - 2. Operation and maintenance data.
 - 3. Warranties.
 - 4. Bonds.
 - 5. Other types as indicated.
- 3.11.D. Submit for Owner's benefit during and after project completion.

3.12 NUMBER OF COPIES OF SUBMITTALS

- 3.12.A. Electronic Documents: Submit one 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.
- 3.12.B. Extra Copies at Project Closeout: See Section 01 7800.

- 3.12.C. Samples: Submit the number specified in individual specification sections; one 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.

3.13 SUBMITTAL PROCEDURES

3.13.A. General Requirements:

1. Use a separate Project Submittal Cover Sheet for each item. Form included at end of this specification section.
2. Submit separate packages of submittals for review and submittals for information, when included in the same specification section.
3. Sequentially identify each item. For revised submittals use original number and a sequential numerical suffix.
4. Identify: Project; Contractor; subcontractor or supplier; pertinent drawing and detail number; and specification section number and article/paragraph, as appropriate on each copy.
5. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the work and Contract Documents.
 - a. Submittals from sources other than the Contractor, or without Contractor's stamp will not be acknowledged, reviewed, or returned.
6. 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. Upload submittals in electronic form to Electronic Document Submittal Service website.
7. Schedule submittals to expedite the Project, and coordinate submission of related items.
 - a. For each submittal for review, allow 15 days excluding delivery time to and from the Contractor.
 - b. For sequential reviews involving Architect's consultants, Owner, or another affected party, allow an additional 15 days.
8. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.
9. When revised for resubmission, identify all changes made since previous submission.
10. Distribute reviewed submittals. Instruct parties to promptly report inability to comply with requirements.
11. Incomplete submittals will not be reviewed, unless they are partial submittals for distinct portion(s) of the work and have received prior approval for their use.

3.13.B. Product Data Procedures:

1. Submit only information required by individual specification sections.
2. Collect required information into a single submittal.
3. Submit concurrently with related shop drawing submittal.

4. Do not submit (Material) Safety Data Sheets for materials or products.

3.13.C. Shop Drawing Procedures:

1. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting Contract Documents and coordinating related work.
2. Do not reproduce Contract Documents to create shop drawings.
3. Generic, non-project-specific information submitted as shop drawings do not meet the requirements for shop drawings.

3.13.D. Samples Procedures:

1. Transmit related items together as single package.
2. Identify each item to allow review for applicability in relation to shop drawings showing installation locations.

3.14 SUBMITTAL REVIEW

- 3.14.A. Submittals for Review: Architect and Cons will review each submittal, and approve, or take other appropriate action.

- 3.14.B. Submittals for Information: Architect will acknowledge receipt and review. See below for actions to be taken.

- 3.14.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.

3.14.D. Architect's and consultants' actions on items submitted for review:

1. Authorizing purchasing, fabrication, delivery, and installation:
 - a. "Reviewed", or language with same legal meaning.
 - b. "Reviewed as Noted, Resubmission not required", or language with same legal meaning.
 - 1) At Contractor's option, submit corrected item, with review notations acknowledged and incorporated.
 - c. "Reviewed as Noted, Resubmit for Record", or language with same legal meaning.
2. Not Authorizing fabrication, delivery, and installation:

3.14.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 01 3000

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SECTION 01 4000
QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Submittals.
- 1.01.B. Quality assurance.
- 1.01.C. References and standards.
- 1.01.D. Testing and inspection agencies and services.
- 1.01.E. Contractor's design-related professional design services.
- 1.01.F. Control of installation.
- 1.01.G. Mock-ups.
- 1.01.H. Tolerances.
- 1.01.I. Manufacturers' field services.
- 1.01.J. Defect Assessment.

1.02 RELATED REQUIREMENTS

- 1.02.A. Document 00 3100 - Available Project Information: Soil investigation data.
- 1.02.B. Section 01 3000 - Administrative Requirements: Submittal procedures.
- 1.02.C. Section 01 6000 - Product Requirements: Requirements for material and product quality.

1.03 REFERENCE STANDARDS

- 1.03.A. IAS AC89 - Accreditation Criteria for Testing Laboratories; 2021.

1.04 DEFINITIONS

- 1.04.A. Contractor's Professional Design Services: Design of some aspect or portion of the project by party other than the design professional of record. Provide these services as part of the Contract for Construction.
 - 1. Design Services Types Required:

- a. Design-Related: Design services explicitly required to be performed by another design professional due to highly technical and/or specialized nature of a portion of the project. Services primarily involve engineering analysis, calculations, and design, and are not intended to alter the aesthetic aspects of the design.

1.04.B. Design Data: Design-related, signed and sealed drawings, calculations, specifications, certifications, shop drawings and other submittals provided by Contractor, and prepared directly by, or under direct supervision of, appropriately licensed design professional.

1.05 CONTRACTOR'S DESIGN-RELATED PROFESSIONAL DESIGN SERVICES

1.05.A. Coordination: Contractor's professional design services are subject to requirements of project's Conditions for Construction Contract.

1.05.B. Base design on performance and/or design criteria indicated in individual specification sections.

1. Submit a Request for Interpretation to Architect if the criteria indicated are not sufficient to perform required design services.

1.05.C. Scope of Contractor's Professional Design Services: Provide for the following items of work:

1.06 SUBMITTALS

1.06.A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

1.06.B. Designer's Qualification Statement: Submit for Architect's knowledge as contract administrator, or for Owner's information.

1. Include information for each individual professional responsible for producing, or supervising production of, design-related professional services provided by Contractor.
 - a. Full name.
 - b. Professional licensure information.
 - c. Statement addressing extent and depth of experience specifically relevant to design of items assigned to Contractor.

1.06.C. Design Data: Submit for Architect's knowledge as contract administrator for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents, or for Owner's information.

1. Include calculations that have been used to demonstrate compliance to performance and regulatory criteria provided, and to determine design solutions.
2. Include required product data and shop drawings.
3. Include a statement or certification attesting that design data complies with criteria indicated, such as building codes, loads, functional, and similar engineering requirements.

4. Include signature and seal of design professional responsible for allocated design services on calculations and drawings.
- 1.06.D. Test Reports: After each test/inspection, promptly submit copies of report to Architect and to Contractor.
1. Include:
 - a. Date issued.
 - b. Project title and number.
 - c. Name of inspector.
 - d. Date and time of sampling or inspection.
 - e. Identification of product and specifications section.
 - f. Location in the Project.
 - g. Type of test/inspection.
 - h. Date of test/inspection.
 - i. Results of test/inspection.
 - j. Compliance with Contract Documents.
 - k. When requested by Architect, provide interpretation of results.
 2. Test report submittals are for Architect's knowledge as contract administrator for the limited purpose of assessing compliance with information given and the design concept expressed in the Contract Documents, or for Owner's information.
- 1.06.E. Certificates: When specified in individual specification sections, submit certification by the manufacturer and Contractor or installation/application subcontractor to Architect, 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.
- 1.06.F. 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.
- 1.07 Quality Assurance
- 1.07.A. Testing Agency Qualifications:
1. Prior to start of work, submit agency name, address, and telephone number, and names of full-time registered Engineer and responsible officer.
 2. Submit copy of report of laboratory facilities inspection made by NIST Construction Materials Reference Laboratory during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.
 3. Qualification Statement: Provide documentation showing testing laboratory is accredited under IAS AC89.

- 1.07.B. Designer Qualifications: Where professional engineering design services and design data submittals are specifically required of Contractor by Contract Documents, provide services of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

1.08 REFERENCES AND STANDARDS

- 1.08.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.
- 1.08.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.
- 1.08.C. Obtain copies of standards where required by product specification sections.
- 1.08.D. Maintain copy at project site during submittals, planning, and progress of the specific work, until Substantial Completion.
- 1.08.E. Should specified reference standards conflict with Contract Documents, request clarification from Architect before proceeding.
- 1.08.F. 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.

1.09 Testing and Inspection Agencies and Services

- 1.09.A. Owner will employ and pay for services of an independent testing agency to perform special tests and inspections required by authorities having jurisdiction as the responsibility of the Owner, as indicated in the Statement of Special Inspections included at the end of this Section and as follows:
 - 1. Notifying Architect and Contractor promptly of any irregularities and deficiencies observed in the Work during performance of its services.
 - 2. Submitting a certified written report of each test, inspection, and similar quality control services to Architect with a copy to Contractor and to authorities having jurisdiction.
 - 3. Retesting and reinspecting corrected Work.
- 1.09.B. Contractor shall employ and pay for services of an independent testing agency to perform other specified testing.
- 1.09.C. 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

3.01 CONTROL OF INSTALLATION

- 3.01.A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.
- 3.01.B. Comply with manufacturers' instructions, including each step in sequence.
- 3.01.C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect before proceeding.
- 3.01.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.
- 3.01.E. Have work performed by persons qualified to produce required and specified quality.
- 3.01.F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.
- 3.01.G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

3.02 MOCK-UPS

- 3.02.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.
- 3.02.B. Accepted mock-ups establish the standard of quality the Architect will use to judge the Work.
- 3.02.C. Notify Architect fifteen (15) working days in advance of dates and times when mock-ups will be constructed.
- 3.02.D. Provide supervisory personnel who will oversee mock-up construction. Provide workers that will be employed during the construction at Project.
- 3.02.E. Tests shall be performed under provisions identified in this section and identified in the respective product specification sections.
- 3.02.F. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.

- 3.02.G. Obtain Architect's approval of mock-ups before starting work, fabrication, or construction.
 - 1. Architect will issue written comments within seven (7) working days of initial review and each subsequent follow up review of each mock-up.
 - 2. Make corrections as necessary until Architect's approval is issued.
- 3.02.H. Architect will use accepted mock-ups as a comparison standard for the remaining Work.
- 3.02.I. 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.

3.03 TOLERANCES

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

3.04 TESTING AND INSPECTION

- 3.04.A. See individual specification sections for testing and inspection required.
- 3.04.B. Testing Agency Duties:
 - 1. Provide qualified personnel at site. Cooperate with Architect and Construction Manager in performance of services.
 - 2. Perform specified sampling and testing of products in accordance with specified standards.
 - 3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
 - 4. Promptly notify Architect and 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/inspections specified.
- 3.04.C. Limits on Testing/Inspection Agency Authority:
 - 1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 - 2. Agency may not approve or accept any portion of the Work.
 - 3. Agency may not assume any duties of Contractor.
 - 4. Agency has no authority to stop the Work.
- 3.04.D. Construction Manager Responsibilities:

1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
 2. Cooperate with laboratory personnel, and provide access to the Work and to manufacturers' facilities.
 3. Provide incidental labor and facilities:
 - a. To provide access to Work to be tested/inspected.
 - b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
 - c. To facilitate tests/inspections.
 - d. To provide storage and curing of test samples.
 4. Notify Architect and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.
 5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
 6. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
- 3.04.E. Re-testing required because of non-compliance with specified requirements shall be performed by the same agency on instructions by Architect.
- 3.04.F. Re-testing required because of non-compliance with specified requirements shall be paid for by Contractor.

3.05 MANUFACTURERS' FIELD SERVICES

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

3.06 DEFECT ASSESSMENT

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

END OF SECTION 01 4000

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SECTION 01 5000
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Dewatering
- 1.01.B. Temporary utilities.
- 1.01.C. Temporary telecommunications services.
- 1.01.D. Temporary sanitary facilities.
- 1.01.E. Temporary Controls: enclosures and Barriers, Fencing, Enclosures.
- 1.01.F. Temporary Fire Protection.
- 1.01.G. Security requirements.
- 1.01.H. Vehicular access and parking.
- 1.01.I. Waste removal facilities and services.
- 1.01.J. Project identification sign.
- 1.01.K. Field offices.

1.02 Dewatering

- 1.02.A. Provide temporary means and methods for dewatering all temporary facilities and controls. Comply with requirements of authorities having jurisdiction.
- 1.02.B. Maintain temporary facilities in operable condition.

1.03 TEMPORARY UTILITIES

- 1.03.A. Provide and pay for all electrical power, lighting, water, heating and cooling, and ventilation required for construction purposes. Construction Manager to coordinate installation, removal, and use charges. Costs to be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including but not limited to, Owner's construction forces, Architect, testing agencies, and authorities having jurisdiction.
- 1.03.B. New permanent facilities may be used.

1.04 ELECTRONIC COMMUNICATION SERVICES

- 1.04.A. Provide, maintain, and pay for a secure WiFi wireless connection to internet services to field office at time of project mobilization. Include provisions for access to relevant parties including but not limited to, Owner's construction forces, Architect, testing agencies, and authorities having jurisdiction.
- 1.04.B. Telecommunications services shall include:

1.05 TEMPORARY SANITARY FACILITIES

- 1.05.A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization.
- 1.05.B. Maintain daily in clean and sanitary condition.

1.06 TEMPORARY CONTROLS: BARRIERS, FENCING, ENCLOSURES

1.06.A. BARRIERS

- 1. 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.
 - a. Provide warning sites and lights as required by authorities having jurisdiction.
- 2. Provide barricades and covered walkways required by governing authorities for public rights-of-way and for public access to existing building.
- 3. Provide protection for plants designated to remain. Replace damaged plants.
- 4. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.
- 5. Traffic Controls: Comply with requirements of authorities having jurisdiction.

1.06.B. FENCING

- 1. Construction: Commercial grade chain link fence.
- 2. Provide 6 foot (1.8 m) high fence around construction site; equip with vehicular and pedestrian gates with locks.
 - a. Extent of Fence: As indicated on the Drawings.
 - b. Coordinate with City.

1.06.C. EXTERIOR ENCLOSURES

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

1.07 TEMPORARY FIRE PROTECTION

- 1.07.A. Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire protection program.
 - 1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
 - 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition in accordance with requirements of authorities having jurisdiction.

1.08 SECURITY

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

1.09 VEHICULAR ACCESS AND PARKING

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

1.10 WASTE REMOVAL

- 1.10.A. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.
- 1.10.B. Provide containers with lids. Remove trash from site periodically.
- 1.10.C. If materials to be recycled or re-used on the project must be stored on-site, provide suitable non-combustible containers; locate containers holding flammable material outside the structure unless otherwise approved by the authorities having jurisdiction.
- 1.10.D. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.11 PROJECT IDENTIFICATION

- 1.11.A. Provide project identification sign of design and construction indicated on drawings.

- 1.11.B. Erect on site at location indicated.
- 1.11.C. No other signs are allowed without Owner permission except those required by law.
 - 1. Provide other temporary signs as indicated and as required to inform public and individuals seeking entrance to Project.
 - 2. Maintain and touch up signs, so they are legible at all times.

1.12 FIELD OFFICES

- 1.12.A. Office: Weathertight, with lighting, electrical outlets, heating, cooling equipment, and equipped with sturdy furniture, drawing rack, and drawing display table.
- 1.12.B. Provide space for Project meetings, with table and chairs to accommodate 10 persons.
- 1.12.C. Locate offices a minimum distance of 30 feet (10 m) from existing and new structures.

1.13 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- 1.13.A. Remove temporary utilities, equipment, facilities, materials, prior to Date of Substantial Completion inspection.
- 1.13.B. Remove underground installations to a minimum depth of 2 feet (600 mm). Grade site as indicated.
- 1.13.C. Clean and repair damage caused by installation or use of temporary work.
- 1.13.D. Restore new permanent facilities used during construction to specified condition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 01 5000

SECTION 01 6000
PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED REQUIREMENTS

- 1.02.A. Section 01 1000 - Summary: Identification of Owner-supplied products.
- 1.02.B. Section 01 2500 - Substitution Procedures: Substitutions made during procurement and/or construction phases.
- 1.02.C. Section 01 4000 - Quality Requirements: Product quality monitoring.

1.03 DEFINITIONS

- 1.03.A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product": includes the terms "material," "equipment," "system," and terms of similar intent.
- 1.03.B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. Published attributes and characteristics of basis-of-design product establish salient characteristics of products.

1.04 SUBMITTALS

- 1.04.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.

- 1.04.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.
- 1.04.C. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
 - 1. For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.

PART 2 PRODUCTS

2.01 NEW PRODUCTS

- 2.01.A. Provide new products unless specifically required or permitted by Contract Documents.
- 2.01.B. See Section 01 4000 - Quality Requirements, for additional source quality control requirements.
- 2.01.C. Use of products having any of the following characteristics is not permitted:
 - 1. Made using or containing CFC's or HCFC's.
- 2.01.D. Where other criteria are met, Contractor shall give preference to products that:
 - 1. If used on interior, have lower emissions, as defined in Section 01 6116.
 - 2. If wet-applied, have lower VOC content, as defined in Section 01 6116.

2.02 PRODUCT OPTIONS

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

2.03 MAINTENANCE MATERIALS

- 2.03.A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.
- 2.03.B. Deliver to Project site; obtain receipt prior to final payment.

PART 3 EXECUTION

3.01 SUBSTITUTION LIMITATIONS

3.01.A. See Section 01 2500 - Substitution Procedures.

3.02 OWNER-SUPPLIED PRODUCTS

3.02.A. See Section 01 1000 - Summary for identification of Owner-supplied products.

3.02.B. Owner's Responsibilities:

1. Arrange for and deliver Owner reviewed shop drawings, product data, and samples, to Contractor.
2. Arrange and pay for product delivery to site.
3. On delivery, inspect products jointly with Contractor.
4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
5. Arrange for manufacturers' warranties, inspections, and service.

3.02.C. Contractor's Responsibilities:

1. Review Owner reviewed shop drawings, product data, and samples.
2. Receive and unload products at site; inspect for completeness or damage jointly with Owner.
3. Handle, store, install and finish products.
4. Repair or replace items damaged after receipt.

3.03 TRANSPORTATION AND HANDLING

3.03.A. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.

3.03.B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.

3.03.C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.

3.03.D. Transport and handle products in accordance with manufacturer's instructions.

3.03.E. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.

3.03.F. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.

3.03.G. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.

- 3.03.H. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.04 STORAGE AND PROTECTION

- 3.04.A. Provide protection of stored materials and products against theft, casualty, or deterioration.
- 3.04.B. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication. See Section 01 7419.
 - 1. Structural Loading Limitations: Handle and store products and materials so as not to exceed static and dynamic load-bearing capacities of project floor and roof areas.
- 3.04.C. Store and protect products in accordance with manufacturers' instructions.
- 3.04.D. Store with seals and labels intact and legible.
- 3.04.E. Arrange storage of materials and products to allow for visual inspection for the purpose of determination of quantities, amounts, and unit counts.
- 3.04.F. Store sensitive products in weathertight, climate-controlled enclosures in an environment favorable to product.
- 3.04.G. For exterior storage of fabricated products, place on sloped supports above ground.
- 3.04.H. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.
- 3.04.I. Comply with manufacturer's warranty conditions, if any.
- 3.04.J. Do not store products directly on the ground.
- 3.04.K. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- 3.04.L. Prevent contact with material that may cause corrosion, discoloration, or staining.
- 3.04.M. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- 3.04.N. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

END OF SECTION 01 6000

SECTION 01 7000
EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Examination, preparation, and general installation procedures.
- 1.01.B. Pre-installation meetings.
- 1.01.C. Cutting and patching.
- 1.01.D. Surveying for laying out the work.
- 1.01.E. Cleaning and protection.
- 1.01.F. Starting of systems and equipment.
- 1.01.G. Demonstration and instruction of Owner personnel.
- 1.01.H. Closeout procedures, including Contractor's Correction Punch List, except payment procedures.

1.02 RELATED REQUIREMENTS

- 1.02.A. Section 01 3000 - Administrative Requirements: Submittals procedures.
- 1.02.B. Section 01 4000 - Quality Requirements: Testing and inspection procedures.
- 1.02.C. Section 01 5000 - Temporary Facilities and Controls: Temporary exterior enclosures.
- 1.02.D. Section 01 7800 - Closeout Submittals: Project record documents, operation and maintenance data, warranties, and bonds.
- 1.02.E. Section 01 7900 - Demonstration and Training: Demonstration of products and systems to be commissioned and where indicated in specific specification sections
- 1.02.F. Section 07 8400 - Firestopping.

1.03 REFERENCE STANDARDS

- 1.03.A. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2022, with Errata (2021).

1.04 SUBMITTALS

- 1.04.A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- 1.04.B. Survey work: Submit name, address, and telephone number of Surveyor before starting survey work.
1. On request, submit documentation verifying accuracy of survey work.
 2. Submit a copy of site drawing signed by the Land Surveyor, that the elevations and locations of the work are in compliance with Contract Documents.
 3. Submit surveys and survey logs for the project record.
- 1.04.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.
 4. Visual qualities of sight exposed elements.
 5. Work of Owner or separate Contractor.

1.05 QUALIFICATIONS

- 1.05.A. For surveying work, employ a land surveyor registered in the State in which the Project is located and acceptable to Architect. Submit evidence of surveyor's Errors and Omissions insurance coverage in the form of an Insurance Certificate. Employ only individual(s) trained and experienced in collecting and recording accurate data relevant to ongoing construction activities,

1.06 PROJECT CONDITIONS

- 1.06.A. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.
- 1.06.B. Erosion and Sediment Control: Plan and execute work by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas. Prevent erosion and sedimentation.

1.07 COORDINATION

- 1.07.A. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- 1.07.B. Notify affected utility companies and comply with their requirements.

- 1.07.C. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- 1.07.D. Coordinate space requirements, supports, and installation of mechanical and electrical work that are indicated diagrammatically on drawings. Follow routing indicated for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- 1.07.E. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- 1.07.F. Coordinate completion and clean-up of work of separate sections.
- 1.07.G. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

- 2.01.A. New Materials: As specified in product sections; match existing products and work for patching and extending work.
- 2.01.B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.
- 2.01.C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- 3.01.A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.
- 3.01.B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.
- 3.01.C. Examine and verify specific conditions described in individual specification sections.
- 3.01.D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.

- 3.01.E. Verify that utility services are available, of the correct characteristics, and in the correct locations.
- 3.01.F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

- 3.02.A. Clean substrate surfaces prior to applying next material or substance.
- 3.02.B. Seal cracks or openings of substrate prior to applying next material or substance.
- 3.02.C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.03 PREINSTALLATION MEETINGS

- 3.03.A. When required in individual specification sections, convene a preinstallation meeting at the site prior to commencing work of the section.
- 3.03.B. Require attendance of parties directly affecting, or affected by, work of the specific section.
- 3.03.C. Notify Architect four days in advance of meeting date.
- 3.03.D. Prepare agenda and preside at meeting:
 - 1. Review conditions of examination, preparation and installation procedures.
 - 2. Review coordination with related work.
- 3.03.E. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.04 LAYING OUT THE WORK

- 3.04.A. Verify locations of survey control points prior to starting work.
- 3.04.B. Promptly notify Architect of any discrepancies discovered.
- 3.04.C. Contractor shall locate and protect survey control and reference points.
- 3.04.D. Control datum for survey is that indicated on drawings.
- 3.04.E. Protect survey control points prior to starting site work; preserve permanent reference points during construction.
- 3.04.F. Promptly report to Architect the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.

- 3.04.G. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Architect.
- 3.04.H. Utilize recognized engineering survey practices.
- 3.04.I. Establish a minimum of two permanent benchmarks on site, referenced to established control points. Record locations, with horizontal and vertical data, on project record documents.
- 3.04.J. Establish elevations, lines and levels. Locate and lay out by instrumentation and similar appropriate means:
 - 1. Site improvements including pavements; stakes for grading, fill and topsoil placement; utility locations, slopes, and invert elevations.
 - 2. Grid or axis for structures.
 - 3. Building foundation, column locations, ground floor elevations.
 - 4. Controlling lines and levels required for mechanical and electrical trades.
- 3.04.K. Periodically verify layouts by same means.
- 3.04.L. Maintain a complete and accurate log of control and survey work as it progresses.
- 3.04.M. On completion of foundation walls and major site improvements, prepare a certified survey illustrating dimensions, locations, angles, and elevations of construction and site work.

3.05 GENERAL INSTALLATION REQUIREMENTS

- 3.05.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.
- 3.05.B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
- 3.05.C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
- 3.05.D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.
- 3.05.E. Make neat transitions between different surfaces, maintaining texture and appearance.

3.06 CUTTING AND PATCHING

- 3.06.A. Whenever possible, execute the work by methods that avoid cutting or patching.
- 3.06.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.
- 3.06.C. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.
- 3.06.D. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.
- 3.06.E. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
- 3.06.F. Restore work with new products in accordance with requirements of Contract Documents.
- 3.06.G. Fit work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- 3.06.H. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 8400, to full thickness of the penetrated element.
- 3.06.I. Patching:
1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
 2. Match color, texture, and appearance.
 3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

3.07 PROGRESS CLEANING

- 3.07.A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
- 3.07.B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.
- 3.07.C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

- 3.07.D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

3.08 PROTECTION OF INSTALLED WORK

- 3.08.A. Protect installed work from damage by construction operations.
- 3.08.B. Provide special protection where specified in individual specification sections.
- 3.08.C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- 3.08.D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- 3.08.E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- 3.08.F. Protect work from spilled liquids. If work is exposed to spilled liquids, immediately remove protective coverings, dry out work, and replace protective coverings.
- 3.08.G. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- 3.08.H. Prohibit traffic from landscaped areas.
- 3.08.I. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.
- 3.08.J. Comply with manufacturer's written instructions for temperature and relative humidity.

3.09 SYSTEM STARTUP

- 3.09.A. Coordinate schedule for start-up of various equipment and systems.
- 3.09.B. Notify Architect and Owner seven days prior to start-up of each item.
- 3.09.C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.
- 3.09.D. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- 3.09.E. Verify that wiring and support components for equipment are complete and tested.
- 3.09.F. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.

- 3.09.G. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
- 3.09.H. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.10 DEMONSTRATION AND INSTRUCTION

- 3.10.A. See Section 01 7900 - Demonstration and Training.

3.11 ADJUSTING

- 3.11.A. Adjust operating products and equipment to ensure smooth and unhindered operation.
- 3.11.B. Testing, adjusting, and balancing HVAC systems: See Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.

3.12 FINAL CLEANING

- 3.12.A. Execute final cleaning prior to Substantial Completion.
- 3.12.B. Use cleaning materials that are nonhazardous. Use materials recommended by manufacturer or fabricator of the surface to be cleaned.
- 3.12.C. 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.
- 3.12.D. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.
- 3.12.E. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
- 3.12.F. Clean filters of operating equipment.
- 3.12.G. Clean debris from roofs, gutters, downspouts, scuppers, overflow drains, area drains, drainage systems, and _____.
- 3.12.H. Clean site; sweep paved areas, rake clean landscaped surfaces.
- 3.12.I. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.13 CLOSEOUT PROCEDURES

- 3.13.A. Make submittals that are required by governing or other authorities.
 - 1. Provide copies to Architect.
- 3.13.B. Accompany Project Coordinator on preliminary inspection to determine items to be listed for completion or correction in the Contractor's Correction Punch List for Contractor's Notice of Substantial Completion.
- 3.13.C. Notify Architect when work is considered ready for Architect's Substantial Completion inspection.
- 3.13.D. 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.
- 3.13.E. Conduct Substantial Completion inspection and create Final Correction Punch List containing Architect's and Contractor's comprehensive list of items identified to be completed or corrected and submit to Architect.
- 3.13.F. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.
- 3.13.G. Notify Architect when work is considered finally complete and ready for Architect's Substantial Completion final inspection.
- 3.13.H. Complete items of work determined by Architect listed in executed Certificate of Substantial Completion.

END OF SECTION 01 7000

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SECTION 01 7800
CLOSEOUT SUBMITTALS

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Project record documents.
- 1.01.B. Operation and maintenance data.
- 1.01.C. Warranties and bonds.

1.02 RELATED REQUIREMENTS

- 1.02.A. Section 01 3000 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
- 1.02.B. Section 01 7000 - Execution and Closeout Requirements: Contract closeout procedures.
- 1.02.C. Individual Product Sections: Specific requirements for operation and maintenance data.
- 1.02.D. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS

- 1.03.A. Project Record Documents: Submit documents to Architect with claim for final Application for Payment.
- 1.03.B. Operation and Maintenance Data:
 - 1. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
 - 2. Submit one copy of completed documents 15 days prior to final inspection. This copy will be reviewed and returned after final inspection, with Architect comments. Revise content of all document sets as required prior to final submission.
 - 3. Submit two sets of revised final documents in final form within 10 days after final inspection.
- 1.03.C. Warranties and Bonds:
 - 1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.
 - 2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.

3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PROJECT RECORD DOCUMENTS

- 3.01.A. Maintain on site one set of the following record documents; record actual revisions to the Work:
 1. Drawings.
 2. Specifications.
 3. Addenda.
 4. Change Orders and other modifications to the Contract.
 5. Reviewed shop drawings, product data, and samples.
 6. Manufacturer's instruction for assembly, installation, and adjusting.
- 3.01.B. Ensure entries are complete and accurate, enabling future reference by Owner.
- 3.01.C. Store record documents separate from documents used for construction.
- 3.01.D. Record information concurrent with construction progress.
- 3.01.E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
 1. Manufacturer's name and product model and number.
 2. Product substitutions or alternates utilized.
 3. Changes made by Addenda and modifications.
- 3.01.F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
 1. Measured depths of foundations in relation to finish first floor datum.
 2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 4. Field changes of dimension and detail.
 5. Details not on original Contract drawings.
- 3.01.G. Submit PDF electronic files of scanned record prints, specifications and product data, including addenda and contract modifications.

3.02 OPERATION AND MAINTENANCE DATA

- 3.02.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.
- 3.02.B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- 3.02.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.
- 3.02.D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3.03 OPERATION AND MAINTENANCE DATA FOR MATERIALS AND FINISHES

- 3.03.A. For Each Product, Applied Material, and Finish:
 - 1. Product data, with catalog number, size, composition, and color and texture designations.
 - 2. Information for re-ordering custom manufactured products.
- 3.03.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.
- 3.03.C. Moisture protection and weather-exposed products: Include product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.
- 3.03.D. Additional information as specified in individual product specification sections.
- 3.03.E. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

3.04 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

- 3.04.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.
- 3.04.B. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

- 3.04.C. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.
- 3.04.D. Include color coded wiring diagrams as installed.
- 3.04.E. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
- 3.04.F. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and troubleshooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
 - 1. Include HVAC outdoor and exhaust air damper calibration strategy.
 - a. Include provisions which ensure that full closure of dampers can be achieved.
 - 2. Include Carbon Dioxide Monitoring Protocol.
 - 3. Include Carbon Monoxide Monitoring Protocol.
 - 4. Include Frost Mitigation Strategy for ventilation heat-recovery system.
- 3.04.G. Provide servicing and lubrication schedule, and list of lubricants required.
- 3.04.H. Include manufacturer's printed operation and maintenance instructions.
- 3.04.I. Include sequence of operation by controls manufacturer.
- 3.04.J. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- 3.04.K. Provide control diagrams by controls manufacturer as installed.
- 3.04.L. Provide Contractor's coordination drawings, with color coded piping diagrams as installed.
- 3.04.M. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- 3.04.N. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- 3.04.O. Include test and balancing reports.
- 3.04.P. Additional Requirements: As specified in individual product specification sections.

3.05 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

- 3.05.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.
- 3.05.B. Where systems involve more than one specification section, provide separate tabbed divider for each system.

- 3.05.C. Binders: Commercial quality, 8-1/2 by 11 inch (216 by 280 mm) three D side ring binders with durable plastic covers; 2 inch (50 mm) maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
- 3.05.D. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.
- 3.05.E. Project Directory: Title and address of Project; names, addresses, and telephone numbers of Construction Manager, Architect, Consultants, Contractor and subcontractors, with names of responsible parties.
- 3.05.F. Tables of Contents: List every item separated by a divider, using the same identification as on the divider tab; where multiple volumes are required, include all volumes Tables of Contents in each volume, with the current volume clearly identified.
- 3.05.G. Dividers: Provide tabbed dividers for each separate product and system; identify the contents on the divider tab; immediately following the divider tab include a description of product and major component parts of equipment.
- 3.05.H. Text: Manufacturer's printed data, or typewritten data on 20-pound paper.
- 3.05.I. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- 3.05.J. Arrangement of Contents: Organize each volume in parts as follows:
 - 1. Project Directory.
 - 2. Table of Contents, of all volumes, and of this volume.
 - 3. Operation and Maintenance Data: Arranged by system, then by product category.
 - a. Source data.
 - b. Operation and maintenance data.
 - c. Field quality control data.
 - d. Photocopies of warranties and bonds.
- 3.05.K. Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
 - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 - 2. File Names and Bookmarks: Bookmark individual documents base 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.

3.06 WARRANTIES AND BONDS

- 3.06.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.
- 3.06.B. Verify that documents are in proper form, contain full information, and are notarized.
- 3.06.C. Co-execute submittals when required.
- 3.06.D. Retain warranties and bonds until time specified for submittal.
- 3.06.E. Manual: Bind in commercial quality 8-1/2 by 11 inch (216 by 279 mm) three D side ring binders with durable plastic covers.
- 3.06.F. Cover: Identify each binder with typed or printed title WARRANTIES AND BONDS, with title of Project; name, address and telephone number of Contractor and equipment supplier; and name of responsible company principal.
- 3.06.G. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification section in which specified, and the name of product or work item.
- 3.06.H. Separate each warranty or bond with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
- 3.06.I. 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 the beginning of each document.

END OF SECTION 01 7800

SECTION 01 7900
DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.01 SUMMARY

- 1.01.A. Demonstration of products and systems where indicated in specific specification sections.

1.02 RELATED REQUIREMENTS

- 1.02.A. Section 01 7800 - Closeout Submittals: Operation and maintenance manuals.
1.02.B. Other Specification Sections: Additional requirements for demonstration and training.

1.03 SUBMITTALS

- 1.03.A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- 1.03.B. Training Plan: Owner will designate personnel to be trained; tailor training to needs and skill-level of attendees.
1. Submit to Architect for transmittal to Owner.
 2. Submit not less than four weeks prior to start of training.
 3. Revise and resubmit until acceptable.
 4. Provide an overall schedule showing all training sessions.
 5. Include at least the following for each training session:
 - a. Identification, date, time, and duration.
 - b. Description of products and/or systems to be covered.
 - c. Name of firm and person conducting training; include qualifications.
 - d. Intended audience, such as job description.
 - e. Objectives of training and suggested methods of ensuring adequate training.
 - f. Methods to be used, such as classroom lecture, live demonstrations, hands-on, etc.
 - g. Media to be used, such as slides, hand-outs, etc.
 - h. Training equipment required, such as projector, projection screen, etc., to be provided by Contractor.
- 1.03.C. Training Manuals: Provide training manual for each attendee; allow for minimum of two attendees per training session.
1. Include applicable portion of O&M manuals.
 2. Include copies of all hand-outs, slides, overheads, video presentations, etc., that are not included in O&M manuals.

3. Provide one extra copy of each training manual to be included with operation and maintenance data.

1.03.D. Training Reports:

1. Identification of each training session, date, time, and duration.
2. Sign-in sheet showing names and job titles of attendees.
3. List of attendee questions and written answers given, including copies of and references to supporting documentation required for clarification; include answers to questions that could not be answered in original training session.

1.03.E. Video Recordings: Submit digital video recording of each demonstration and training session for Owner's subsequent use.

1. Format: DVD Disc.
2. Label each disc and container with session identification and date.

1.04 QUALITY ASSURANCE

1.04.A. Instructor Qualifications: Familiar with design, operation, maintenance and troubleshooting of the relevant products and systems.

1. Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.
2. Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 DEMONSTRATION - GENERAL

3.01.A. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by Owner.

3.01.B. Demonstration may be combined with Owner personnel training if applicable.

3.01.C. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.

1. Perform demonstrations not less than two weeks prior to Substantial Completion.
2. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.

3.01.D. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.

1. Perform demonstrations not less than two weeks prior to Substantial Completion.

3.02 TRAINING - GENERAL

- 3.02.A. Conduct training on-site unless otherwise indicated.
- 3.02.B. Owner will provide classroom and seating at no cost to Contractor.
- 3.02.C. Provide training in minimum two-hour segments.
- 3.02.D. Training schedule will be subject to availability of Owner's personnel to be trained; re-schedule training sessions as required by Owner; once schedule has been approved by Owner failure to conduct sessions according to schedule will be cause for Owner to charge Contractor for personnel "show-up" time.
- 3.02.E. Review of Facility Policy on Operation and Maintenance Data: During training discuss:
 - 1. The location of the O&M manuals and procedures for use and preservation; backup copies.
 - 2. Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
 - 3. Typical uses of the O&M manuals.
- 3.02.F. Product- and System-Specific Training:
 - 1. Review the applicable O&M manuals.
 - 2. For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.
 - 3. Review instructions for proper operation in all modes, including start-up, shut-down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.
 - 4. Provide hands-on training on all operational modes possible and preventive maintenance.
 - 5. Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
 - 6. Discuss common troubleshooting problems and solutions.
 - 7. Discuss any peculiarities of equipment installation or operation.
 - 8. Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
 - 9. Review recommended tools and spare parts inventory suggestions of manufacturers.
 - 10. Review spare parts and tools required to be furnished by Contractor.
 - 11. Review spare parts suppliers and sources and procurement procedures.
- 3.02.G. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three days.

END OF SECTION 01 7900

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SECTION 03 2000
CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The provisions of the General Conditions, Supplementary Conditions, and the Sections included under Division 1, General Requirements, are included as a part of this Section as though bound herein.

1.2 SUMMARY

- A. Provide concrete and masonry reinforcement as indicated. The Work includes fabrication and placement of reinforcement for cast-in-place concrete including bars, welded wire fabric, ties, and supports. Related Work Specified Elsewhere
 - 1. Division 1– Quality Control: For inspection of reinforcing steel placement.
 - 2. Section 03 3000 - Cast-in-Place Concrete.
 - 3. Division 4 - Masonry Reinforcement and Anchoring: For reinforcement for unit masonry.
- B. Refer to Division 1 for Alternates that may affect the Work of this Section.

1.3 SUBMITTALS

- A. Product Data
 - 1. Submit manufacturer's specifications and installation instructions for proprietary materials and reinforcement accessories.
- B. Shop Drawings
 - 1. Submit shop drawings for fabrication, bending, and placement of concrete and masonry reinforcement. Comply with the ACI 315-latest edition "Details and Detailing of Concrete Reinforcement". Show bar schedules, stirrup spacing, diagrams of bent bars, arrangements, and assemblies as required for the fabrication and placement of concrete reinforcement. Show building plans with bar sizes, spacing, and quantities for all bent and straight reinforcing bars. For walls, floor slabs, and roof slabs with openings or special reinforcing details, show elevations or plans detailing all reinforcing.
- C. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
 - 1. Steel reinforcement and reinforcement accessories.

1.4 QUALITY ASSURANCE

- A. Codes and Standards: Comply with requirements of the latest edition of the following codes and standards, except as herein modified:
1. American Welding Society, AWS D 1.4, latest edition - "Structural Welding Code - Reinforcing Steel."
 2. Concrete Reinforcing Steel Institute, "Manual of Standard Practice."
 3. American Concrete Institute, ACI 318-latest edition "Building Code Requirements for Reinforced Concrete."

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver reinforcement to the project site bundled, tagged, and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams.
- B. Store concrete reinforcement materials at the site to prevent damage and accumulation of dirt or excessive rust.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Reinforcing Bars (Rebar): ASTM A615, and as follows:
1. Provide Grade 60 (Grade 420), deformed for bars No. 3 to 11, except as otherwise indicated.
 2. Provide Low-Alloy Steel Reinforcing Bars, ASTM A706 deformed bars, where welding of reinforcing is required.
- B. Steel Wire: ASTM A82, as shown.
- C. Welded Wire Fabric (WWF): ASTM A185, fabricated from cold steel wire into flat sheets.
1. Provide sheet stock only for interior slab on grade (roll stock not acceptable).
 2. Fiber reinforcement shall not be substituted for WWF.
- D. Supports for Reinforcement (including welded wire fabric): Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement in place.
1. Use wire bar type supports complying with CRSI recommendations, unless otherwise indicated. Do not use wood, brick, and other unacceptable materials.
 2. Over waterproof membranes, use precast concrete chairs to prevent penetration of the membrane.
 3. For footings, trench footings, slabs on grade, and grade beams use precast concrete bricks ($f'c = 3000$ psi min. at 28 days). (Concrete masonry bricks not acceptable.)

4. For concrete masonry bond beams use #3 bar laterally, tied to each longitudinal reinforcing bar below to hold bars apart and up from bottom. Space #3 bars at 48 inches o.c.
- E. Adhesive Anchor Bolts (In Concrete): Chemically grouted adhesive anchor bolts. Subject to compliance with requirements, provide one of the following:
1. Products; Subject to compliance with specified requirements, provide one of the following:
 - a. HILTI HIT-HY 200 Adhesive Anchors; Hilti, Inc., Tulsa, Oklahoma.
 - b. EPCON System Ceramic 6 Adhesive Anchors; ITW Ramset/Red Head, Wood Dale, Illinois.
 - c. Chem-Stud Adhesive Anchors; Powers Fasteners, Inc., New Rochelle, New York.
 - d. Simpson Set Epoxy-Tie Adhesive Anchors; Simpson Strong-Tie Company, Inc, Pleasanton, California.
 2. Anchors to be ASTM A193, Grade B7 galvanized steel threaded rods (Fy = 105 ksi) unless otherwise noted.
 3. Where noted on the drawings anchors to be ASTM F593, Condition CW stainless steel threaded rods (Fy = 65 ksi for diameters 3/8 inch through 5/8 inch and Fy = 45 ksi for diameters 3/4 inch through 1-1/4 inch).
 4. Anchors to be installed in strict conformance to manufacturer's installation instructions.
 5. Adhesive and Epoxy Anchors shall have the following minimum allowable load capacities:

(Based on embedment in 4000 psi concrete and a minimum safety factor on ultimate load capacities or 3.5. Use proportional allowable loads for other strengths of concrete.)

<u>Size</u>	<u>Allowable Shear</u>	<u>Allowable Tension</u>	<u>Minimum Embedment</u>
3/8 inch	2000 lbs.	2000 lbs.	3-1/2 inch
1/2 inch	3500 lbs.	4150 lbs.	4-1/4 inch
5/8 inch	5500 lbs.	5200 lbs.	5 inch
3/4 inch	8000 lbs.	9000 lbs.	6-5/8 inch
1 inch	14,000 lbs.	13,500 lbs.	8-1/4 inch

2.2 FABRICATION

- A. General: Fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI "Manual of Standard Practice." In case of fabricating errors, do not rebend or straighten reinforcement in a manner that will injure or weaken the material.
- B. Unacceptable Materials: Reinforcement with any of the following defects will not be permitted in the work.
 1. Bar lengths, depths, and bends exceeding specified fabrication tolerances.
 2. Bends or kinks not indicated on Drawings or final shop drawings.

3. Bars with reduced cross-section due to excessive rusting or other cause.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The installer must examine the substrate and the conditions under which concrete reinforcement is to be placed and notify the Contractor in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.
- B. The Architect shall be notified by the Contractor for this Section shall notify the A/E when steel placement for a concrete pour is nearing completion so that the Work may be observed.

3.2 INSTALLATION

- A. Comply with the specified codes and standards and Concrete Reinforcing Steel Institute recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports, and as herein specified.
 1. Do not cut or puncture vapor barrier. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement to remove loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.
- C. Position, support, and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by precast concrete brick, metal chairs, runners, bolsters, spacers, and hangers as required.
- D. Place reinforcement to obtain the minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports together with 16 gauge wire to hold reinforcement accurately in position during concrete placement operations. Set wire ties so that twisted ends are directed away from exposed concrete surfaces. Do not tack weld crossing reinforcing bars.
- E. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with 16-gauge wire spaced at 48 inches. Do not make end laps midway between supporting beams or directly over beams of continuous structures. Offset end laps in adjacent widths to prevent continuous laps.
- F. Provide sufficient numbers of supports and of strength to support reinforcement in the correct position as detailed in the plans. Do not place reinforcing bars more than 2 inches beyond the last leg of continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

- G. Provide standard reinforcement splices by lapping ends, placing bars in contact, and tightly tying wire. Comply with requirements of ACI 318 for minimum lap of spliced bars.
- H. Reinforcing steel installed in continuous footings shall run continuous. This shall include specially shaped components with proper lap where corner reinforcing and step footings occur.
- I. Provide additional reinforcing around required openings in footings, and slabs having a one foot least dimension.
- J. Support welded wire fabric in slabs on grade with precast concrete bricks at 2 feet spacing in both directions.
- K. Provide continuous chairs or bolsters to support welded wire fabric in elevated slabs at each line of support for the steel deck (e.g., at centerline of supporting joists or beams) and as required to support reinforcing steel in the correct position as detailed in the Plans.

END OF SECTION 03 2000

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SECTION 03 3000
CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Section includes cast-in-place concrete, including reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.2 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
- C. Steel Reinforcement Shop Drawings: Details of fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement." Reinforcing bars as noted on drawings.
- D. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance with requirements indicated, based on comprehensive testing of current materials:

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
- C. Source Limitations: Obtain each type of cement of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.
- D. Comply with ACI 301, "Specification for Structural Concrete," including the following, unless modified by the requirements of the Contract Documents.
 - 1. General requirements, including submittals, quality assurance, acceptance of structure, and protection of in-place concrete.
 - 2. Formwork and form accessories.
 - 3. Steel reinforcement and supports.

4. Concrete mixtures.
5. Handling, placing, and constructing concrete.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle steel reinforcement to prevent bending and damage.

PART 2 – PRODUCTS

2.1 FORM-FACING MATERIALS

- A. Furnish formwork and form accessories according to ACI 301.
- B. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
 1. Plywood, metal, or other approved panel materials.
 2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - a. High-density overlay, Class 1, or better.
 - b. Medium-density overlay, Class 1, or better, mill-release agent treated and edge sealed.
- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch minimum.
- D. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
- C. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.
- D. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

2.3 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Types I or II or Type III.
 1. Fly Ash: ASTM C 618, Class C or F.
 2. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

- B. Normal-Weight Aggregate: ASTM C 33, uniformly graded, not exceeding 1 1/2 inch nominal size. For slab with thickness less than 3 inches use max. 3/8" aggregate. For masonry fill use 3/8" aggregate.
- C. Water: Potable and complying with ASTM C 94.

2.4 ADMIXTURES

- A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cement and to be compatible with other admixtures. Do not use admixtures containing calcium chloride.
- B. Air-Entraining Admixture: ASTM C 260.
- C. Water-Reducing Admixture: ASTM C 494, Type A.
- D. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
- E. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
- F. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

2.5 RELATED MATERIALS

- A. Vapor Retarder: Plastic sheet, ASTM E 1745, Class A or B.
- B. Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils thick; or plastic sheet, ASTM E 1745, Class C.
- C. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.

2.6 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

- F. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

2.7 CONCRETE MIXES

- A. Comply with ACI 301 requirements for concrete mixtures.
- B. Prepare design mixes, proportioned according to ACI 301, for normal-weight concrete determined by either laboratory trial mix or field test data bases, as follows:
 - 1. Minimum Compressive Strength: 3500 psi at 28 days. Minimum Portland Cement 500 lbs.
 - 2. Maximum Water-Cementitious Materials Ratio: 0.45
 - 3. Slump: 4 inches.
 - a. Slump Limit for Concrete Containing High-Range Water-Reducing Admixture: Not more than 8 inches after adding admixture to plant- or site-verified, 2- to 3-inch slump.
 - 4. Add water-reducing admixture.
 - 5. Air Content: Maintain within range permitted by ACI 301 (ACI 301M). Do not allow air content of trowel-finished floor slabs to exceed 3 percent.
 - 6. Max. Fly Ash: 20%
- C. For masonry fill (grouting), 2500 psi at 28 days with superplasticizer.
- D. For all exterior concrete conform to ODOT Item 499 Class QC1.

2.8 FABRICATING REINFORCEMENT

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

2.9 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116, and furnish batch ticket information.
 - 1. When air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

2.10 BONDING AGENT

- A. Film-forming, freeze-thaw resistant acrylic latex admixture and bonding agent suitable for brush or spray application, complying with ASTM C881. Where epoxy bonding agent is indicated, provide bonding agent with minimum 1500 PSI bond strength from the listed manufacturers. Subject to compliance with requirements, provide one of the following:
 - 1. Adbond (J40); Dayton Superior Corp., Oregon, Illinois.
 - 2. Euoweld; Euclid Chemical, Cleveland, Ohio.
 - 3. Everbond; L&M Construction Chemicals, Omaha, Nebraska

4. Acrylic Additive; Sonneborn Building Products, Shakopee, Minnesota
5. Intralok; W.R. Meadows, Inc., Elgin, Illinois
6. Strong Bond; Conspec Marketing & Manufacturing Co., Inc., Kansas City, Kansas
7. SIKA Corp. – Various

2.11 ADHESIVE ANCHOR

- A. Chemically grouted adhesive anchor bolts. Anchors to be installed per the approved ICC Evaluation Report and manufacturer’s strict recommendations. Subject to compliance with requirements, provide one of the following:
1. Products: Subject to compliance with specified requirements, provide one of the following:
 - a. HILTI Super HAS Rod Material with HIT HY 200 Epoxy, Hilti, Inc., Tulsa, Oklahoma. ICC Evaluation Report ESR-3013 (latest issue).
 - b. Powers PE1000+ Epoxy Adhesive; Powers Fasteners, Inc., Brewster, New York. ICC Evaluation Report ESR-2583 (latest issue) .
 - c. Simpson Set Epoxy-Tie SET-XP Adhesive Anchors; Simpson Strong-Tie Company, Inc, Pleasanton, California. ICC Evaluation Report ESR-2508 (latest issue).
 - d. Approved equals must be rated for cracked and uncracked concrete and meet the requirements in accordance with the ICC-ES Acceptance Criteria for Post-installed Adhesive Anchors in Concrete (AC308).
 2. Anchors to be ASTM A193, Grade B7 galvanized steel threaded rods (Fy = 105 ksi) unless otherwise noted.
 3. Where noted on the drawings anchors to be ASTM F593, Condition CW stainless steel threaded rods (Fy = 65 ksi for diameters 3/8 inch through 5/8 inch and Fy = 45 ksi for diameters 3/4 inch through 1-1/4 inch).
 4. Anchors to be installed in strict conformance to manufacturer’s installation instructions.
 5. Adhesive and Epoxy Anchors shall have the following minimum allowable load capacities: (Based on embedment in 4000 psi concrete and a minimum safety factor on ultimate load capacities or 3.5. Use proportional allowable loads for other strengths of concrete.)

<u>Size</u>	<u>Allowable Shear</u>	<u>Allowable Tension</u>	<u>Minimum Embedment</u>
3/8 inch	2000 lbs.	2000 lbs.	3-1/2 inch
1/2 inch	3500 lbs.	4150 lbs.	4-1/4 inch
5/8 inch	5500 lbs.	5200 lbs.	5 inch
3/4 inch	8000 lbs.	9000 lbs.	6-5/8 inch
1 inch	14,000 lbs.	13,500 lbs.	8-1/4 inch

PART 3 – EXECUTION

3.1 FORMWORK

- A. Design, construct, erect, shore, brace, and maintain formwork according to ACI 301.

3.2 EMBEDDED ITEMS

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

3.3 VAPOR RETARDERS

- A. Install, protect, and repair vapor retarders according to ASTM E 1643; place sheets in position with longest dimension parallel with direction of pour.
 - 1. Lap joints 6 inches and seal with manufacturer recommended adhesive or joint tape.

3.4 STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.5 CONCRETE PLACEMENT

- A. Comply with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete.
- B. Do not add water to concrete during delivery, at Project site, or during placement.

3.6 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Contraction Joints in Slabs-on-Grade: Form weakened-plane, sawed contraction joints, sectioning concrete into areas as indicated. Where not specifically indicated, joint shall be 2.5 times thickness of slab. For exterior, max 10' C/C. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness.
- C. Isolation Joints: Install joint-filler strips at junctions with slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint fillers full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.

3.7 CONCRETE PLACEMENT

- A. Comply with ACI 301 for placing concrete.
- B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
- C. Do not add water to concrete during delivery, at Project site, or during placement.
- D. Consolidate concrete with mechanical vibrating equipment.
- E. For all exterior concrete, conform to ODOT Item 499 Class C.

3.8 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding 1/2 inch (13 mm).
 1. Apply to concrete surfaces (not exposed to public view).
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch (3 mm).
 1. Apply to concrete surfaces exposed to public view, or to receive a rubbed finish.
- C. Rubbed Finish: Apply the following rubbed finish, defined in ACI 301 (ACI 301M), to smooth-formed finished as-cast concrete where indicated:
 1. Smooth-rubbed finish.
 2. Grout-cleaned finish.
 3. Cork-floated finish.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.9 FINISHING UNFORMED SURFACES

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

- B. Screed surfaces with a straightedge and strike off. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane before excess moisture or bleedwater appears on surface.
 - 1. Do not further disturb surfaces before starting finishing operations.
- C. Scratch Finish: Apply scratch finish to surfaces indicated and surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes, unless otherwise indicated.
- D. Float Finish: Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, fluid-applied or direct-to-deck-applied membrane roofing, or sand-bed terrazzo.
- E. Trowel Finish: Apply a hard trowel finish to surfaces indicated and to floor and slab 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.
- F. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set methods. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
- G. Nonslip Broom Finish: Apply a nonslip broom finish to surfaces indicated and to exterior concrete platforms, steps, and ramps. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

3.10 TOLERANCES

- A. Comply with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

3.11 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. 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 (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

- C. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.
- D. Curing Methods: Cure formed and unformed concrete for at least seven days by a curing compound.
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - 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.

3.12 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Tests: Perform according to ACI 301 (ACI 301M).
 - 1. Testing Frequency: One composite sample shall be obtained for each day's pour of each concrete mix exceeding 5 cu. yd. (4 cu. m) but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
 - 2. Testing Frequency: One composite sample shall be obtained for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mix placed each day.

3.13 REPAIRS

- A. Remove and replace concrete that does not comply with requirements in this Section, at no additional cost to Owner.

END OF SECTION 03 3000

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SECTION 03 3543
POLISHED CONCRETE FINISHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Polished concrete finishing and scoring.
2. Concrete for polished concrete, including concrete materials, mixture design, placement procedures, initial finishing, and curing is specified in Section 03 3000 "Cast-in-Place Concrete."

1.2 DEFINITIONS

- A. Design Reference Sample: Sample designated by Architect in the Contract Documents that reflects acceptable surface quality and appearance of polished concrete.

1.3 PREINSTALLATION MEETINGS

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

1. Review curing procedures, construction joints, concrete repair procedures, concrete finishing, and protection of polished concrete.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

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

1. Repair materials.
2. Stain materials.
3. Liquid floor treatments.

1.6 QUALITY ASSURANCE

- A. Mockups: Before casting concrete, build mockups to verify selections made under Sample submittals and to demonstrate typical joints, surface finish, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed Work:
 - 1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.
 - 2. Demonstrate curing, finishing, and protecting of polished concrete.

1.7 FIELD CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatments for Polished Concrete Finish: Clear, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and is suitable for polished concrete surfaces.
- B. VOC Content: Provide materials that comply with VOC limits of authorities having jurisdiction. Review manufacturer's indicated products for compliance to VOC requirements.
- C. Hardener Densifier Lithium Silicate Treatment: A water-based chemically reactive penetrating lithium silicate sealer and hardener treatment reacting with the calcium hydroxide from concrete hydration to produce insoluble calcium silicate hydrate.
 - 1. Basis of Design Product: Prosoco Consolideck LS.
- D. Concrete Hardener and Sealer: High-gloss penetrating sealer, lithium silicate hardener.
 - 1. Basis of Design Product: Prosoco Consolideck LS Guard.
- E. Concrete Sealer: Penetrating water and oil repellent.
 - 1. Basis of Design Product: Prosoco Consolideck SB Water and Oil Repellent.

2.2 MIXES

- A. Mix product, in clean containers, according to manufacturer's written instructions.

1. Do not add water, thinners, or additives unless recommended by manufacturer.
2. When practical, use manufacturer's premeasured packages to ensure that materials are mixed in proper proportions. When premeasured packages are not used, measure ingredients using graduated measuring containers; do not estimate quantities or use shovel or trowel as unit of measure.
3. Do not mix more materials than can be used within recommended open time. Discard materials that have begun to set.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrate, with installer present, for conditions affecting performance of finish. Correct conditions detrimental to timely and proper work. Do not proceed until unsatisfactory conditions are corrected.
- B. Verify that base slab meets finish and surface profile requirements in Division 3 Section "Cast-In-Place Concrete", and Project Conditions above.
- C. Prior to application, verify that floor surfaces are free of construction latents.

3.2 PREPARATION

- A. Clean dirt, dust, oil, grease and other contaminants from surfaces that interfere with penetration or performance of specified product.
- B. Repair, patch and fill cracks, voids, defects and damaged areas in surface as approved by the Architect. Allow repair materials to cure completely before application of product.
- C. Protect people, equipment and surrounding construction from injury resulting from concrete rehabilitation work.
 1. Protect adjacent equipment and surfaces by covering them with heavy polyethylene film and waterproof masking tape. If practical, remove items, store and reinstall after potentially damaging operations are complete.
- D. Apply specified sealants and caulking and allow complete curing before treatment of concrete.

3.3 POLISHING

- A. Polish: Level 2: Low sheen, 400 grit.
- B. Apply polished concrete finish system to cured and prepared slabs to match accepted mockup.

1. Machine grind floor surfaces to receive polished finishes level and smooth and to depth required to reveal aggregate to match approved mockup.
2. Apply penetrating liquid floor treatment for polished concrete in polishing sequence and according to manufacturer's written instructions, allowing recommended drying time between successive coats.
 - a. Saturate surface with silicate hardener; re-spray or broom excess onto dry spots to ensure uniform wetting. Allow minimum soak-in period recommended by manufacturer. Remove all excess material in accordance with the manufacturer's installation instructions.
3. Continue polishing with progressively finer-grit diamond polishing pads to gloss level, to match approved mockup.
4. Control and dispose of waste products produced by grinding and polishing operations.
5. Concrete Sealer with Burnishing (polishing) Treatment:
 - a. Sealing Coat: Uniformly apply a continuous sealing coat to hardened concrete by low-pressure spray, microfiber mop or roller according to manufacturer's installation instructions.
 - b. Burnish surface to a gloss finish using high-speed burnishing equipment consistent with approved mock-up. Apply second coat and burnish where required to achieve desired finish of approved mock-up.
6. Neutralize and clean polished floor surfaces.

3.4 PROTECTION OF FINISHED CONCRETE FLOORING

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

END OF SECTION 03 3543

SECTION 04 2200
CONCRETE UNIT MASONRY

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

B. Related Requirements:

1. Section 03 3000 "Cast-In-Place Concrete" for grout for masonry core fill.
2. Section 05 1200 "Structural Steel Framing" for grout and installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
3. Section 07 1900 "Water Repellents" for water repellents applied to unit masonry assemblies.
4. Section 07 6200 "Sheet Metal Flashing and Trim" for exposed sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.

1.3 DEFINITIONS

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

1.4 PREINSTALLATION MEETINGS

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

1.5 ACTION SUBMITTALS

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

B. Shop Drawings: For 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.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

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

1. Masonry units.
 - a. Include data on material properties, and material test reports substantiating compliance with requirements.
 - b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
2. Integral water repellent 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.

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

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91/C 91M for air content.
2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

D. 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 according to TMS 602/ACI 530.1/ASCE 6.

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

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 (600 mm) 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 (4 deg C) 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

- A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

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) according to TMS 602/ACI 530.1/ASCE 6.
 2. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C 1314.

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 and will be within 20 feet (6 m) vertically and horizontally of a walking surface.
- C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.
 1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.4 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 bullnose units for outside corners unless otherwise indicated.
- B. CMUs: ASTM C 90.
 - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2250 psi (15.5 MPa).
 - 2. Density Classification: Normal weight, unless otherwise indicated.
 - 3. Size (Width): Manufactured to dimensions 3/8 inch (10 mm) less-than-nominal dimensions.

2.5 CONCRETE AND MASONRY LINTELS

- A. General: Provide lintels as indicated on the structural drawings.
- B. Concrete Lintels: ASTM C 1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated. Provide lintels with net-area compressive strength not less than that of CMUs.
- C. Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Section 03 3000 "Cast-in-Place Concrete," and with reinforcing bars indicated.
- D. 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. Masonry Cement: ASTM C 91/C 91M.
- B. Mortar Cement: ASTM C 1329/C 1329M.
- C. Aggregate for Grout: ASTM C 404.
- D. Epoxy Pointing Mortar: ASTM C 395, epoxy-resin-based material formulated for use as pointing mortar for glazed or pre-faced masonry units (and approved for such use by manufacturer of units); in color indicated or, if not otherwise indicated, as selected by Architect from manufacturer's colors.
- E. Water: Potable.

2.7 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420).
- 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. Products
 - a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
 - b. Heckman Building Products, Inc.; No. 376 Rebar Positioner.
 - c. Hohman & Barnard, Inc.; #RB or #RB – Twin Rebar Positioner.
 - d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.
- C. Masonry-Joint Reinforcement, General: Ladder type complying with ASTM A 951/A 951M.
 - 1. Interior Walls: Mill- galvanized carbon steel.
 - 2. Exterior Walls: Hot-dip galvanized carbon steel.
 - 3. Wire Size for Side Rods: 0.148-inch (3.77-mm diameter).
 - 4. Wire Size for Cross Rods: 0.148-inch (3.77-mm) diameter.
 - 5. Spacing of Cross Rods: Not more than 16 inches (407 mm) o.c.
 - 6. Provide in lengths of not less than 10 feet (3 m), with prefabricated corner and tee units.
- D. Masonry Cleaner:
 - 1. Use potable water and detergents to clean masonry unless otherwise acceptable.
 - 2. Unless otherwise required, do not use acid or caustic solutions.

2.8 TIES AND ANCHORS

- A. General: Ties and anchors shall extend at least 1-1/2 inches (38 mm) into masonry but with at least a 5/8-inch (16-mm) 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 A 82/A 82M, with ASTM A 641/A 641M, Class 1 coating.
 - 2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M, with ASTM A 153/A 153M, Class B-2 coating.
 - 3. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.

4. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- 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- (6.35-mm-) diameter, hot-dip galvanized steel wire.
 2. Tie Section: Triangular-shaped wire tie made from 0.187-inch- (4.76-mm-) diameter, hot-dip galvanized steel wire.
- D. Partition Top Anchors: 0.105-inch-(2.66-mm-) thick metal plate with a 3/8-inch-(9.5-mm-) diameter metal rod 6 inches (152 mm) long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.
- E. Rigid Anchors: Fabricate from steel bars 1-1/2 inches (38 mm) wide by 1/4 inch (6.35 mm) thick by 24 inches (610 mm) long, with ends turned up 2 inches (51 mm) or with cross pins unless otherwise indicated.
1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M.

2.9 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene urethane or PVC.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D 226/D 226M, Type I (No. 15 asphalt felt).

2.10 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 masonry cement or mortar cement mortar unless otherwise indicated.
 3. For exterior masonry, use masonry cement or mortar cement mortar.
 4. For reinforced masonry, use masonry cement 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. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C 270, 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 or Type M.
 2. For reinforced masonry, use Type S.
 3. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type S.
 4. For interior nonload-bearing partitions, use Type N may be used instead of Type S.
- D. 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 TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
 2. Proportion grout in accordance with ASTM C 476, paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2500 psi (17.2 MPa).
 3. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured according to ASTM C 143/C 143M.
- E. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.
 1. Application: Use epoxy pointing mortar for exposed mortar joints with pre-faced CMUs.

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.
- D. ut 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 (12 mm) or minus 1/4 inch (6 mm).
 - 2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).
 - 3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) 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 (6 mm in 3 m), or 1/2-inch (12-mm) 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 (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.
 - 3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2-inch (12-mm) 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 (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.
 - 5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2-inch (12-mm) maximum.

6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2-inch (12-mm) maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.5 mm).

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm).

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 (100-mm) 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 (100 mm). Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch (100-mm) 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 (600 mm) 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 (13-mm) clearance between end of anchor rod and end of tube. Space anchors 48 inches (1200 mm) 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.

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 (6 mm) 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 (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).
 - 1. Space reinforcement not more than 16 inches (406 mm) o.c.
 - 2. Space reinforcement not more than 8 inches (203 mm) o.c. in foundation walls and parapet walls.
 - 3. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) 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 (25 mm) 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 (610 mm) o.c. vertically and 36 inches (915 mm) 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.

3.9 BOND BEAMS

- A. Continuous bond beams shall be located at the following locations and as noted on the plans:
 1. Under roof framing bearing locations
 2. Floor framing bearing locations
- B. Bond beam reinforcing shall be continuous through control joints at bearing walls, unless noted otherwise on drawings.
- C. Continuous bond beams shall be located at the top of non-load bearing partition walls.
 1. Where joists pass through the concrete masonry wall, bond beam shall be lowered so the bond beam is not cut by the joist pass-thru.

3.10 LINTELS

- A. Provide concrete or masonry lintels where shown and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are shown without structural steel or other supporting lintels.
- B. Provide minimum bearing of 16 inches (200 mm) at each jamb unless otherwise indicated.

3.11 REINFORCED UNIT MASONRY INSTALLATION

- 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 (1520 mm).

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 shall be done at Contractor's expense.
- B. Inspections: Special inspections according to Level C 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. (464 sq. m) of wall area or portion thereof.
- E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.
- F. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.
- G. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.
- H. Prism Test: For each type of construction provided, according to ASTM C 1314 at 28 days.

3.13 PARING

- A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of 3/4 inch (19 mm). 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 (3 mm per 300 mm). 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 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. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04 2200

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SECTION 04 2613
MASONRY VENEER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brick.
2. Decorative concrete masonry units.
3. Mortar materials.
4. Ties and anchors.
5. Embedded flashing.
6. Accessories.

B. Products Installed but not Furnished under This Section:

1. Steel lintels in masonry veneer.

C. Related Requirements:

1. Section 04 2200 "Concrete Unit Masonry" for masonry joint reinforcement.
2. Section 05 1200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
3. Section 05 5000 "Metal Fabrication" for furnishing steel lintels and shelf angels for unit masonry.
4. Section 07 1900 "Water Repellents" for water repellents applied to masonry assemblies.
5. Section 07 2100 "Thermal Insulation" for cavity wall insulation.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Initial Selection:

1. Colored mortar.
2. Weep/cavity vents.

C. Samples for Verification: For each type and color of the following:

1. Clay face brick, in the form of straps of five or more bricks.
2. Decorative CMUs.

1.3 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each type and size of the following:
 - 1. Masonry units.
 - a. Include material test reports substantiating compliance with requirements.
 - b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
 - c. For exposed brick, include test report for efflorescence in accordance with ASTM C67/C67M.
 - 2. Cementitious materials. Include name of manufacturer, brand name, and type.
 - 3. Mortar admixtures.
- B. Mix Designs: For each type of mortar. 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.
- C. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.4 MOCKUPS

- A. Sample Panels: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.
 - 1. Build sample panels for typical exterior wall in sizes approximately 48 inches long by 36 inches high.
 - 2. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.
 - a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless such deviations are specifically approved by Architect in writing.

1.5 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. 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.
- D. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.6 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of veneer, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
- B. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry. Immediately remove grout, mortar, and soil that come in contact with 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.
- 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 unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602.
 - 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.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602.

PART 2 - PRODUCTS

2.1 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602, 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 will be exposed in the completed Work.

2.2 BRICK

- A. Face Brick Basis-of-Design: Belden
 - 1. Utility Size, Modular (or architect approved equal by another manufacturer).
 - 2. Color: Blend of (78-200234) 20% 920-26 to 80% 920-22.
- B. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units.
 - 1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
 - 2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including corners, movement joints, bond beams, sashes, and lintels, requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing, where shapes produced by sawing would result in sawed surfaces being exposed to view.

2.3 DECORATIVE CONCRETE MASONRY UNITS

- A. Description: Burnished Masonry Units.
 - 1. Basis of Design: Premier Ultra Burnished Masonry Units as manufactured by County Materials Corporation, 205 North Street, PO Box 100, Marathon, WI, 54448-0100; phone: 800-242-7733. Email: info@countymaterials.com. Web: www.countymaterials.com.
 - a. Acceptable Alternate Manufacturer: Grand Blanc Cement Products.
 - 2. Description: Integrally pigmented loadbearing hollow units with a new compressive strength of greater than or equal to 2000 psi.
 - 3. Compliance: ASTM C90.
 - 4. Coloring: Integral, through-body coloring; synthetic or natural iron oxide pigments.
 - 5. Water Repellent: Integral water repellent, TK Bright Kure & Seal.
 - 6. Finish: Ground Face.
 - 7. Color: Burnt Embers (63250A).
- B. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
 - 1. 15 5/8" high x 15 5/8" wide x 3 5/8" depth.

2.4 MORTAR MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color selected by Architect from manufacturer's full range of colors.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Colored Cement Products: Packaged blend made from portland cement and hydrated lime and mortar pigments, all complying with specified requirements, and containing no other ingredients.
 - 1. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
- E. Preblended Dry Mortar Mix: Packaged blend made from portland cement and hydrated lime, masonry cement, or mortar cement, sand, mortar pigments, and admixtures and complying with ASTM C1714/C1714M.
- F. Aggregate for Mortar: ASTM C144.
 - 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 - 2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
 - 3. White-Mortar Aggregates: Natural white sand or crushed white stone.
 - 4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- G. Water: Potable.

2.5 TIES AND ANCHORS

- A. General: Ties and anchors extend at least 1-1/2 inches into veneer 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. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M, with ASTM A153/A153M, Class B-2 coating.
- 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.

D. 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 0.1084-inch-thick steel sheet, galvanized after fabrication.
3. Fabricate wire ties from 0.187-inch-diameter, hot-dip galvanized steel wire unless otherwise indicated.
4. Contractor's Option: Unless otherwise indicated, provide any of the adjustable masonry-veneer anchors specified.

2.6 EMBEDDED FLASHING

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

1. Asphalt-Coated Copper Flashing: 5 oz./sq. ft. Use only where flashing is fully concealed in masonry.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Advanced Building Products, Inc. Cop-R-Cote.
 - 2) Dayton Superior Corporation, Dur-O-Wall Division; Copper Coated Thru-Wall Flashing.
 - 3) Hohmann & Barnard, Inc. H & B C-Coat Flashing.
 - 4) Phoenix Building Products: Type ACC-Asphalt Bituminous Coated.
 - 5) Sandell Manufacturing Co., Inc. Coated Copper Flashing.

B. Solder and Sealants for Sheet Metal Flashings:

1. Solder for Copper: ASTM B32, Grade Sn50.
2. Elastomeric Sealant: ASTM C920, chemically curing urethane sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.

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.

D. Termination Bars for Flexible Flashing: Aluminum steel bars 1/8 inch by 1 inch.

2.7 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, or PVC.

- B. Weep/Vent Products: Use the following unless otherwise indicated:
 - 1. Rectangular Plastic Weep/Vent by Advanced Building Products or architect approved equal. 3/8" by 3-1/2" by 3-1/2" long. Architect to select color from manufacturer's full range of available colors.
- C. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

2.8 MASONRY CLEANERS

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

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.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. 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.
- B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

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 ft., 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 ft., 1/4 inch in 20 ft., or 1/2-inch maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., 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 ft., 1/4 inch in 20 ft., or 1/2-inch maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 ft., 3/8 inch in 20 ft., 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 ft., or 1/2-inch maximum.

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. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

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.

1. Bricks are a two-tone mix of Color A (920-26) and Color B (920-22).
2. Color A represents 20% of brick pattern and Color B represents 80% of brick pattern.
3. Color A bricks are to be laid in horizontal "lines" of between four and nine bricks at randomly determined points.
4. Lines should be spaced such that no line is adjacent to another line in the vertical or horizontal direction.
5. All lengths and spacing are to be randomly determined within the describe parameters. There should be no observable "pattern" to the placement of lines.

- C. Bond Pattern for Burnished Concrete Masonry Units: As indicated on Drawings.
- 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. Do not use masonry units with broken corners and edges in excess of ASTM C90.

3.5 MORTAR BEDDING AND JOINTING

- A. Lay hollow brick with face shells fully bedded in mortar and with head joints of depth equal to bed joints. At starting course, fully bed entire units, including area under cells.
1. At anchors and ties, fully bed units and fill cells with mortar as needed to fully embed anchors and ties in mortar.
 2. Fill cores in hollow CMUs with grout 24 inches deep x 32 inches wide under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- B. Set cast-stone caps and banding elements in full bed of mortar with full vertical joints.
1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
 2. Allow cleaned surfaces to dry before setting.
 3. Rake out mortar joints for pointing with sealant.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.6 ANCHORED MASONRY VENEERS

- A. Anchor masonry veneers to wall framing, and concrete and masonry backup with masonry-veneer anchors to comply with the following requirements:
1. Fasten screw-attached anchors through sheathing to wall framing, and, to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
 2. Embed connector sections and continuous wire in masonry joints.
 3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
 4. Space anchors as indicated, but not more than 18 inches o.c. vertically and 24 inches o.c. horizontally, with not less than one anchor for each 2 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 8 inches, around perimeter.
- B. Provide not less than as indicated on Drawings of airspace between back of masonry veneer and face of sheathing or insulation.
1. Keep airspace clean of mortar droppings and other materials during construction. Bevel beds away from airspace, to minimize mortar protrusions into airspace. Do not attempt to trowel or remove mortar fins protruding into airspace.

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 2 inches wide, or as indicated on drawings, 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 EXPANSION JOINTS

- A. General: Install expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form expansion joints as follows:
1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.

2. Build flanges of factory-fabricated, expansion-joint units into masonry.
 3. Build in compressible joint fillers where indicated.
 4. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Section 07 9200 "Joint Sealants."
 5. Single-Wythe Concrete Units: Joints shall not exceed the lesser of a maximum panel length to height ratio of 1-1/2:1 or a distance of 25 feet. Coordinate locations with Architect.
 6. Concrete Masonry Unit: Joints shall not exceed the lesser of a maximum panel length of height ratio of 1-1/2:1 or a distance of 20 feet. Coordinate locations with Architect.
- C. Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 07 9200 "Joint Sealants," but not less than 3/8 inch.
1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry. Coordinate locations with Architect.

3.9 LINTELS

- A. Install steel lintels where indicated.
- B. Provide offset angle supports where indicate and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are indicated without structural steel or other supporting lintels.

3.10 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. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and 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.
 2. Extend flashing through veneer, across airspace behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under air barrier, lapping at least 4 inches. Fasten upper edge of flexible flashing to sheathing through termination bar.
 3. At lintels and shelf angles, extend flashing 6 inches minimum, to edge of next full unit at each end. At heads and sills, extend flashing 6 inches minimum, to edge of next full unit and turn ends up not less than 2 inches to form end dams.
 4. Interlock end joints of sawtooth 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 07 9200 "Joint Sealants" for application indicated.

5. Install metal drip edges, and sealant stops with sawtooth sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 07 9200 "Joint Sealants" for application indicated.
 6. 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.
 7. 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.
 8. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.
- C. Install reglets and nailers for flashing and other related construction where they are indicated to be built into masonry.
- D. Install weep holes in veneers in head joints of first course of masonry immediately above embedded flashing.
1. Use specified weep/cavity vent products to form weep holes.
 2. Space weep holes formed from wicking material 16 inches o.c.
 3. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
- E. Place cavity drainage material in airspace behind veneers to comply with configuration requirements for cavity drainage material in "Accessories" Article.
- F. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/cavity vent products 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.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections. 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 will be at Contractor's expense.
- B. Inspections: Special inspections in accordance with Level 2 in TMS 402.
1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.

- C. Testing Prior to Construction: One set of tests.
- D. Clay Masonry Unit Test: For each type of unit provided, in accordance with ASTM C67/C67M for compressive strength.
- E. Concrete Masonry Unit Test: For each type of unit provided, in accordance with ASTM C140/C140M 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 mortar air content, and compressive strength.

3.12 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 (within 14 days) 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 non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 - 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 - 5. Clean brick by pressurized water cleaning method described in BIA Technical Notes 20.
 - 6. Clean masonry with a proprietary detergent/acidic cleaner applied according to manufacturer's written instructions.

3.13 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.

END OF SECTION 04 2613

SECTION 05 1200
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The provisions of the General Conditions, Supplementary Conditions, and the Sections included under Division 1, General Requirements, are included as a part of this Section as though bound herein.

1.2 SUMMARY

- A. The Work required under this Section consists of structural steel, steel erection, shop painting, field touch-up painting, and related items necessary to complete the Work indicated.
- B. Miscellaneous angles, channels, anchor bolts, bent plates, sleeves, sag rods, leveling plates, bearing plates for structural steel and steel joists, and other incidental items of structural steel required to be built into concrete or masonry shall be provided as indicated or specified and be furnished to respective trades at proper time; including instructions and templates for their installation.
- C. Provide, where specifically called for, lintels, steel shelf angles, perimeter angle closure and accessories.

For openings in metal deck 12 by 12 inches inches and larger, provide steel reinforcing members on all sides of opening. Reinforcing shall be not less than 3 by 3 inches by 3/8 inch angles, unless otherwise indicated. Openings in deck shall be cut under Section 05 31000 - Metal Deck.

- D. Related Work Specified Elsewhere
 1. Division I – Quality Control
 2. Section 09 91 00 – Painting
 3. Section 03 30 00 – Cast in Place Concrete
- E. Refer to Section Division I for Alternates that may affect the Work of this Section.

1.3 SUBMITTALS

- A. Approved manufacturer's published complete product data for:
 1. Proposed base plate grout.
- B. Complete shop Complete shop drawings by approved fabricator including dimensioned plan layouts of columns and anchor bolt locations, dimensioned erection diagrams, and shop detail drawings. Symbols and indications used for structural components on design

drawings must appear identically on submitted shop drawings. Types of electrodes proposed for welding processes must also appear thereon.

1. The fabricator must review, and check shop drawings prepared by the fabricator or the fabricators subcontractors prior to submission to the Structural Engineer (SE).
 2. AutoCAD drawings, for use in preparation of erection plans and shop drawings: Drawings may be available from the SE. The Contractors requiring this service must contact the SE to verify availability.
 3. Changes to shop drawings for resubmissions shall be “clouded” or “flagged” to clearly indicate all changes, additions, or deletions to the previous submission. Resubmissions will be reviewed only to verify those items clouded or flagged. All other information will be assumed to be unchanged from the previous submission.
- C. Letter from a Professional Engineer (PE) licensed within the state of construction activities certifying that he has carefully studied the design drawings, that shop drawings have been prepared under his direct guidance and supervision, and that provided components and connections will meet or exceed loading requirements, where loads are shown at element ends. PE’s full signature and seal of authenticity must evidence such letter of certification. It should not be expected that Structural Engineer’s (SE’s) review of shop drawings will begin until such certification has been received. This certification is to verify the adequacy of members and connections designed by the fabricator and are not intended to require verifications of the design of structural elements shown in the plans.

1.4 QUALITY ASSURANCE

- A. Structural fasteners shall be manufactured in the United States. Fabricator shall furnish proof of U.S. manufacturer. If it becomes necessary to use imported fasteners, each size, type, and each large quantity package (500 pcs. or more) shall undergo a random sampling of a minimum 5 pieces for testing, and the test results to be provided to SE. Test shall be performed by an independent testing agency, and the cost shall be included in the Base Bid. If inferior fasteners are discovered, all fasteners of that type shall be removed and replaced with acceptable fasteners at no cost to the Owner. If possible, fasteners shall be tested prior to use in construction.
- B. Comply with the provisions of applicable building codes as well as the following specific requirements: Latest Edition:
1. AISC “Code of Standard for Steel Buildings and Bridges.”
 2. AISC “Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings” and including the “Commentary of the AISC Specification,” and the current supplements.
 3. AISC “Specifications for Structural Joints using ASTM A325 Bolts” approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation.
 4. AWS “Structural Welding Code,” AWS D1.1 and its latest revision.
 5. ASTM A6 “General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piping, and Bars for Structural Use.”
- C. Structural Steel Alignment Quality Control: Refer to Division 1 – Quality Control.

- D. See Section 3.05 – Field Quality Control for additional requirements.
- E. DELIVERY, STORAGE, AND HANDLING
- F. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Paint Products: 5 percent, but not less than 1 gal. of each material and color applied.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site at such intervals to ensure uninterrupted progress of work.
- B. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete or masonry, in ample time to not delay work.
- C. Store materials to permit easy access for observation and identification. Keep steel members off ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
 - 1. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 FABRICATORS

- A. Firms acceptable as fabricators for structural steel work under this Section shall be certified in the category of “Conventional Steel Buildings (Sbd)” by the American Institute of Steel Construction. The fabricator shall cooperate with and make available to the testing agency records and documents which focus on general management, engineering and drafting, procurement, operations and quality control and shall allow access to facilities to allow the testing agency to examine actual fabrication work in the shop and drafting room at the time of the inspection. Source Limitations: Obtain each paint product from single source from single manufacturer.

2.2 MATERIALS

- A. Structural Angles, Plates, and Bars: ASTM A572 Grade 50, unless otherwise noted.
- B. Rolled Steel Shapes (Wide Flanges and WT Shapes): ASTM A992 (Fy=50 ksi).
- C. Hollow Structural Sections
 - 1. Square, Rectangular, and Special Shapes: ASTM A500, Grade B (Fy=46 ksi).

2. Round, Structural Steel Pipe: ASTM A53, Type E or S, Grade B or ASTM A500, Grade B (Fy=46 ksi).
- D. High Strength Threaded Fasteners: Heavy hexagon structural bolts, heavy hexagon nuts, and hardened washers, as follows:
1. Quenched and tempered medium-carbon steel bolts, nuts, and washers, complying with ASTM A325. Use 3/4 inch bolts, unless noted otherwise on the Drawings.
 2. Direct tension indicator washers may be used at Contractors option per ASTM F959.
- E. Electrodes for Manual Shielded and Metal-Arch Welding: AWS Code and ASTM A233, Series E60 and E70 as required.
- F. Electrodes and Flux for Submerged Arc Welding: AWS Code and ASTM A588, Series F60 and F70 as required.
- G. Structural Steel Primer Paint: Steel Structures Painting Council (SSPC) - Paint 15.
- H. Shrinkage-Resistant Grout (SR-G): CE (Corps of Engineers) CRD-C621 latest edition (formerly CRD-588) and ASTM C 1107, premixed, factory-packaged, flowable, mortar grouting compound with a minimum compressive strength of 9000 psi at 28 days. Products offered by manufacturers to comply with the requirements include the following:
1. Non-Ferrous Aggregate
 - a. Five Star Fluid Grout 100; Five Star Products, Inc., Fairfield, Connecticut.
 - b. Crystex; L&M Construction Chemicals, Inc., Omaha, Nebraska.
 - c. Sure-Grip High Performance Grout; Dayton Superior Corp., Miamisburg, Ohio.
 - d. SonnogROUT 10K; Sonneborn Building Products, Shakopee, Minnesota.
 - e. Sealtight Pack-H Grout; W. R. Meadows, Inc., Hampshire, Illinois.
 - f. Enduro 50; Conspec Marketing & Manufacturing Co., Inc., Kansas City, Kansas.
- I. Masonry Bearing Plates
1. All Joists shall bear on masonry bearing plates with anchor rods embedded in the masonry below. Weld joists to bearing plates in accordance with SJI Specifications. See Framing Details and Plans for bearing plate sizes.
 2. All beams shall bear on masonry bearing plates with anchor rods embedded in the masonry below. Weld beams to bearing plates unless otherwise noted.
 3. Bearing plates are to be set under the work of Division 4 – Masonry.
- J. Anchor bolts – threaded rods per ASTM A307.
- K. Adhesive Anchor Bolts
1. Concrete Base Material: Refer to Section 03 2000 - Concrete Reinforcing.
- L. Preformed Joint Material: Provide closed cell polyethylene expansion joint material equal to the following manufacturers:
1. Sonoflex F; Sonneborn Building Products, Shakopee, Minnesota.
 2. Deck-O-Foam; W. R. Meadows, Inc., Hampshire, Illinois.

3. Econo Foam; Williams Products, Inc., Troy, Michigan

2.3 FABRICATION

- A. General: Fabricate items of structural steel in accordance with AISC Specifications and as indicated on the final shop drawings. Provide camber in structural members as shown.
 1. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials.
 2. Where finishing is required, complete the assembly, including riveting and welding of units, before start of finishing operations.
- B. Connections.
 1. Weld or bolt shop connections as shown.
 2. Bolt field connections, except where welded connections or other connections are shown or specified.
- C. High-Strength Bolted Construction: Install high-strength threaded fasteners in accordance with AISC "Specifications for Structural Joints."
- D. Welded Construction: Comply with AWS Code for procedures, appearance and quality of welds, and methods used in correcting welding work. Assemble and weld built-up sections by methods which will produce true alignment of axis without warp
- E. Galvanizing:
 1. Provide a zinc coating for those items shown or specified to be galvanized, as follows:
 - a. ASTM A123 for galvanizing rolled, pressed, and forged steel shapes, plates, bars, and strip 1/8 inch thick and heavier
 2. Lintels in exterior walls and in other walls exposed to moist environments shall be hot-dipped galvanized.
 - a. Lintels consisting of a plate and rolled beam W16 and smaller shall have both plate and beam galvanized after welding.
 - b. Lintels consisting of a plate and rolled beam larger than W16 shall have plate galvanized and beam painted a cold applied mill galvanizing.
- F. Holes for Other Work: Provide holes required for securing other work to structural steel framing, such as nailers, plates, and for the passage of other work through steel framing members, as shown on the final shop drawings. Provide threaded nuts welded to framing and other specialty items as shown to receive other

2.4 FINISHES

- A. General: Shop paint structural steel work, except those members or portions of members to be embedded in concrete or mortar. Paint embedded steel which is partially exposed on the exposed portions and the initial 2 inch of embedded areas only. Do not paint contact surfaces that are to be welded or high-strength bolted with friction-type

connections. Coat with tar all steel encased in concrete and/or masonry below adjacent slab on grade.

- B. Surface Preparation: After observation and before shipping, clean steel work to be painted. Remove loose rust, mill scale, and spatter, slag or flux deposits. Clean steel in accordance with SSPC (Steel Structures Painting Council) as follows:
 - 1. SP-2 "Hand Tool Cleaning"
- C. Painting: immediately after surface preparation, apply structural steel rust inhibitive primer paint in accordance with the manufacturer's instructions and at a rate to provide a uniform dry film thickness of 1.5 mils. Use painting methods that will result in full coverage of joints, comers, edges, and exposed surfaces.
- D. Galvanizing: Joints between plates and beams and between intermittent welds shall be touched-up with cold applied galvanizing coating as required to insure uniform coating.
 - 1. Galvanized Repair Paint: High-zinc-dust-content paint for regalvanizing welds and repair painting galvanized steel, with dry film containing not less than 93 percent zinc dust by weight, and complying with DOD-P-21 035A or 95 PC-Paint 20.

2.5 SOURCE QUALITY CONTROL

- A. The materials and workmanship to be furnished under this Specification shall be subject to observation in the mill, shop, and field by the SE. Observation will be conducted without expense to the Contractor; however, observation in the mill or shop shall not relieve the Contractor of his responsibility to furnish materials and workmanship in accordance with contract requirements.
- B. Refer to Division 1- Quality

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Erector must examine the areas and conditions under which structural steel work is to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Erector.

3.2 ERECTION

- A. General: Comply with the AISC Specifications and Code of Standard Practice and with specified requirements.
- B. Surveys and Bench Marks: Establish permanent bench marks as shown and as necessary for the accurate erection of structural steel. Check elevations of concrete and masonry

bearing surfaces and locations of anchor bolts and similar devices before erection work proceeds and report measurement discrepancies to the A/E. Do not proceed with erection until corrections have been made or until compensating adjustments to the structural steel work have been agreed upon with the NE.

- C. Temporary Shoring and Bracing: Provide temporary shoring and bracing members as required, with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy lines to achieve proper alignment of the structures as erection proceeds.
- D. Temporary Planking: Provide temporary planking and working platforms as required and as necessary to effectively complete the work.
- E. Anchor Bolts: Furnish anchor bolts and other connectors required for securing structural steel to foundations and other in-place work. Electrodes for Manual Shielded and Metal-Arch Welding: AWS Code and ASTM A233, Series E60 and E70 as required.
 - 1. Furnish templates and other devices as necessary for presetting bolts and other anchors to accurate locations.
 - 2. Refer to Division 3 of these Specifications for anchor bolt installation requirements in concrete, and Division 4 for masonry installation, if required.
 - 3. Where anchor bolts are broken after installation, the concrete shall be removed around the remaining portion of the bolt in the concrete to a depth of 1/2 inch below the top of the bolt. A new segment of bolt of the same steel strength shall be full penetration welded to the remaining bolt in the concrete. The new segment of bolt shall be tapered on the welded end to a 30-degree bevel all around to leave a thickness at the beveled end of 1/4 inch.
 - 4. Where anchor bolts are incorrectly located in the concrete or masonry which encases them, the following procedures shall be used
 - a. For bolt misalignment less than 5/16 inch: offset the column with base plate as required to locate column correctly. The 5/16 inch oversized holes in the column base plates will allow this movement without modification to the column or the anchor bolts.
 - b. For bolt misalignment more than 5/16 inch and less than 2 inches: cut and remove base plate from column, relocate base plate and reweld to column.
 - c. For bolt misalignment more than 2 inch and less than 6 inches: cut off anchor bolts flush with surface of concrete or masonry and install adhesive anchor bolts as specified in Division 4 for masonry and Division 3 for concrete base material.
- F. Setting Bases and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean the bottom surface of base and bearing plates.
 - 1. Setting Plate Procedure
 - a. Set loose and attached base plates and bearing plates for structural members on wedges or other adjustable devices.

- b. Tighten the anchor bolts after the supported members have been positioned and plumbed. Do not remove wedges or shims, but, if protruding, cut off flush with the edge of the base or bearing plate prior to packing with grout.
 - c. Pack bedding grout solidly between bearing surfaces and bases or plates to ensure that no voids remain. Finish exposed surfaces, protect installed materials, and allow curing in strict compliance with the manufacturers instructions, or as otherwise required.
- G. Field Assembly: Set structural frames accurately to the lines and elevations indicated. Align and adjust the various members forming a part of a complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
- 1. Level and plumb individual members of the structure within specified AISC tolerances.
 - 2. Splice members only where shown or specified, unless approved otherwise by the A/E or his representative.
- H. Erection Bolts: On exposed welded construction, remove erection bolts, fill holes with plug welds, and grind smooth at exposed surfaces
- I. Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and the removal of paint on surfaces adjacent to field welds.
- 1. Do not enlarge unfair holes in members by burning or by the use of drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.
- J. Gas Cutting: Do not use gas cutting torches in the field for correcting fabrication errors in the structural framing.
- K. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of the shop paint. Apply paint to exposed areas with the same material as used for shop painting. Apply by brush or spray to provide a minimum dry film thickness of 1.5 mils.
- L. Lintels and Shelf Angles: Weld or bolt members together where so indicated.
- 1. Lintels shall have 8-inch bearing at each end, minimum, unless shown otherwise. Bearing pressures shall not exceed the allowable stress for masonry
 - 2. Where shelf angles are attached to concrete with bolts and adjustable inserts, provide slotted holes of proper size and spacing in the vertical leg of shelf angles.
- ### 3.3 HIGH STRENGTH BOLTS
- A. Structural joints using high strength bolts, hardened washers, and nuts shall be tightened to a high tension; the materials, methods of installation and tension control, type of wrenches to be used, and observation methods shall conform to specifications for “Structural Joints

using ASTM A325 or A490 Bolts,” as approved by the Research Council on Structural Connections of the Engineering Foundation, Latest Edition

- B. The high strength bolts used shall have a suitable identifying mark placed on top of the head before leaving the factory.
- C. All high strength bolted connections shall be “snug-tight” connections, unless otherwise indicated on the Drawings.
 - 1. “Snug-tight” is defined as the tightness that exists when all plies in a joint are in firm contact and can be attained with a few impacts of an impact wrench or by the full effort of a person using an ordinary spud wrench
- D. Where specifically noted on the Drawings, bolted connections shall be installed “slip-critical”.
 - 1. Tightening of nuts shall be done by the turn-of-nut method, according to the Specifications for Structural Joints” using ASTM A325 or A490 bolts,” endorsed by AISC, unless direct tension indicator washers are used, in which case tightening will terminate when the proper gap is attained.
 - 2. For the “turn-of-nut” method, bolts that have been “snug-tight” shall be marked on both the bolt head and the nut with an identifying symbol, and then given an additional fraction of a turn as specified in Table 5 of the above referenced specification. Marks shall be such that visual observation can be made of finished connections. Snug-tight is defined as the tightness developed by the full effort of a man using a spud wrench on all bolts in the connections.
 - 3. Slotted holes will be allowed in following locations, only and shall have snug tight bolted connections
 - a. The outstanding legs of angles used in beam shear splices
 - b. Hip and valley beams where both ends frame into steel members in an all steel frame.
 - c. Diagonal or skewed beams where both ends frame into steel members in an all steel frame.
 - d. Other connections where specifically detailed in the drawings.
 - e. All other holes shall be standard bolt (1/16 inch larger than bolt).

3.4 ERECTION ALIGNMENT

- A. Framing: The framing shall be carried up true, plumb, and level within a tolerance of 1:500; and temporary bracing shall be introduced, wherever necessary, to take care of loads to which the structure may be subjected, including erection equipment and its operation. Such bracing shall be left in place as long as may be required for safety. The Contractor as part of his equipment shall finally remove it. As erection progresses, the Work shall be securely connected to take care of dead load, wind, and erection stresses.

3.5 FIELD QUALITY CONTROL

- A. Contractor shall retain an independent testing agency to check connection and (Note retained by contractor of owner) fastening as specified herein. Conform to Division One — Quality Control.
- B. Steel (includes work for metal joists and metal deck).
- C. Structural Steel
 - 1. The Testing Agency shall conduct and interpret tests and state in each report whether test specimens comply with the requirements, and specifically state any deviations from requirements.
 - a. Contractor shall provide access for the Testing Agency to places where structural steel is being fabricated or produced so inspection and testing can be accomplished.
 - 2. Bolted Connections: Inspection in accordance with AISC Specification for Structural Joints, as follows:
 - a. Visually inspect all bolts.
 - b. Check for proper torque with a calibrated torque wrench. Minimum two bolts of alternate design connections between beams and girders. Minimum two bolts of every connection between girders and columns.
 - c. All bolted connections that fail shall be corrected and all bolts in that connection shall be retested. The cost of retests on connections that fail shall be borne by the contractor.
 - 3. Field During erection of structural steel, inspect and test assemblies in accordance with AWS Structural Welding Code and as follows:
 - a. Perform visual inspection of all welds and test those which are questionable.
 - b. Perform non-destructive tests of weld as required above, as follows:
 - 1) Fillet Welds: One spot test per member. Magnetic particle testing may be used.
 - 2) Partial Penetration Welds: One spot test per weld using ultrasonic testing techniques.
 - 3) Full Penetration Welds: One spot test per weld for shop welds and the entire length of all field welds. Use radiographic or ultrasonic testing techniques.
 - c. Ultrasonic inspection shall be performed on all welds subject to tension in moment connections. See drawings for locations. In addition, any other welds in question or selected at random by the inspector or Structural Engineer shall be tested by this method. When ultrasonic inspection is used, 100 percent of the length of the weld shall be inspected. Any retesting required shall be paid for by the Contractor responsible for work being tested.
 - d. Re-inspect and retest defective welds which have been re-welded. The cost of re-welding, re-inspection and retesting shall be paid by the Contractor.

END OF SECTION 05 1200

SECTION 05 2100
STEEL JOIST FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The provisions of the General Conditions, Supplementary Conditions, and the Sections included under Division 1, General Requirements, are included as a part of this Section as though bound herein.

1.2 SUMMARY

- A. The Work required under this Section consists of steel joists, steel truss accessories, and related items necessary to complete the Work indicated.
- B. When outriggers, angles, or other components are attached to the open web steel joists in the shop, in such a way that they are a component part of the joists, they are to be provided under this Section.
- C. The Work includes bridging and bridging anchors, sag rods, wall anchors, and beam anchors.
- D. Related Work Specified Elsewhere
 - 1. Section 051200 — Structural Steel Framing: For field welding quality control.
 - 2. Ends of joists resting on masonry require steel bearing plates furnished under Section 051200 - Structural Steel Framing and installed under Division 4 Masonry over a leveling bed of mortar.
- E. Refer to Section 012300 for Alternates that may affect the Work of this Section.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide special joists and connections capable of withstanding design loads within limits and under conditions indicated.
- B. Design joists to withstand design loads with total load deflections no greater than the following:
 - 1. Floor Joists: Vertical deflection of 1/240 of the span, max 1" unless approved otherwise.
 - 2. Roof Joists: Vertical deflection of 1/240 of the span, max 1.5" unless approved otherwise.

1.4 SUBMITTALS

- A. Shop Drawings by Approved Fabricator: Include plan layouts of joists, joist girders, and special joist locations, loading diagrams, and shop detail drawings. Symbols and indications used for structural components on design drawings must appear identically on submitted shop drawings. Types of electrodes proposed for welding processes shall also appear thereon.

1. Indicate locations and details of anchorage devices and bearing plates to be embedded in other construction.
 2. Comprehensive engineering analysis certified by the qualified professional engineer responsible for its preparation.
- B. Certification Letter: Professional Engineer licensed within the state of construction activities certifying that has carefully studied the design drawings, that shop drawings have been prepared it under his direct guidance and supervision, and that provided components and connections will meet or exceed loading requirements. Such letter of certification shall be evidenced by A/E's full signature and seal of authenticity. A/E's review of shop drawings will not begin until such certification has been received.
- C. Welding Certificates: Copies of certificates for welding procedures and personnel.
- D. Manufacturer Certificate: Signed by joist manufacturer certifying that products furnished comply with SJI standard specifications and is certified by SJI to manufacturer joists.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing joists similar to those indicated for this Project and with a record of successful in-service performance.
1. Manufacturer must be certified by SJI to manufacturer joists similar to those indicated for this Project and with a record of successful in-service performance.
 2. Assumes responsibility for engineering special joists to comply with performance requirements. This responsibility includes preparation of shop drawings and comprehensive engineering analysis by a qualified professional engineer.
 3. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installation of joists that are similar to those indicated for this Project in material, storage, and extent.
- B. Provide joists fabricated in compliance with the following and as herein specified.
1. SJI "Standard Specifications and Load Tables" for KCS, LH, and DLH Series Open Web Steel Joists, latest edition, sizes as indicated on the Drawings.
 2. Customized joists / truss profile as indicated. Special top chord, bottom chord profile as shown.
- C. Qualification of Field Welding Work
1. Qualify welding processes and welding operators in accordance with the AWS D1 .1, "Structural Welding Code-Steel" and AWS D1 .3, "Structural Welding Code— Sheet Steel". Welders shall be certified to perform the type of work required.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle steel joists as recommended in SJI and AISC “Standard Specifications,” in a manner to avoid excessive stresses or deforming of members. Joists shall be supported on timbers such that no part of the joist touches the ground. Timbers shall be located under joist panel points.
- B. Bent or damaged joist members shall be cause for joist rejection. Rejected joists shall be repaired or replaced within 10 working days of notification.
- C. Joists shall be lifted from trucks to the storage timbers with a crane or other lifting device. Joists shall not be dropped or slid off of trucks to the ground.

1.7 PROJECT CONDITIONS

- A. During the construction period, Contractors shall provide means for the adequate distribution of concentrated loads so that the carrying capacity of any joist is not exceeded.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Steel: Comply with SJI and AISC “Standard Specifications.”
 - 1. Yield strength used as a basis for the design stresses shall be as follows:
 - a. Chords = 50,000 psi
 - b. Webs = 36,000psi or 50,000psi
 - 2. Evidence that the steel furnished meets or exceeds the design yield strength shall be provided, on A/E’s request, in the form of certified test reports.
 - 3. Deduct the area of holes in chords from the area of the chord when calculating the strength of the member.
 - 4. Bolts: Carbon or high-strength carbon steel

2.2 FABRICATION

- A. General: Fabricate steel joists in accordance with SJI and AISC “Standard Specifications,” and as follows:
 - 1. Shop connections and splices shall be welded with either arc or resistance welding. Shop-bolted connections are not acceptable. Field bolted splices are acceptable where shown on the Drawings.
 - 2. Top and bottom chords shall be of uniform size throughout their full length.
- B. Top Chords: Shall be absolutely flat across its full width and length for application of metal decking.
- C. Bottom Chords: Shall be extended and connected to columns or webs of girders at column lines and where shown on structural drawings.
- D. Joist Ends: Shall be beveled when slope exceeds 1/4 inch in 12 inch or sloped shoes

shall be provided.

- E. Extended Ends, Headers, and Ceiling Extensions: Shall be provided where indicated on the Drawings, in conformance with manufacturer's standards and applicable SJJ and AISC "Standard Specifications."
- F. Camber joists according to SJI's "Specifications", unless otherwise noted.
- G. Comply with AWS requirements and procedures for shop welding, appearance, quality of welds, and methods used in correcting welding work.
- H. Bridging: Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joint, chord size, spacing, and span. Note additional bridging requirements indicated on the drawing.
- I. Provide additional bridging (diagonal or horizontal) at next to the last bay.

2.3 FINISHES

- A. Remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories before application of shop paint.
 - 1. Shop painting shall comply with Federal Specification preparation requirement #TTP636.
- B. Paint: Comply with SJI and AISC "Standard Specifications," except asphalt type paint is not permitted. Provide Type 1, red oxide, steel joist shop paint conforming to Steel Structure Painting Council (SSPC) - Paint 15.
- C. Apply one shop coat of steel joist primer paint to steel joists and accessories by spray, dipping, or other method to provide a continuous dry paint film thickness of not less than 1.0 mil.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine supporting substrates, embedded bearing plates, and abutting structural framing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Roof joist anchorage shall be designed to resist net uplift force as indicated.
- B. Joist anchorage for unenclosed areas and roof overhangs shall be designed to the upward pressure indicated on the Drawings, or as per OBC, whichever is stricter.

3.3 INSTALLATION

- A. General: Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written recommendations, and requirements in this Section.
 - 1. Before installation, splice joists delivered to Project site in more than one piece.
 - 2. Space, adjust, and align joists accurately in location before permanently fastening.
 - 3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
 - 4. Delay rigidly connecting bottom chord extensions to columns or supports until dead loads have been applied.
- B. Spacing: Set joists at specified slope and to spacing shown with the specified end bearing at supports. Check alignment, plumbness and uninterrupted slopes prior to the installation of the deck.
- C. End Anchorage
 - 1. At steel supports the joist ends shall extend not less than 2-1/2 inches over beams, or as specified in the SJI "Standard Specifications."
 - 2. At masonry the joist ends shall extend not less than 4 inches over walls, or as specified in the SJI "Standard Specifications." The center line of bearing of the joist shall coincide with the center line of the masonry bearing plate and the masonry wythe on which it bears, except where 2 joists from opposite sides bear on the same wythe.
 - 3. Ends shall be anchored as specified in the SJI "Standard Specifications."
- D. Bridging: Shall be installed prior to release of hoisting cable.
 - 1. Do not hang piping, ducts, or other equipment from bridging.
- E. Anchors: Bridging shall extend to walls or beams and shall be anchored thereto before construction loads are placed on the joists. Bridging connections to masonry wall shall be with adhesive anchors as specified in Division 4. Mechanical or wedge type anchor shall not be used.
- F. Field Welding
 - 1. The total length of weld at a cross-section shall not exceed 50 percent of the overall developed width of cold-formed members.
 - 2. Extreme caution shall be exercised during welding. Completely cover and protect masonry and concrete in place from damage during welding.
 - 3. Field welds will be visually inspected according to AWS D1. 1. and in accordance with specification Section 05 1000.
- G. Touch-Up Painting
 - 1. After joist installation, paint field bolt heads and nuts and abraded or rusty surfaces on joists and steel supporting members. Wire brush surfaces and clean with solvent before painting. Use the same type of paint as used for shop painting.

H. Support of Other Work

1. Suspension wires, straps, chains, etc. used to support lights, ceiling grid, ductwork piping conduit, etc. shall be hung from top or bottom chord panel points.

END OF SECTION 05 2100

SECTION 05 3100
STEEL DECKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The Work of this Section consists of providing all metal decking and related items necessary to complete the Work indicated:
 - 1. Metal Roof Deck units.
- B. Related Requirements:
 - 1. Section 05 1200 "Structural Steel Framing" for shop priming structural steel.
 - 2. Section 05 2100 "Steel Joist Framing" for shop priming metal fabrications.
 - 3. The cutting, drilling, or punching of openings smaller than 12 by 12 inches for passage of pipes, ducts, and the attachment of other items shall be performed in the field by the respective trades requiring same.
 - 4. For openings 12 by 12 inches and larger, each shall be predetermined and provided or cut under this Section. Steel framing members indicated or required around openings 12 by 12 inches and larger through decks shall be provided and erected under Section 05 1200.

1.3 SYSTEM DESCRIPTION

- A. Design Requirements.
 - 1. Compute the properties of metal roof deck sections on the basis of the effective design width as limited by the provisions of the SDI specifications. Provide the deck section properties, including section modulus and moment of inertia per foot of width.
 - 2. Allowable Deflection: Design and fabricate deck for a maximum deflection of 1/240 of the clear span under the uniform live load.

1.4 SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product specified.
- B. Shop Drawings: Show layout of deck panels, anchorage details, and every condition requiring closure panels, supplementary framing, special jointing, or other accessories.

- C. Product Certificates: Signed by steel deck manufacturers certifying that products furnished comply with requirements.

1.5 QUALITY ASSURANCE

- A. Qualification of Welding Work
 1. Quality welding processes and welding operators in accordance with the AWS "Standard Qualification Procedure."
 2. Decking welded place is subject to inspection and testing. Remove and replace work found to be defective and not complying with requirements.
- B. Codes and Standards
 1. Comply with the provisions of the following codes and standards, except as otherwise shown or specified:
 2. AISI "Specification for the Design of Cold-Formed Steel Structural Members"
 3. AWS "Structural Welding Code," AWS D1 .1
 4. SDI "Steel Roof Deck Design Manual"
 5. Comply with Factory Mutual requirements, Class I fire rating and Class I-90 windstorm ratings.
 6. Conform to testing as per Section 05 10 00 – Structural Metal Framing.

1.6 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Products of the following manufacturers will be considered, providing their products equal or exceed the quality specified; and they can provide products of the type, size, function, and arrangement required:
 1. Wheeling Steel Corporation, Wheeling, West Virginia
 2. Vulcraft/Div. Nucor Corp., St. Joe, Indiana
 3. United Steel Deck, Inc., Summit, New Jersey
 4. Consolidated Systems, Inc., Columbia South Carolina
 5. Epic Metals Corporation, Rankin, Pennsylvania
- B. Products of other manufacturers will be considered for acceptance provided they equal or exceed the material requirements and functional qualities of the specified product. Requests for A/Es approval must be accompanied by the "Substitution Request Form"

and complete technical data for evaluation. All materials for evaluation must be received by the Project Manager and Specification Department at least 10 days prior to bid due date. Additional approved manufacturers will be issued by Addendum.

1. Refer to Division 1 – Instruction to Bidders and Section 01 3300 – Substitution Request Form for additional requirements.

2.2 MATERIALS

- A. Steel for Galvanized Deck: ASTM A653, Structural Quality Grade 33 or higher, G60 Zinc Coating
- B. Miscellaneous Steel Shapes: ASTM A36
- C. Galvanizing for Roof Decks and Metal Accessories: ASTM A525, G60 (.60 oz. per sq.ft).
- D. Galvanizing Repair Paint: SSPC Paint 20 or DOD-P-21 035, with dry film containing a minimum of 94 percent zinc dust by weight.
- E. Flexible Closure Strips: Manufacturers standard vulcanized, closed-cell, synthetic rubber.
- F. Acoustic Sound Barrier Closures: Manufacturers standard mineral fiber closures.
- G. Self-Drilling Screws: No. 10 self-drilling screws by Hilti or ITW Buildex with lengths adequate for thickness of base material.
- H. Powder Actuated Fasteners: Hilti ENP2 or X-EDNI9/X-EDNK22/ENP2K pins, ITW Buildex BXI4 fasteners, Pneutek SDK-series, or proposed equal
- I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch thick with factory punched hole of 3/8 inch minimum diameter.

2.3 FABRICATION

- A. General: Form deck units in lengths to span 3 or more support spacings, with flush, telescoped or nested 2-inch end laps and nesting side laps, unless otherwise shown or specified. Provide deck configurations complying with SDI “Basic Design Specification” and as specified herein.
- B. Metal Roof Deck Units
 1. For all roof slopes, provide galvanized Type WR (1-1/2 inches deep) or 3” inches deep as specified by the Steel Deck Institute. Depth and gauge shall be as indicated on the Drawings.
- C. Metal Cover Plates: Fabricate metal cover plates for end-abutting floor deck units of galvanized sheet steel not less than same thickness as decking. Form to match contour of deck units and approximately 6 inches wide.

- D. Ridge and Valley Plates: Fabricate ridge and valley plates of galvanized sheet steel of the same quality as the deck units; not less than 6 inches wide, bent to provide tight fitting closure with deck units. Provide plates in 10-foot lengths where possible.
- E. Metal Closure Strips: Fabricate metal closure strips of galvanized sheet steel of the same quality and gauge as the deck units; except not less than 18 gauge. Form to the configuration required to provide tight fitting closures at open ends and sides of decking.
- F. Roof Sump Pans: Shall be fabricated from a single piece of galvanized sheet steel of the same quality as the deck steel and shall be of not less than 0.0747 inch thick before galvanizing.
 - 1. Pans shall have an overall dimension of not less than 29 by 33 inches. Pans shall have a recessed surface of not less than 1-1/2 inch to receive roof sump.
 - 2. Bearing flanges for metal deck shall be not less than 3 inches wide.
 - 3. Pans shall be formed to provide flat (level) sump surface in relationship to the roof slope.
 - a. Accessories: Provide closure plate, pour stop, edge strip, and other accessories required for complete installation.

PART 3 - EXECUTIONS

3.1 EXAMINATION

- A. Installer must examine the areas and conditions under which metal roof decking items are to be installed. Notify the NE in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.
- B. Install deck panels and accessories according applicable specifications and commentary of SDI Publication No. 29, manufacturer's recommendations, and requirements of this Section.

3.2 INSTALLATION

- A. General Install roof and floor deck units and accessories in accordance with manufacturers' recommendations and final shop drawings and as specified herein
- B. Placing Roof Deck Units
 - 1. Do not start placement of roof deck units before supporting members are installed. Place deck units on the supporting steel framework and adjust to final position with ends bearing on supporting members and accurately aligned end to end before being permanently fastened.
 - a. Lap ends of 1-1/2 inch roof deck and noncomposite floor deck units not less than 2 inches centered over supports.
 - b. Butt ends of 3-inch deck units over supports.
 - c. Do not stretch or compress the side-lap interlocks.

- d. Place deck units flat and square, secured to adjacent framing without warp or excessive deflection.
 2. Coordinate and cooperate with structural steel erector in locating decking bundles to prevent overloading of structural members.
 3. Do not use deck units for storage or working platforms until permanently secured in position.
- C. Fastening Roof Deck Units
1. To structural steel supporting members:
 - a. Permanently fasten roof deck units to steel supporting members by not less than 5/8 inch diameter puddle weld at a 36/5 pattern. Along boundaries and ends of decks space welds at 6" on center.
 - b. Comply with AWS requirements and procedures for manual shielded metal-arc welding, the appearance and quality of welds, and the methods used in correcting welding work.
 - c. Lock side laps between adjacent deck units with No. 10 self-tapping screws at intervals not exceeding 24 inches o.c., unless otherwise noted.
 2. Pneumatic fasteners may be submitted as an alternative for approval by Engineer of Record and Deck Supplier.
 - a. Acceptable manufacturer's: Hilti Inc
- D. Cut and Fitting.
1. Cut and fit roof deck units and accessories around other work projecting through or adjacent to the decking. Provide neat, square and trim cuts.
- E. Reinforcement at Openings
1. Provide additional metal reinforcement and closure pieces as required for strength, continuity of decking, and support of other work, unless otherwise shown.
 2. Reinforce roof and floor decking around openings less than 12 inches in any dimension by means of a flat steel sheet placed over the opening and fusion welded to the top surface of the deck. Provide steel sheet of the same quality as the deck units, not less than 20 gauge and at least 12 inches wider and longer than the opening. Provide welds at each corner and spaced not more than 12 inches o.c. along each side
- F. Roof Sump Pans
1. Place roof sump pans over openings provided in the roof decking and weld to the top decking surface. Space welds not more than 12 inches o.c. with at least one weld in each corner and at center along perimeter. Cut opening in the bottom of the sump to accommodate the drain size indicated.
- G. Ridge and Valley Plates
1. Weld ridge and valley plates to the top surface of the roof decking. Lap end joints not less than 3 inches, with laps made in the direction of water flow. Minimum gauge shall be 14.
- H. Closure Strips

1. Provide metal closure strips at open uncovered ends and edges of roof decking and in the voids between decking and other construction. Weld into position to provide a complete decking installation.
 2. Provide metal joint covers at abutting ends and changes in direction of floor deck units, except where taped joints are required.
 3. Provide flexible closure strips instead of metal closures, at Contractors option, wherever their use will ensure complete closure. Install with adhesive in accordance with manufacturers instructions.
- I. Touch-Up Painting – Galvanized Deck
1. After roof decking and metal accessory installation, wire brush, clean, and paint scarred areas, welds, and rust spots on the top and bottom surfaces of decking units, and supporting steel members with galvanizing repair paint, applied in accordance with manufacturer’s instructions and ASTM A780.
- J. Repair of Blow Holes in Deck
1. Holes up to 1 1/2 inch in diameter, fill with urethane or silicone sealant and cover with duct tape.
 2. Holes above 1/2 inch diameter require sheet metal plate patches fastened to deck.
- K. Support of Other Work
1. Suspension wires, straps, and chains such as those used to support acoustical ceilings, ductwork, and lights shall not be attached to or through steel roof decks.

END OF SECTION 05 3100

SECTION 05 4000
COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.02 DESCRIPTION

- A. Work included: All labor and materials required to design, furnish, and install cold-formed metal framing as shown on the Drawings and or required by these specifications. Cold-formed metal framing includes:
 - 1. Interior and Exterior non-load bearing wall studs and framing.
 - 2. Exterior soffit framing.
 - 3. Related accessories and necessary fasteners to complete the system.
- B. Related work specified elsewhere: The general provisions of the Contract apply to the work of this Section, as though reproduced herein. Carefully examine all other sections and all Drawings for related work.
- C. Provide openings and special framing required by other trades. Equipment framing, loads, openings, and structure are shown for bidding purposes only. Obtain approval of other trades before proceeding with such work. Coordinate work with mechanical and electrical requirements.
- D. Field measurement of the existing construction shall be conducted when required to ensure the proper coordination and fit of new work.

1.03 QUALITY ASSURANCE

- A. Standards: Comply with American Iron and Steel Institute (AISI) "Specifications for the Design of Cold-Formed Structural Steel Members", except as otherwise indicated.
 - 1. The minimum uncoated thickness of the cold-formed metal framing delivered to the project shall not be less than 95% of the design thickness indicated. Lesser thicknesses shall be permitted at the bends due to cold forming.
- B. Welding of CFMF: Comply with American Welding Society, AWS D1.1 "Structural Welding Code – Steel" and AWS D1.3 "Structural Welding Code – Sheet Steel".

Qualify welding processes and welding operators in accordance with AWS “Standard Qualification Procedure”.

- C. Provide each type of cold-formed metal framing required produced by one manufacturer.
- D. Reference Standards:
 - 1. American Society for Testing and Materials (ASTM):
 - a. ASTM A653 “Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by the Hot-Dip Process”.
 - b. ASTM A780 “Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings”.
 - c. ASTM A924 “Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process”.
 - d. ASTM A1003 “Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members”.
 - e. ASTM C955 “Standard Specification for Load bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Board and Metal Plaster Bases”.
 - f. ASTM C1007 “Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories”.
 - 2. American Welding Society (AWS):
 - a. AWS A2.4 “Symbols for Welding and Nondestructive Testing”.
 - b. AWS D1.1 “Structural Welding Code-Steel”.
 - c. AWS D1.3 “Structural Welding Code – Sheet Steel”.
 - 3. Association of Wall and Ceiling Industries-International (AWCI) and Metal Lath/Steel Framing Association (ML/SFA)
 - a. AWCI-ML/SFA “Steel Framing Systems Manual”.

1.04 PERFORMANCE REQUIREMENTS

- A. Provide cold-formed metal framing capable of withstanding design loads and within deflection limits indicated.
- B. Design Loads: Occupancy Live, Roof Live, Snow, Wind, and Seismic loads shall be as indicated in the General Structural Notes on the Structural Drawings.
- C. Deflection Limits: Design framing systems to withstand the total design loads without the deflection exceeding the following:
 - 1. Exterior wall framing horizontal deflection where “L” is the stud height:
 - a. Supporting flexible finishes (including EIFS): L/240
 - b. Supporting Portland Cement-based Plaster (Stucco): L/360
 - c. Supporting masonry, brick, or stone finishes: the more stringent of L/600 or 3/8”.

- d. Supporting extremely brittle finishes: $L/720$ or as defined by finish manufacturer.
2. Interior wall framing horizontal deflection where “L” is the stud height and the applied horizontal live load is 5 psf (ASD) loading:
 - a. Supporting flexible finishes: $L/240$.
 - b. Supporting brittle finishes: $L/360$.
3. Ceiling and soffit joist framing vertical deflection where “L” is the horizontal span of the joist:
 - a. Total Loads: $L/240$ or $L/360$.

1.05 SUBMITTALS

- A. Submit Manufacturer’s product data and installation instructions for each type of cold-formed metal framing and accessory required.
- B. Delegated design:
 1. Stud size and details shown on the Drawings indicate general installation and connection methods. Complete detail of components for all loads and forces is to be shown on the Shop Drawings. No changes from sizes and installation methods shown on the Construction Drawings will be permitted without verification that the design criteria cannot be met and without express written consent of the Architect and the Engineer of Record.
 2. Professional Engineer Qualifications: A Professional Engineer who is legally qualified to practice in the jurisdiction where the project is located and who is experienced in providing engineering services for installations of cold-formed metal framing that are similar to those indicated for this project in material, design, and extent.
 3. Shop drawings must include structural analysis data of all cold-formed metal framing and connections in conformance with design loads stated on the Structural Drawings. Shop drawings and analysis must bear the seal of the qualified Engineer responsible for their preparation.
- C. Shop Drawings: submit drawings for approval that include the following minimum information:
 1. Fully dimensioned plans and elevations with cross sections and details depicting all component member locations, orientations, and layout.
 2. Wall, Floor, and/or Roof member sizes and gauge designations, number, type and spacing.
 3. Supplemental strapping, bracing, bridging accessories, and details required for proper installation.
 4. Details of connections that indicate screw types, quantities, locations, weld size and locations, and any other fastener requirements.
- D. Supplier’s Certification:
 1. The supplier of the cold-formed metal framing shall submit written evidence of having a minimum of five years’ experience on projects of similar type and

scope, including a description of physical facilities, quality control, methods, personnel experience, and erection capacities.

2. Cold-formed pre-engineered steel truss manufacturer must adhere to Special Inspection requirements for fabricated items.
- E. Welding of cold-formed metal components shall only be performed by operators qualified per AWS D1.1 and D1.3 for the thickness of materials being used. Submit copies of welder certificates upon request only.
- F. Upon request only, submit mill certificates from the steel producer.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturers unopened containers or bundles fully identified by name, brand, type, and grade. Exercise care to avoid damage during unloading, storing, and erection.
- B. Protect cold-formed metal framing members and accessories from corrosion, deformation, damage, and deterioration when stored at the job site as required in AISI's Code of Standard Practice. Store cold-formed metal framing off the ground on pallets, platforms or other supports, and provide a waterproof covering. Keep cold-formed metal framing free of dirt and other foreign material.

1.07 PROJECT CONDITIONS

- A. Coordinate metal frame positioning with trades furnishing items for attachment of built-in members.
- B. Promptly furnish anchors, bolts, inserts, clips, and other items required under this section but built in with work of other trades.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Cold-formed metal framing products by the following manufacturers are approved for use on this project: ClarkDietrich Metal Framing; Marino Ware, a division of Ware Industries; United Metal Products, Inc.; Scafco Corp.; and The Steel Network, Inc.
- B. Connection component and fastener products by the following manufacturers are approved for use on the project: ClarkDietrich Metal Framing; Marino Ware, a division of Ware Industries; and The Steel Network Inc.

- C. Alternate manufacturers of cold-formed metal framing, connection components, and fasteners are to be submitted for review and approval two weeks before submitting bids.

2.02 MATERIALS AND FINISHES:

- A. Steel sheet: ASTM 1003, Structural Grade, Type H, metallic coated, of thickness and grade as follows:
1. 33 mils – 0.0346 inches (20 gauge), $F_y = 33$ ksi.
 2. 43 mils – 0.0451 inches (18 gauge), $F_y = 33$ ksi.
 3. 54 mils – 0.0566 inches (16 gauge), $F_y = 50$ ksi.
 4. 68 mils – 0.0713 inches (14 gauge), $F_y = 50$ ksi.
 5. 97 mils – 0.1017 inches (12 gauge), $F_y = 50$ ksi.
 6. Track and bridging components shall have a minimum $F_y = 33$ ksi.
 7. Connection clip angles and vertical or horizontal deflection connections shall have a minimum $F_y = 33$ ksi.
- B. Framing Components: Manufacturer's standard C-shaped cold-formed metal framing having punched and/or un-punched webs with stiffened flanges shall comply with ASTM C955. Provide sizes, shapes, and gauges indicated. Nomenclature used on the Drawings is designated by: Depth, Shape, Width, and Thickness of framing components. i.e. "600 S162-54".
1. Depth: The number represents the depth of the member multiplied by 100 and expressed as a whole number in inches. i.e. '362' = 3-5/8"; 600' = 6"; '800' = 8".
 2. Shape: 'S' = C-shaped member; 'T' = Track member; 'F' = Furring channel; 'U' = U-shaped member.
 3. Width: The number represents the flange width of the member multiplied by 100 and expressed as a whole number in inches. i.e. '162' = 1-5/8"; '200' = 2"; 250 = 2-1/2".
 4. Thickness: Expressed in mils as defined above.
- C. System Accessories: Provide manufacture's standard steel tracks, bridging, blocking, clip angles, reinforcements, stiffeners, fasteners, braces, and accessories for each type of cold-formed metal framing required. Provide all components recommended by the manufacturer for the applications indicated and as needed to provide a complete metal framing system.
- D. Finish:
1. Galvanized: Provide framing components: studs, joists, rafters, and headers with protective zinc coating complying with ASTM A1003, minimum G60 coating.
 2. Provide connection components; clip angles, deflection angles, joist hangers, hurricane ties, holdowns, etc. with protective zinc coating complying with ASTM A1003, minimum G90 coating.

3. Galvanized repair paint: Tnemec Co., Inc. – No. 92 “Tneme-Zinc”; SSPC-Paint 20; or an approved equal zinc-rich primer paint.
- E. Fasteners:
1. Manufacturer’s recommended self-drilling, self-tapping screws, bolts, nuts, and washers with hot-dip galvanized finish complying with ASTM C1513.
 2. Anchorage devices: Power-actuated Fasteners (PAF), anchor rods, drilled expansion anchors, or chemical anchors.
 3. Welding: Comply with AWS D1.1 when applicable, and AWS D1.3 for welding base materials less than 1/8” thick.
- F. Shims: Load-bearing, high-density multimonomer plastic, non-leaching.

2.03 FABRICATION

- A. Cut framing to fit squarely against abutting members. Hold members securely in position until properly fastened.
- B. Saw cut all field cuts of cold-formed metal framing members and components squarely for attachment to perpendicular members, or as required for an angular fit against abutting members.
- C. Attach and join indicated components by welding. Attach and join other components by welding, bolting, or screw fasteners as recommended by the manufacturer. Wire-tying of framing members is not permitted.

PART 3 EXECUTION

3.01 INSTALLATION – GENERAL

- A. Install cold-formed metal framing in accordance with ASTM C1007 unless otherwise indicated.
- B. Install load bearing shims or grout between underside of wall bottom track or rim track and top of foundation wall or slab at studs or joist locations to ensure a uniform bearing surface on supporting concrete or masonry construction.
- C. Install cold-formed metal framing and accessories plumb, square, and true to line according to the manufacturer’s written recommendations and requirements in this Section.
- D. Connections of cold-formed metal framing members and components are to be securely anchored to the supporting structure according to the manufacturer’s written recommendations and requirements of this Section.

- E. Do not bridge building expansion joints and control joints with cold-formed metal framing members or accessories. Frame each side of joints with independent members.
- F. Install insulation in assemblies and built-up members in exterior framing, such as headers, multiple stud columns and jambs, sills, and boxed beams or joists that are not accessible to the insulation contractor upon erection of framing work.
- G. Fasten hole-reinforcing plates over web penetrations that exceed the manufacturer's standard punched openings.

3.02 INSTALLATION – INTERIOR AND EXTERIOR NON-LOAD BEARING STUD WALLS

- A. Install continuous top and bottom tracks sized to match studs. Align tracks securely to layout at base and top of studs. Secure tracks at corners, ends, and laps as recommended by the manufacturer for type of construction involved. Anchor tracks to building framing as recommended by the manufacturer except do not exceed 16 inches on center spacing for nail or power actuated fasteners, or 32 inches on center for anchor rods, expansion and chemical anchors, and other similar types of attachment.
- B. Set studs plumb except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.
- C. Where stud systems abut structural columns or walls, including masonry walls, anchor ends of stiffeners to supporting structure.
- D. Install supplementary framing, blocking and bracing in cold-formed metal framing systems wherever required to provide a complete and stable wall-framing system. Where type of supplementary support is not otherwise indicated, comply with stud manufacturer's recommendations and industry standards in each case, considering weight for loading resulting from item supported.
- E. Squarely set studs against web of tracks and secure studs to top and bottom runner tracks by either welding or fastening with screws at both inside and outside flanges.
- F. Install stud wall bridging (continuous cold-rolled channels positioned through the stud punch-outs) either by welding directly to the stud or attaching with clips. Bridging shall consist of the following:
 - 1. 3-5/8" and 6" studs: 1-1/2" x 16-ga. channel fastened to each stud with standard clip angles.
 - 2. Proprietary bridging bars provided and installed according to manufacturer's written instructions.
 - 3. A combination of flat, taut, steel straps of width and thickness indicated and stud-track solid blocking of width and thickness to match stud. Fasten straps

- to stud flanges and secure solid blocking to stud webs or flanges with standard clip angles.
4. Install bridging rows at a maximum spacing of 4'-0" on center.
- G. Frame wall openings larger than 2'-0" square with double stud at each jamb of frame, except where more than 2 studs are shown. Provide stud or joist header at all rough openings greater than 24 inches. Install tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with stud shoes or by welding, and space jack studs same as full-height studs of wall. Secure stud system wall opening frame in manner indicated.
- H. Provide extra studs, tracks, headers, etc. as required to frame the perimeter of openings.
- I. Provide insulation, as indicated elsewhere, in all double jamb studs, double header members, and other assemblies that will not be accessible to the insulation contractor after erection.
- J. Splicing of load-bearing studs and box headers is not permitted, unless specifically detailed otherwise.
- K. Install steel sheet diagonal straps to both stud flanges, terminate at and fastened to reinforced top and bottom tracks. Fasten clip angle connectors to multiple studs at ends of bracing and anchor to structure.

3.03 TOLERANCES

- A. Fabricate and install members and assemblies to a maximum allowable variation as follows:
1. Variation from plumb, level, and true to line: 1/8 inch in 10 feet.
 2. Variation of member spacing: not more than 1/8 inch plus or minus from spacing indicated. Cumulative error shall not exceed the minimum fastening requirements of the sheathing or other finishing materials.
 3. Squareness: fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

3.04 FIELD REPAIRS AND PROTECTION

- A. Galvanized repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing, connections, and components with galvanized repair paint according to ASTM A780 and manufacturer's written instructions.

- B. Provide final protection and maintain conditions in a manner acceptable to the manufacturer and installer, which ensure cold-framed metal framing is without damage or deterioration at time of Substantial Completion.

3.05 FIELD QUALITY CONTROL

- A. Inspection and testing shall be in accordance with Special Inspections designated for this project as approved by the Building Official. Special Inspections must be documented with all corrective measures completed to satisfy compliance certificates as deemed necessary by the Jurisdiction.

END OF SECTION 05 4000

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SECTION 05 5000
METAL FABRICATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Shop fabricated steel items, including: Dumpster enclosure supports and gate frame. Refer to drawings for gate hardware.
- 1.01.B. Downspout boots.

1.02 RELATED REQUIREMENTS

- 1.02.A. Section 05 5133 - Metal Ladders.
- 1.02.B. Section 09 9123 - Interior Painting: Paint finish.

1.03 REFERENCE STANDARDS

- 1.03.A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- 1.03.B. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.
- 1.03.C. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
- 1.03.D. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- 1.03.E. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2018.
- 1.03.F. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2021.
- 1.03.G. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.
- 1.03.H. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).
- 1.03.I. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 2004.
- 1.03.J. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.
- 1.03.K. SSPC-SP 2 - Hand Tool Cleaning; 2018.

1.04 SUBMITTALS

- 1.04.A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- 1.04.B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
 - 1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

- 2.01.A. Steel Sections: ASTM A36/A36M.
- 2.01.B. Steel Tubing: ASTM A501/A501M hot-formed structural tubing.
- 2.01.C. Plates: ASTM A283/A283M.
- 2.01.D. Pipe: ASTM A53/A53M, Grade B Schedule 40, black finish.
- 2.01.E. Mechanical Fasteners: Same material as or compatible with materials being fastened; type consistent with design and specified quality level.
- 2.01.F. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- 2.01.G. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
- 2.01.H. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.02 FABRICATION

- 2.02.A. Fit and shop assemble items in largest practical sections, for delivery to site.
- 2.02.B. Fabricate items with joints tightly fitted and secured.
- 2.02.C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- 2.02.D. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- 2.02.E. Furnish components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.03 FABRICATED ITEMS

- 2.03.A. Bollards: Steel pipe, concrete filled, crowned cap, as detailed; prime paint finish.
- 2.03.B. Ships ladder for mechanical platform.
- 2.03.C. Guard rail for mechanical platform.

2.04 FINISHES - STEEL

- 2.04.A. Prime paint steel items.
 - 1. Exceptions: Do not prime surfaces in direct contact with concrete, where field welding is required, and items to be covered with sprayed fireproofing.
- 2.04.B. Prepare surfaces to be primed in accordance with SSPC-SP2.
- 2.04.C. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- 2.04.D. Prime Painting: One coat.
- 2.04.E. Galvanizing of Structural Steel Members: Galvanize after fabrication to ASTM A123/A123M requirements. Provide minimum 1.7 oz/sq ft galvanized coating. (Provide minimum 530 g/sq m galvanized coating.)
- 2.04.F. Galvanizing of Non-structural Items: Galvanize after fabrication to ASTM A123/A123M requirements.

2.05 FABRICATION TOLERANCES

- 2.05.A. Squareness: 1/8 inch (3 mm) maximum difference in diagonal measurements.
- 2.05.B. Maximum Offset Between Faces: 1/16 inch (1.5 mm).
- 2.05.C. Maximum Misalignment of Adjacent Members: 1/16 inch (1.5 mm).
- 2.05.D. Maximum Bow: 1/8 inch (3 mm) in 48 inches (1.2 m).
- 2.05.E. Maximum Deviation from Plane: 1/16 inch (1.5 mm) in 48 inches (1.2 m).

PART 3 EXECUTION

3.01 EXAMINATION

- 3.01.A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

- 3.02.A. Clean and strip primed steel items to bare metal where site welding is required.

3.03 INSTALLATION

- 3.03.A. Install items plumb and level, accurately fitted, free from distortion or defects.
- 3.03.B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- 3.03.C. Obtain approval prior to site cutting or making adjustments not scheduled.
- 3.03.D. After erection, prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete.

3.04 TOLERANCES

- 3.04.A. Maximum Variation from Plumb: 1/4 inch (6 mm) per story, non-cumulative.
- 3.04.B. Maximum Offset from True Alignment: 1/4 inch (6 mm).
- 3.04.C. Maximum Out-of-Position: 1/4 inch (6 mm).

END OF SECTION 05 5000

SECTION 06 1000
ROUGH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Sheathing.
- 1.01.B. Preservative treated wood materials.
- 1.01.C. Concealed wood blocking, nailers, and supports.
- 1.01.D. Wall sheathing with factory applied water-resistive and air barrier sheet.

1.02 RELATED REQUIREMENTS

- 1.02.A. Section 07 2100 - Thermal Insulation: Vapor retarder.
- 1.02.B. Section 07 6200 - Sheet Metal Flashing and Trim: Sill flashings.

1.03 REFERENCE STANDARDS

- 1.03.A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- 1.03.B. ASTM C557 - Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing; 2003 (Reapproved 2017).
- 1.03.C. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials; 2021a.
- 1.03.D. AWWA U1 - Use Category System: User Specification for Treated Wood; 2023.
- 1.03.E. PS 2 - Performance Standard for Wood Structural Panels; 2018.
- 1.03.F. PS 20 - American Softwood Lumber Standard; 2021.
- 1.03.G. SPIB (GR) - Standard Grading Rules; 2021.

1.04 SUBMITTALS

- 1.04.A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- 1.04.B. Product Data: Provide technical data on insulated sheathing.

1.05 DELIVERY, STORAGE, AND HANDLING

- 1.05.A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- 2.01.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.

2.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- 2.02.A. Grading Agency: Southern Pine Inspection Bureau, Inc; SPIB (GR).
- 2.02.B. Sizes: Nominal sizes as indicated on drawings, S4S.
- 2.02.C. Moisture Content: S-dry or MC19.

2.03 CONSTRUCTION PANELS

- 2.03.A. Wall Sheathing: Glass mat faced gypsum with integral water-resistive and air barrier, ASTM C1177/C1177M, 5/8 inch (15.9 mm) thick.
1. Edges: Square.
 2. Water Vapor Permeance: 1 perm (57.5 ng/(Pa s sq m)), minimum, when tested in accordance with ASTM E96/E96M.
 3. Air Permeance, Sheathing: 0.001 cfm/sq ft (0.005 L/s per sq m), maximum, when tested in accordance with ASTM E2178.
 4. Products:
 - a. Georgia-Pacific LLC; DensElement Barrier System: www.DensElement.com/#sle.
 - b. USG Corporation; Securock ExoAir 430 Panel 5/8 in. (15.9 mm): www.usg.com/#sle.
- 2.03.B. Wall Sheathing: Polyisocyanurate insulation bounded to fire treated plywood.
1. 5/8" plywood – total thickness 2.10", R-Value 9.8.
 - a. Hunter Xci Ply basis of design.

2.04 ACCESSORIES

2.04.A. Fasteners and Anchors:

1. Metal and Finish: Hot-dipped galvanized steel complying with ASTM A153/A153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.

2.04.B. Sill Gasket on Top of Foundation Wall: 1/4 inch (6 mm) thick, plate width, closed cell plastic foam from continuous rolls.

2.04.C. Sill Flashing: See Section 07 6200.

2.04.D. General Purpose Construction Adhesives: Comply with ASTM C557.

2.05 FACTORY WOOD TREATMENT

2.05.A. Treated Lumber and Plywood: Comply with requirements of AWWA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.

1. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWWA standards.

2.05.B. Preservative Treatment:

1. Preservative Pressure Treatment of Plywood Above Grade: AWWA U1, Use Category UC2 and UC3B, Commodity Specification F using waterborne preservative.
 - a. Kiln dry plywood after treatment to maximum moisture content of 19 percent.

PART 3 EXECUTION

3.01 PREPARATION

3.01.A. Coordinate installation of rough carpentry members specified in other sections.

3.02 INSTALLATION - GENERAL

3.02.A. Select material sizes to minimize waste.

3.02.B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.

3.02.C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.03 BLOCKING, NAILERS, AND SUPPORTS

- 3.03.A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.
- 3.03.B. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.
- 3.03.C. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.

3.04 INSTALLATION OF CONSTRUCTION PANELS

- 3.04.A. Wall Sheathing: Secure panels with long dimension perpendicular to framing members, with ends staggered and over firm bearing.
 - 1. Nail panels to framing; staples are not permitted.

3.05 TOLERANCES

- 3.05.A. Framing Members: 1/4 inch (6 mm) from true position, maximum.
- 3.05.B. Variation from Plane, Other than Floors: 1/4 inch in 10 feet (2 mm/m) maximum, and 1/4 inch in 30 feet (7 mm in 10 m) maximum.

3.06 FIELD QUALITY CONTROL

- 3.06.A. See Section 01 4000 - Quality Requirements for additional requirements.

END OF SECTION 06 1000

SECTION 06 4100
ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Specially fabricated cabinet units.
- 1.01.B. Hardware.

1.02 RELATED REQUIREMENTS

- 1.02.A. Section 06 1000 - Rough Carpentry: Support framing, grounds, and concealed blocking.
- 1.02.B. Section 12 3600 - Countertops.

1.03 REFERENCE STANDARDS

- 1.03.A. ANSI A208.1 - American National Standard for Particleboard; 2022.
- 1.03.B. ANSI A208.2 - Medium Density Fiberboard (MDF) for Interior Applications; 2022.
- 1.03.C. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
- 1.03.D. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.
- 1.03.E. BHMA A156.9 - Cabinet Hardware; 2020.
- 1.03.F. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.

1.04 ADMINISTRATIVE REQUIREMENTS

- 1.04.A. Preinstallation Meeting: Convene a preinstallation meeting not less than one week before starting work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

- 1.05.A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- 1.05.B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
 - 1. Scale of Drawings: 1-1/2 inch to 1 foot (125 mm to 1 m), minimum.

1.05.C. Product Data: Provide data for hardware accessories.

1.05.D. Samples for Verification: Provide the following.

1. Plastic Laminates, 8 x 10 inch for each type, color, pattern and surface finish.
2. Lumber products with Shop-Applied Opaque Finish: 5 x 12 inch.

1.06 QUALITY ASSURANCE

1.06.A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.

1. Single Source Responsibility: Provide and install this work from single fabricator.

1.07 DELIVERY, STORAGE, AND HANDLING

1.07.A. Protect units from moisture damage.

1.08 FIELD CONDITIONS

1.08.A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

PART 2 PRODUCTS

2.01 CABINETS

2.01.A. Quality Standard: Premium Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.

2.01.B. Plastic Laminate Faced Cabinets: Premium grade.

2.01.C. Cabinets:

1. Finish - Exposed Exterior Surfaces: Decorative laminate.
2. Finish - Semi-Exposed Surfaces: Decorative laminate
3. Finish - Concealed Surfaces: Manufacturer's option.
4. Door and Drawer Front Edge Profiles: Square edge with inset band.
5. Door and Drawer Front Retention Profiles: Fixed panel.
6. Casework Construction Type: Type A - Frameless.
7. Interface Style for Cabinet and Door: Style 1 - Overlay; reveal overlay.
8. Adjustable Shelf Loading: 40 psf (19.5 gm/sq cm).
9. Cabinet Style: Flush overlay.
10. Cabinet Doors and Drawer Fronts: Flush style.
11. Drawer Construction Technique: Dovetail joints.

2.02 WOOD-BASED COMPONENTS

2.02.A. Wood fabricated from old growth timber is not permitted.

2.03 Panel Core Materials

2.03.A. Particleboard: Composite panel composed of cellulosic particles, additives, and bonding system; comply with ANSI A208.1.

1. Grade: M-2; moisture resistance: MR10.
2. Panel Thickness: 3/4 inch (19.1 mm).

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

1. Grade: 115; moisture resistance: MR10.
2. Panel Thickness: 3/4 inch (19.1 mm).

2.04 Thermally Fused Laminate Panels

2.04.A. Thermally Fused Laminate (TFL): Melamine- or polyester-resin-saturated decorative papers; for fusion to composite wood substrates under heat and pressure.

1. Test in accordance with NEMA LD 3 Section 3.
2. Panel Core Substrate: Particleboard.
3. Color: White.

2.05 LAMINATE MATERIALS

2.05.A. Manufacturers:

1. As indicated on the drawings..

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

2.05.C. Provide specific types as indicated.

1. Horizontal Surfaces: HGS, 0.048 inch (1.22 mm) nominal thickness, colors as indicated, finish as indicated.
2. Vertical Surfaces: VGS, 0.028 inch (0.71 mm) nominal thickness, colors as indicated, finish as indicated.
3. Laminate Backer: BKL, 0.020 inch (0.51 mm) nominal thickness, undecorated; for application to concealed backside of panels faced with high pressure decorative laminate.

2.06 COUNTERTOPS

2.06.A. Countertops: See Section 12 3600.

2.07 ACCESSORIES

- 2.07.A. Adhesive: Type recommended by fabricator to suit application.
- 2.07.B. Plastic Edge Banding: Extruded PVC, convex shaped; smooth finish; self locking serrated tongue; of width to match component thickness.
 - 1. Color: As indicated on drawings.
- 2.07.C. Fasteners: Size and type to suit application.
- 2.07.D. Grommets: Standard plastic grommets for cut-outs, 3 inch OD, with matching plastic caps with slot for wire passage. .
 - 1. Product: Doug Mockett & Company, Inc., "SG Series".
 - a. Color: To be selected by the Architect.
- 2.07.E. Sliding pass-thru window and framing system.
 - 1. Materials: Clear anodized aluminum frame and clear tempered glass. Refer to Division 8 Section 08 1000 "Glazing" for glass.
 - 2. Product: Framed opening with recessed bottom track, head and jambs to support sliding glass panels. Provide Knopt and Vogt Roll-Ezy Aluminum track assembly or equal.
 - 3. Accessories: Cam-type locks.

2.08 HARDWARE

- 2.08.A. Hardware: BHMA A156.9, types as indicated for quality grade specified.
- 2.08.B. Adjustable Cabinet Shelf Supports: Standard side-mounted system using recessed metal shelf standards or multiple holes for pin supports and coordinated self rests, polished chrome finish, for nominal 1 inch (25 mm) spacing adjustments.
- 2.08.C. Adjustable Shelf Standards and Supports: Standard back-mounted system using surface mounted metal shelf standards and coordinated cantilevered shelf brackets, satin chrome finish, for nominal 1 inch (25 mm) spacing adjustments.
 - 1. Products:
 - a. Knappe and Vogt; #82 Heavy Duty Steel Standards and #182 Steel Shelf Supports.
 - b. Location: Tactical Gear Storage.
- 2.08.D. Workstation Brackets: Fixed, L-shaped, face-of-stud mounting.
 - 1. Materials: Steel; L-shape cross-section.
 - a. Finish: Manufacturer's standard, factory-applied, powder coat.
 - b. Color: Almond.
 - c. Height: 15 inches (380 mm).
 - d. Support Length: 21 inches (530 mm).
 - e. Width: 1-1/2 inches (38 mm).
 - 2. Products:

- a. A&M Hardware, Inc; Standard Brackets: www.aandmhardware.com/#sle.
- 2.08.E. Drawer and Door Pulls: Extruded aluminum pull, full width of drawer, polished finish.
- 2.08.F. Drawer Slides: General purpose cabinet drawers and specialty purpose drawers including but not limited to keyboard trays, pencil drawers and file drawers.
 1. Type: Full extension with overtravel.
 2. Static Load Capacity: Heavy Duty grade (HD-100).
 - a. File drawers: Provide Heavy Duty grade (HD-200)
 3. Mounting: Side mounted.
 4. Stops: Integral type.
 5. Features: Provide self closing/stay closed type.
- 2.08.G. Drawer Slides: General purpose cabinet drawers in the Kitchen only.
 1. Type: Full extension with overtravel.
 2. Static Load Capacity: Heavy Duty grade (HD-100)
 3. Mounting: Bottom mounted.
 4. Stops: Integral type.
- 2.08.H. Hinges: European style concealed self-closing type, 125 degrees of opening , steel with nickel-plated finish.
 1. Manufacturers:
 - a. Blum, Inc; CLIP top BLUMOTION: www.blum.com/#sle. 71B7550D

2.09 FABRICATION

- 2.09.A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.
- 2.09.B. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.
- 2.09.C. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.
- 2.09.D. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners.

PART 3 EXECUTION

3.01 EXAMINATION

- 3.01.A. Verify adequacy of backing and support framing.
- 3.01.B. Verify location and sizes of utility rough-in associated with work of this section.

3.02 INSTALLATION

- 3.02.A. Install work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.
- 3.02.B. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.
- 3.02.C. Use concealed joint fasteners to align and secure adjoining cabinet units.
- 3.02.D. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch (0.79 mm). Do not use additional overlay trim for this purpose.
- 3.02.E. Secure cabinets to floor using appropriate angles and anchorages.

3.03 ADJUSTING

- 3.03.A. Adjust installed work.
- 3.03.B. Adjust moving or operating parts to function smoothly and correctly.

3.04 CLEANING

- 3.04.A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION 06 4100

SECTION 07 1900
WATER REPELLENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Water repellents applied to exterior, masonry, and concrete surfaces.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS

- 1.03.A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- 1.03.B. Product Data: Provide product description, details of tests performed, limitations, and chemical composition.
- 1.03.C. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention; cautionary procedures required during application.
- 1.03.D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- 1.03.E. Manufacturer's Field Reports: Report whether manufacturer's "best practices" are being followed; if not, state corrective recommendations. Email report to Architect the same day as inspection occurs; mail report on manufacturer's letterhead to Architect within 2 days after inspection.
- 1.03.F. Manufacturer's Qualification Statement.
- 1.03.G. Installer's Qualification Statement.

1.04 QUALITY ASSURANCE

- 1.04.A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years documented experience.
- 1.04.B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience
- 1.04.C. Owner reserves the right to provide continuous independent inspection of surface preparation and application of water repellent.

1.05 FIELD CONDITIONS

- 1.05.A. Protect liquid materials from freezing.
- 1.05.B. Do not apply water repellent when ambient temperature is lower than 50 degrees F (10 degrees C) or higher than 100 degrees F (38 degrees C).

1.06 WARRANTY

- 1.06.A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- 1.06.B. Correct defective Work within a five-year period after Date of Substantial Completion.
- 1.06.C. Provide five-year manufacturer warranty for water repellency.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- 2.01.A. Silane, Siloxane, Silane-Siloxane Blend, and Siliconate Water Repellents:
 - 1. Dayton Superior Corporation: www.daytonsuperior.com/#sle.
 - 2. Pecora Corporation; KlereSeal 910-W/920-W Water-Based Penetrating Masonry Sealer: www.pecora.com/#sle.
 - 3. PROSOCO, Inc: www.prosoco.com/#sle.

2.02 MATERIALS

- 2.02.A. Water Repellent: Non-glossy, colorless, penetrating, water-vapor-permeable, non-yellowing sealer, that dries invisibly leaving appearance of substrate unchanged.
 - 1. Applications: Vertical surfaces and non-traffic horizontal surfaces.
 - 2. Number of Coats: Two.
 - 3. Silane, siloxane, silane-siloxane blend, or siliconate that reacts chemically with concrete and masonry.

PART 3 EXECUTION

3.01 EXAMINATION

- 3.01.A. Verify existing conditions before starting work.
- 3.01.B. Verify joint sealants are installed and cured.
- 3.01.C. Verify surfaces to be coated are dry, clean, and free of efflorescence, oil, or other matter detrimental to application of water repellent.

3.02 PREPARATION

- 3.02.A. Protection of Adjacent Work:
 - 1. Protect adjacent landscaping, property, and vehicles from drips and overspray.
 - 2. Protect adjacent surfaces not intended to receive water repellent.
- 3.02.B. Prepare surfaces to be coated as recommended by water repellent manufacturer for best results.
- 3.02.C. Do not start work until masonry mortar substrate is cured a minimum of 60 days.
- 3.02.D. Remove loose particles and foreign matter.
- 3.02.E. Remove oil and foreign substances with a chemical solvent that will not affect water repellent.
- 3.02.F. Scrub and rinse surfaces with water and let dry.
- 3.02.G. Allow surfaces to dry completely to degree recommended by water repellent manufacturer before starting coating work.

3.03 APPLICATION

- 3.03.A. Apply water repellent in accordance with manufacturer's instructions, using procedures and application methods recommended as producing the best results.
- 3.03.B. Apply at rate recommended by manufacturer, continuously over entire surface.
- 3.03.C. Apply two coats, minimum.
- 3.03.D. Remove water repellent from unintended surfaces immediately by a method instructed by water repellent manufacturer.
- 3.03.E. Provide manufacturer's field service representative to inspect preparation and application work continuously during entire application period to ensure that manufacturer's "best practices" for preparation and application are being followed.

END OF SECTION 07 1900

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SECTION 07 2100
THERMAL INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Board insulation at perimeter foundation wall, underside of floor slabs, and exterior wall.
- 1.01.B. Batt insulation and vapor retarder in exterior wall, ceiling, and roof construction.
- 1.01.C. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior wall and roof.
- 1.01.D. Board insulation at exterior walls.

1.02 RELATED REQUIREMENTS

- 1.02.A. Section 07 5300 - Elastomeric Membrane Roofing: Installation requirements for board insulation over low slope roof deck.

1.03 REFERENCE STANDARDS

- 1.03.A. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2023.
- 1.03.B. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2023.
- 1.03.C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- 1.03.D. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C; 2024.

1.04 SUBMITTALS

- 1.04.A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- 1.04.B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.

1.05 FIELD CONDITIONS

- 1.05.A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

PART 2 PRODUCTS

2.01 APPLICATIONS

- 2.01.A. Insulation Under Concrete Slabs: Extruded polystyrene (XPS) board.
- 2.01.B. Insulation at Perimeter of Foundation: Extruded polystyrene (XPS) board.
- 2.01.C. Insulation Over Metal Stud Framed Walls, Continuous: Extruded polystyrene (XPS) board.
- 2.01.D. Insulation in Metal Framed Walls: Batt insulation with separate vapor retarder.
- 2.01.E. Insulation behind metal panel system: polyisocyanurate insulated bonded to fire treated plywood.

2.02 FOAM BOARD INSULATION MATERIALS

- 2.02.A. Extruded Polystyrene (XPS) Board Insulation: Comply with ASTM C578 with either natural skin or cut cell surfaces.
 - 1. Type and Compressive Resistance: Type XII, 15 psi (104 kPa), minimum.
 - 2. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
 - 3. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
 - 4. Type and Thermal Resistance, R-value (RSI-value): Type IV, 5.0 (0.88), minimum, per 1 inch (25.4 mm) thickness at 75 degrees F (24 degrees C) mean temperature.
 - 5. Products:
 - a. DuPont de Nemours, Inc; Styrofoam Brand
UtilityFit: building.dupont.com/#sle.
 - b. Styrofoam Cavitymate Ultra System
 - c. Owens Corning Corporation

2.03 MINERAL FIBER BLANKET INSULATION MATERIALS

- 2.03.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: 50 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. Thermal Resistance: R-value (RSI-value) as indicated on the drawings.
5. Thickness: As indicated on the drawings.
6. Facing: Unfaced.
7. Products:
 - a. CertainTeed Corporation: www.certainteed.com/#sle.
 - b. Johns Manville: www.jm.com/#sle.
 - c. Owens Corning Corporation; EcoTouch PINK FIBERGLAS Insulation: www.ocbuildingspec.com/#sle.

2.04 RIGID INSULATION PANEL

- 2.04.A. Energy efficient rigid insulation panel. Comply with ASTM C 1289 Type V made with Type II Class 2 foam.
1. Compressive Strength: ASTM 1621, 20 PSI.
 2. Flame Spread: ASTM 84 < 75.
 3. Smoke Developed: ASTM 84 < 450.
 4. Products:
 - a. Xci Ply – Hunter.
 - b. Approved equal.

2.05 ACCESSORIES

- 2.05.A. Sheet Vapor Retarder: Black polyethylene film for above grade application, 10 mil, 0.010 inch (0.25 mm) thick.
- 2.05.B. Tape: Reinforced polyethylene film with acrylic pressure sensitive adhesive.
1. Application: Sealing of interior circular penetrations, such as pipes or cables.
 2. Width: Are required for application.
- 2.05.C. Adhesive: Type recommended by insulation manufacturer for application.
- 2.05.D. Roof Ventilation Baffles: Prefabricated ventilation channels for placement under roof sheathing with baffles to prevent wind-washing.
1. Material: Polyvinyl Chloride (PVC)
 2. Roof Joist/Truss Spacing: 16 inch (406 mm) on center nominal.
 3. Manufacturers:
 - a. Brentwood Industries, Inc.; AccuVent Original.

PART 3 EXECUTION

3.01 EXAMINATION

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

- 3.01.B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.02 BOARD INSTALLATION AT FOUNDATION PERIMETER

- 3.02.A. Install boards horizontally on foundation perimeter.
 - 1. Place boards to maximize adhesive contact.
 - 2. Butt edges and ends tightly to adjacent boards and to protrusions.
- 3.02.B. Extend boards over expansion joints, unbonded to foundation on one side of joint.
- 3.02.C. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.03 BOARD INSTALLATION AT EXTERIOR WALLS

- 3.03.A. Adhere 6 inches (152 mm) wide strip of polyethylene sheet over expansion joints with double beads of adhesive each side of joint.
 - 1. Tape seal joints between sheets.
 - 2. Extend sheet full height of joint.
- 3.03.B. Apply adhesive to back of boards:
 - 1. Three continuous beads per board length.
 - 2. Full bed 1/8 inch (3.2 mm) thick.
- 3.03.C. Install boards horizontally on walls.
 - 1. Place boards to maximize adhesive contact.
 - 2. Butt edges and ends tightly to adjacent boards and protrusions.
- 3.03.D. Extend boards over expansion joints, unbonded to wall on one side of joint.
- 3.03.E. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.
- 3.03.F. Tape insulation board joints.

3.04 BOARD INSTALLATION UNDER CONCRETE SLABS

- 3.04.A. Place insulation under slabs on grade after base for slab has been compacted.
- 3.04.B. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.
- 3.04.C. Prevent insulation from being displaced or damaged while placing vapor retarder and placing slab.

3.05 BATT INSTALLATION

- 3.05.A. Install insulation and vapor retarder in accordance with manufacturer's instructions.

- 3.05.B. Install in exterior wall and roof spaces without gaps or voids. Do not compress insulation.
- 3.05.C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- 3.05.D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.
- 3.05.E. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically.
- 3.05.F. At wood framing, place vapor retarder on warm side of insulation by stapling at 6 inches (152 mm) on center. Lap and seal sheet retarder joints over face of member.
- 3.05.G. At metal framing, place vapor retarder on warm side of insulation; lap and seal sheet retarder joints over face of member
- 3.05.H. Tape seal tears or cuts in vapor retarder.
- 3.05.I. Extend vapor retarder tightly to full perimeter of adjacent window and door frames and other items interrupting the plane of the membrane; tape seal in place.
- 3.05.J. Place insulation against baffles, and do not impede natural attic ventilation to soffit.

3.06 PROTECTION

- 3.06.A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION 07 2100

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SECTION 07 4113.16
STANDING-SEAM METAL ROOF PANELS

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 standing-seam metal roof panels.
- B. Related Sections:
 - 1. Section 07 4213.53 "Metal Soffit Panels" for metal panels used in horizontal soffit applications.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Shop Drawings:
 - 1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
 - 2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches (1:10).
- C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
 - 1. Metal Panels: 12 inches (305 mm) long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- C. Field quality-control reports.
- D. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panels to include in maintenance manuals.

1.6 QUALITY ASSURANCE

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

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal panels during installation.

1.8 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
- B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.
 - 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.
- C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.
 - 1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E 283 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa).
- B. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 1646 or ASTM E 331 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).
- C. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E 2140.

- D. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
 - 1. Uplift Rating: UL 90.
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 CURVED STANDING-SEAM METAL ROOF PANELS

- A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
 - 1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.
- B. Curved Vertical-Rib, Snap-Lock, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and snapping panels together.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 - a. Nominal Thickness: 0.028 inch (0.71 mm).
 - b. Exterior Finish: Three-coat fluoropolymer.
 - c. Color: White.
 - 3. Clips: One-piece fixed to accommodate thermal movement.
 - a. Material: 0.028-inch-(0.71-mm)-0.064-inch-(1.63-mm-)nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
 - 4. Panel Coverage: 18 inches (457 mm).

5. Panel Height: 1.50 inches.
6. Basis-of-Design Product: Subject to compliance with requirements, provide Dimensional Metals, Inc. – Curved Double-Lock CR-DL20 and Curved Snap-On-Seam CR-SS10 Color: White or comparable product by the following:
 - a. Peterson Aluminum Corporation
 - b. Berridge Mfg. Company

2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils (0.76 mm) thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
 1. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D 1970.
 2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.

2.4 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C 645; cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fascia, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
 1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-(25-mm-)thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

- D. Panel Fasteners: Self-tapping screws designed to withstand design loads.
- E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 - 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
 - 2. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.

2.5 FABRICATION

- A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
 - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 - 2. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 3. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
 - 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 - 5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.6 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. 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.
- C. Steel Panels and Accessories:
 - 1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
 - 1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
 - 2. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.
 - a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.3 UNDERLAYMENT INSTALLATION

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated on Drawings, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (152 mm) staggered 24 inches (610 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.
 - 1. Apply over the entire roof surface.
 - a. Valleys, from lowest point to highest point, for a distance on each side of 18 inches (460 mm). Overlap ends of sheets not less than 6 inches (152 mm).
- B. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 07 6200 "Sheet Metal Flashing and Trim."

3.4 METAL PANEL INSTALLATION

- A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 1. Shim or otherwise plumb substrates receiving metal panels.
 - 2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
 - 3. Install screw fasteners in predrilled holes.
 - 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 5. Install flashing and trim as metal panel work proceeds.
 - 6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 - 7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
 - 8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners:

1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
- C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.
- D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
 1. Install clips to supports with self-tapping fasteners.
 2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
 3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
 4. Watertight Installation:
 - a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
 - b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
 - c. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.
- F. Clipless Metal Panel Installation: Fasten metal panels to supports with screw fasteners at each lapped joint at location and spacing recommended by manufacturer.
- G. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
 1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.
- H. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
 1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems.

Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.

2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).
- I. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.5 ERECTION TOLERANCES

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

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.
- B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.
- C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- D. Prepare test and inspection reports.

3.7 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain a clean condition during construction.
- B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 4113.16

SECTION 07 4213.13
METAL WALL PANELS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Concealed fastener metal wall panels as part of the assembly described in Section 2.1.

1.2 RELATED REQUIREMENTS

- A. Division 07 Section "Sheet Metal Flashing and Trim" for sheet metal copings, flashings, reglets and roof drainage items.
- B. Division 07 Section "Joint Sealants" for field-applied joint sealants.
- C. Division 07 Section "Air Barriers" for transition and flashing components of air/moisture barrier.
- D. American Architectural Manufacturer's Association (AAMA):
 - 1. AAMA 620 - Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Aluminum Substrates.
 - 2. AAMA 621 - Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates.
- E. American Society of Civil Engineers (ASCE):
 - 1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
- F. ASTM International (ASTM):
 - 1. ASTM A 653/A 653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 2. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 - 3. ASTM A 755/A 755M - Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.
 - 4. ASTM A 792/A 792 M - Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
 - 5. ASTM B 209 - Specification for Aluminum and Aluminum Alloy Sheet and Plate.
 - 6. ASTM C 754 - Specification for Installation of Steel Framing Members to Receive Screw Attached Gypsum Panel Products.
 - 7. ASTM C 920 - Specification for Elastomeric Joint Sealants.
 - 8. ASTM C 1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.

9. ASTM E 72 - Standard Test Methods of Conducting Strength Tests of Panels for Building Construction.
10. ASTM E 283 - Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen.
11. ASTM E 331 - Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

G. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA):

1. Architectural Sheet Metal Manual.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Provide metal wall panel assemblies meeting performance requirements as determined by application of specified tests by a qualified testing agency on manufacturer's standard assemblies.

1.4 QUALITY ASSURANCE

- A. Manufacturer/Source: Provide metal wall panel and panel accessories from a single manufacturer.

- B. Manufacturer Qualifications: Approved manufacturer listed in this Section with minimum 10 years' experience in manufacture of similar products in successful use in similar applications.

1. Approval of Comparable Products: Submit the following in accordance with project substitution requirements, within time allowed for substitution review:

- a. Product data, including certified independent test data indicating compliance with requirements.
- b. Load span tables including evaluation of panel clip and panel side joint interaction.
- c. Samples of each component.
- d. Project references: Minimum of 5 installations not less than 5 years old, with Owner and Architect contact information.
- e. Sample warranty.

2. Substitutions following award of contract are not allowed except as stipulated in Division 01 General Requirements.

3. Approved manufacturers must meet separate requirements of Submittals Article.

- C. Wall Systems Installer Qualifications: Experienced Installer with minimum of 5 years experience with successfully completed projects of a similar nature and scope.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Conduct preinstallation meeting at site attended by Owner, Architect, manufacturer's representative, and other trade contractors.
 - 1. Coordinate building framing in relation to metal wall panel assembly.
 - 2. Coordinate installation of building air and water barrier behind metal wall panel assembly.
 - 3. Coordinate window, door and louver, and other openings and penetrations of metal wall panel assembly.

1.6 ACTION SUBMITTALS

- A. Product Data: Manufacturer's data sheets, for specified products.
 - 1. Include data indicating compliance with performance requirements.
- B. Shop Drawings: Provide shop drawings prepared by manufacturer or manufacturer's authorized Installer. Include full elevations showing openings and penetrations. Include details of each condition of installation and attachment. Provide details at a minimum scale of 1-1/2-inch per foot (1:8) of all required trim and extrusions needed for a complete installation.
 - 1. Indicate points of supporting structure that must coordinate with metal wall panel assembly installation.
 - 2. Indicate details of fastening, including clip spacing, supported by load span tables that include an evaluation of clip and panel side joint interaction.
- C. Samples for Initial Selection: For each product specified. Provide representative color charts of manufacturer's full range of colors.
- D. Samples for Verification: Provide 12-inch (300 mm) section of panel(s) showing finishes. Provide 12-inch (300 mm) long pieces of trim pieces and other exposed components.

1.7 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Indicating compliance of products with requirements, from a qualified independent testing agency.
- B. Qualification Information: For Installer firm.
- C. Manufacturer's warranty: Submit sample warranty.

1.8 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect metal wall panel products during shipping, handling, and storage to prevent staining, denting, deterioration of components or other damage.
 - 1. Deliver, unload, store, and erect metal wall panel products and accessory items without misshaping panels or exposing panels to surface damage from weather or construction operations.

1.10 WARRANTY

- A. Special Manufacturer's Warranty: On manufacturer's standard form, in which manufacturer agrees to repair or replace components of metal wall panel assemblies that fail in materials and workmanship within two years from date of Substantial Completion.
- B. Special Panel Finish Warranty: On manufacturer's standard form, in which manufacturer agrees to repair or replace metal wall panels that display evidence of deterioration of finish within 10 years from the date of substantial completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Metal Wall Panels over Multi-Component Framed Wall System: Single-skin concealed fastener metal wall panels applied as exterior rainscreen cladding over wall framing specified in Division 05 Section "Cold-Formed Metal Framing" with exterior sheathing specified in Division 06 Section "Sheathing", an applied membrane that provides air, moisture, and water vapor control specified in Division 07 Section "Air Barriers", and insulation within the framing specified in Division 07 Section "Thermal Insulation". Metal wall panel installation specified in this Section may include secondary metal subgirt framing and mounting clips for panel attachment.
 - 1. Air, moisture, and water vapor control membrane is provided under Division 07 Section "Air Barriers."

2.2 MANUFACTURERS

- A. Basis of Design: CENTRIA, Concept Series Metal Wall Panels. Provide basis of design product, or comparable product approved by Architect 30 days prior to bid.
 - 1. CENTRIA Architectural Systems; Moon Township, PA 15108-2944. Tel: (800)759-7474. Tel: (412)299-8000. Fax: (412)299-8317. Email: info@CENTRIA.com. Web: www.CENTRIA.com.

Michael Rathburn, CENTRIA Architectural Systems; Tel: (614)767-9663. Email: mstrathburn@CENTRIA.com.
 - 2. Approved equal.

2.3 PANEL MATERIALS

- A. Metallic-Coated Steel Face Sheet: Coil-coated, ASTM A 755/A 755M.
 - 1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Class Z275), structural steel.
 - 2. Aluminum-zinc alloy-coated (Galvalume) Steel Sheet: ASTM A 792/A 792M, Class AZ50 Grade 50 (Class AZM150, Grade 275), structural steel quality.
 - 3. Face Sheet: Minimum 0.030 inch/22 gage (0.76 mm) nominal uncoated thickness.
 - 4. Surface: Smooth.

2.4 CONCEALED FASTENER METAL WALL PANELS

- A. Metal Wall Panels, General: Factory-formed, concealed fastener panels with interconnecting side joints, fastened to supports with concealed fasteners, with factory-applied sealant in side laps when required to meet performance requirements.
- B. Reveal-joint profile with raised flat pan:
 - 1. Basis of Design Product: CENTRIA, CS-200.
 - 2. Panel Coverage: 12 inches (305 mm).
 - 3. Panel Height: 0.875 inch (22 mm).
- C. Triple-reveal profile with raised flat pan and two ribs:
 - 1. Basis of Design Product: CENTRIA, CS-612.
 - 2. Panel Coverage: 16 inches (406 mm).
 - 3. Panel Height: 0.875 inch (22 mm).
- D. Exposed Coil-Coated Finish System:
 - 1. Fluoropolymer Two-Coat System: 0.2 mil primer with 0.8 mil 70 percent PVDF fluoropolymer color coat, AAMA 620.
 - a. Basis of Design: CENTRIA Fluorofinish.
- E. Color:
 - 1. Exterior Surface: #9946, Silversmith, as selected by Architect from manufacturer's color options.
 - 2. Interior Surface: Manufacturer's standard primer color.

2.5 METAL WALL PANEL ACCESSORIES

- A. Metal Wall Panel Accessories, General: Provide complete metal wall panel assembly incorporating trim, copings, fasciae, parapet caps, soffits, sills, inside and outside corners, and miscellaneous flashings. Provide manufacturer's factory-formed clips, shims, flashings,

lap tapes, and closure strips for a complete installation. Fabricate and install accessories in accordance with SMACNA Manual.

- B. Mitered Corners: Structurally-bonded horizontal interior and exterior trimless corners matching metal wall panel material, profile, and factory-applied finish, fabricated and finished by metal wall panel manufacturer.
 - 1. Welded, riveted, fastened, or field-fabricated corners do not meet the requirements of this specification.
 - 2. Basis of Design: CENTRIA, MicroSeam Corners.
- C. Formed Flashing and Trim: Match material, thickness, and color of metal wall panel face sheets.
- D. Sealants: Type recommended by metal wall panel manufacturer for application, meeting requirements of Division 07 Section "Joint Sealants."
- E. Flashing Tape: 4-inch wide self-adhering butyl flashing tape.
- F. Fasteners, General: Self-tapping screws, bolts, nuts, and other acceptable fasteners recommended by panel manufacturer. Where exposed fasteners cannot be avoided for miscellaneous applications, supply corrosion-resistant fasteners with heads matching color of metal wall panels by means factory-applied coating.
- G. Concealed Clips: Galvanized steel, 0.06 inch/16 ga. (1.52 mm) nominal thickness, designed to allow unimpeded thermal movement of panel and configured to hold panel minimum 1/2 inch (12.7 mm) from substrate.

2.6 SECONDARY METAL SUBGIRT FRAMING

- A. Miscellaneous Framing Components, General: Cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z180).
 - 1. Hat Channels: 0.06 inch/16 ga. (1.52 mm) minimum – nominal thickness.
 - 2. Sill Channels: 0.06 inch/16 ga. (1.52 mm) minimum – nominal thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine metal wall panel substrate with Installer present. Inspect for erection tolerances and other conditions that would adversely affect installation of metal wall panels.
- B. Wall Substrate: Confirm that wall substrate is within tolerances acceptable to metal wall panel system manufacturer.
 - 1. Maximum deviations acceptable:

- a. 1/4-inch in 20 feet (6.4 mm in 6 m) vertically or horizontally from face plane of framing.
 - b. 1/2-inch (12.7 mm) across building elevation.
 - c. 1/8-inch in 5 feet (3.2 mm in 1.5 m).
- C. Framing: Inspect framing that will support metal wall panels to determine if support components are installed as indicated on approved shop drawings. Confirm presence of acceptable framing members at recommended spacing to match installation requirements of metal wall panels.
- D. Advise G.C., in writing, of out-of-tolerance work and other deficient conditions prior to proceeding with metal wall panel system installation.
- E. Correct out of tolerance work and other deficient conditions prior to proceeding with insulated composite backup panel installation.

3.2 SECONDARY FRAMING INSTALLATION

- A. Secondary Metal Framing: Install secondary metal framing components to tolerances indicated, as shown on approved shop drawings. Install secondary metal framing and other metal panel supports per ASTM C 1007 and metal wall panel manufacturer's recommendations.

3.3 METAL WALL PANEL INSTALLATION

- A. General: Install metal wall panels in accordance with approved shop drawings and manufacturer's recommendations. Install metal wall panels in orientation, sizes, and locations indicated. Anchor metal wall panels and other components securely in place. Provide for thermal and structural movement
- B. Joint Sealers: Install joint sealants where indicated on approved shop drawings.

3.4 ACCESSORY INSTALLATION

- A. General: Install metal wall panel accessories with positive anchorage to building and provide for thermal expansion. Coordinate installation with flashings and other components.
1. Install related flashings and sheet metal trim per requirements of Division 07 Section "Sheet Metal Flashing and Trim."
 2. Install components required for a complete metal wall panel assembly, including trim, copings, corners, lap strips, flashings, sealants, fillers, closure strips, and similar items.
 3. Comply with performance requirements and manufacturer's written installation instructions.
 4. Provide concealed fasteners except where noted on approved shop drawings.
 5. Set units true to line and level as indicated.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a service representative authorized by metal wall panel manufacturer to inspect completed installation. Submit written report.
- B. Correct deficiencies noted in manufacturer's report.

3.6 CLEANING AND PROTECTION

- A. Remove temporary protective films. Clean finished surfaces as recommended by metal wall panel manufacturer. Clear weep holes and drainage channels of obstructions, dirt, and sealant. Maintain in a clean condition during construction.
- B. Replace damaged panels and accessories that cannot be repaired by finish touch-up or minor repair.

END OF SECTION 07 4213.13

SECTION 07 4213.53
METAL SOFFIT PANELS (LINEAR PANELS)

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 metal soffit panels.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
- B. Shop Drawings:
 - 1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Shop drawings to be prepared by the manufacturer.
 - 2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.
- C. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.
 - 1. Include similar Samples of trim and accessories involving color selection.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each product, tests performed by a qualified testing agency that meets or exceeds minimum standards.
- C. Field quality-control reports.

- D. Sample Warranties: For special warranties.
- E. Manufacturer weekly inspection report.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panels to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Material Manufacturer will provide minimum two days a week job inspections during installation and weekly progress reports.
- B. Manufacturer must have minimum 20 years of experience in metal roofing.
- C. All roofing, wall panels and soffits are to be from one manufacturer with one system warranty.
- D. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer with no less than 10 years experience with the roofing system specified and no less than 5 roofs of similar scope.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal panels during installation.

1.8 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

- A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of walls, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, cracking, or puncturing.
 - b. Deterioration of metals and other materials beyond normal weathering.
 - 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592.
- B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E 283 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 6.24 lbf/sq. ft.
- C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 331 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 6.24 lbf/sq. ft.

- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METAL SOFFIT PANELS

- A. General: Provide metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.

- B. Flush-Profile Metal Soffit Panels: Unperforated linear panels.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong Metalworks.
 - b. Approved equal.
2. Material: 0.028" electrogalvanized steel.
3. Panel Coverage: As shown on Drawings, 4" panels.
4. Panel Height: 5/8".
5. Color: Effects Oak.

2.3 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C 645, cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 coating designation or ASTM A 792/A 792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

- E. Panel Sealants: Provide sealant types recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 - 1. Joint Sealant: ASTM C 920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.

2.4 FABRICATION

- A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

2.5 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal panel manufacturer.
2. Examine sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal panel manufacturer.
 - a. Verify that air- or water-resistive barriers been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.
 1. Soffit Framing: Wire tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

3.3 METAL PANEL INSTALLATION

- A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
- B. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- C. Watertight Installation
- D. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
 1. Install components required for a complete metal panel system including trim, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.

- E. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

3.4 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 4213.53

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SECTION 07 4243
COMPOSITE WALL PANELS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Wall panel assembly consisting of:
 - a. Metal Composite Material (MCM)
 - b. Installation System
 - c. Accessories
 - 2. The extent of the wall panel assembly as indicated in these specifications and in the drawings.

- B. Related Sections:
 - 1. Section 05 10 00 - Structural Metal Framing
 - 2. Section 06 10 00 - Rough Carpentry
 - 3. Section 07 20 00 - Thermal Protection
 - 4. Section 07 60 00 - Flashing And Sheet Metal
 - 5. Section 07 90 00 - Joint Protection

1.2 REFERENCES

- A. American Society For Testing And Materials (ASTM)
 - 1. ASTM B117 Standard Practice For Operating Salt Spray (Fog) Apparatus
 - 2. ASTM B137 Standard Test Method For Measurement Of Coating Mass Per Unit Area On Anodically Coated Aluminum
 - 3. ASTM B211 Standard Specification For Aluminum And Aluminum-Alloy Rolled Or Cold Finished Bar, Rod, And Wire
 - 4. ASTM B680 Standard Test Method For Seal Quality Of Anodic Coatings On Aluminum By Acid Dissolution
 - 5. ASTM C267 Standard Test Methods For Chemical Resistance Of Mortars, Grouts, And Monolithic Surfacing And Polymer Concretes
 - 6. ASTM C297 Standard Test Method For Flatwise Tensile Strength Of Sandwich Construction
 - 7. ASTM C1371 Standard Test Method For Determination Of Emittance Of Materials Near Room Temperature Using Portable Emisometers
 - 8. ASTM D523 Standard Test Method For Specular Gloss
 - 9. ASTM D635 Standard Test Method For Rate Of Burning And/Or Extent And Time Of Burning Of Plastics In A Horizontal Position
 - 10. ASTM D714 Standard Test Method For Evaluating Degree Of Blistering Of Paints
 - 11. ASTM D968 Standard Test Methods For Abrasion Resistance Of Organic Coatings By Falling Abrasive
 - 12. ASTM D1308 Standard Test Method For Effect Of Household Chemicals On Clear And Pigmented Organic Finishes

13. ASTM D1781 Standard Test Method For Climbing Drum Peel For Adhesives
 14. ASTM D1929 Standard Test Method For Determining Ignition Temperature Of Plastics
 15. ASTM D2244 Standard Practice For Calculation Of Color Tolerances And Color Differences From Instrumentally Measured Color Coordinates
 16. ASTM D2247 Standard Practice For Testing Water Resistance Of Coatings In 100% Relative Humidity
 17. ASTM D2248 Standard Practice For Detergent Resistance Of Organic Finishes
 18. ASTM D2794 Standard Test Method For Resistance Of Organic Coatings To The Effects Of Rapid Deformation (Impact)
 19. ASTM D3359 Standard Test Methods For Measuring Adhesion By Tape Test
 20. ASTM D3363 Standard Test Method For Film Hardness By Pencil Test
 21. ASTM D4145 Standard Test Method For Coating Flexibility Of Prepainted Sheet
 22. ASTM D4214 Standard Test Methods For Evaluating The Degree Of Chalking Of Exterior Paint Films
 23. ASTM D5420 Standard Test Method For Impact Resistance Of Flat, Rigid Plastic Specimen By Means Of A Striker Impacted By A Falling Weight (Gardner Impact)
 24. ASTM E84 Standard Test Method For Surface Burning Characteristics Of Building Materials
 25. ASTM E283 Standard Test Method For Determining Rate Of Air Leakage Through Exterior Windows, Curtain Walls, And Doors Under Specified Pressure Differences Across The Specimen
 26. ASTM E330 Standard Test Method For Structural Performance Of Exterior Windows, Doors, Skylights And Curtain Walls By Uniform Static Air Pressure Difference
 27. ASTM E331 Standard Test Method For Water Penetration Of Exterior Windows, Skylights, Doors, And Curtain Walls By Uniform Static Air Pressure Difference
 28. ASTM E903 Standard Test Method For Solar Absorptance, Reflectance And Transmittance Of Materials Using Integrated Spheres
- B. American Architectural Manufacturers Association (AAMA)
1. AAMA 2605 Voluntary Specification, Performance Requirements And Test Procedures For Superior Performing Organic Coatings On Aluminum Extrusions And Panels

1.3 DEFINITIONS

- A. Metal Composite Material (MCM):
A factory manufactured panel consisting of metal skins bonded to a plastic core, as defined by the International Building Code (IBC) Section 1402.
- B. Leadership In Energy And Environmental Design (LEED):
A set of guidelines set forth by the United States Green Building Council (USGBC) to promote the building of environmentally responsible and sustainable structures.

- C. ISO 9001:2008
A set of guidelines set forth by the International Organization For Standardization (ISO) to provide guidance and tools for companies and organizations who want to ensure that their products and services consistently meet customer's requirements, and that quality is consistently improved.

1.4 SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. Barrier System:
Wall panel assembly shall be designed in accordance with manufacturer's guidelines to be sealed at all panel joints, intersections, dissimilar material abutments, and cutouts, thus providing a weathertight barrier system.
 - 2. Expansion And Contraction:
Wall panel assembly shall be designed with provisions for thermal expansion and contraction of the component parts to prevent buckling, failure of joint seals, undue stress on fasteners or other detrimental effects due to accumulation of dead loads and various live loads.
 - 3. Windload:
Wall panel assembly shall be designed to withstand a positive and negative windload pressure acting inward and outward normal to the plane of the wall to meet the requirements of the latest adopted Local Building Code.
- B. General Performance:
Wall panel assembly shall comply with performance requirements, as determined by the following testing performed by a qualified agency.

1.5 SUBMITTALS

- A. Product Data:
 - 1. Submit manufacturer's datasheet for specified product.
 - 2. Submit manufacturer's installation guidelines for specified product.
 - 3. Submit manufacturer's literature indicating pre-consumer and post-consumer percentages of recycled content in the context of LEED MR Credit 4.1 and/or MR Credit 4.2.
 - 4. Submit manufacturer's literature indicating compliance with the American Recovery & Reinvestment Act (ARRA), Section 1605.
- B. Shop Drawings:
Submit shop drawings indicating project layout and elevations, fastening and anchoring methods, dimensions of individual components and profiles, detail and location of joints, sealants and gaskets, flashing and accessories.
- C. Samples:
 - 1. Submit two (2) samples 3" x 5" of each product specified.
 - 2. Submit two (2) samples 3" x 5" of each finish specified.

- D. Test Reports:
Submit test reports indicating compliance of products with specified performance requirements from an independent testing agency.
- E. Warranty:
Submit manufacturer's warranty meeting the requirements of this section.

1.6 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer:
Manufacturer shall have a minimum of ten (10) years' experience in the manufacture of this product, shall be an ISO 9001:2008 Registered Company, and shall be located within the United States of America.
 - 2. Installer:
Installer shall be experienced in performing work of this section and in work of similar scope required by this project.
- B. Pre-Installation Meeting:
Conduct pre-installation meeting to verify project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Acceptance At Site:
Materials to be packaged to protect against transportation damage. Examine materials upon receipt to ensure that no damage has occurred during shipment.
- B. Storage And Protection:
 - 1. Storage:
Materials should be stored horizontally on pallets or platforms, covered with a suitable ventilated and weathertight covering. Do not store materials where accumulation of moisture may occur or in contact with materials that might cause staining, denting, or other damage.
 - 2. Material Handling:
Use care in unloading, storing, and erecting the materials to prevent bending, warping, and twisting. Protect finish and edges from damage. The protective film on the panel surface is to remain in place until installation and shall be removed immediately upon completion.

1.8 PROJECT CONDITIONS

- A. Field Measurements:
Verify location and dimension of all elements related to the installation of the wall panel assembly. Indicate those measurements on the shop drawings.
- B. Limitations:

Proceed with installation of the wall panel assembly only when existing site conditions comply with manufacturer's recommendations.

1.9 WARRANTY

A. Metal Composite Material (MCM):

1. Panel:

The integrity of the panel bond will remain intact for a minimum of ten (10) years from the Date Of Substantial Completion.

2. Finish:

a. Polyvinylidene Fluoride (PVDF):

- 1) The finish will not have a Fade Differential of greater than 5E units. Testing shall be in accordance with ASTM D2244.
- 2) The finish will not have a Chalk Rating of less than 8. Testing shall be in accordance with ASTM D4214.
- 3) The finish will not check, peel, lose adhesion or fracture (other than minute fractures which may develop due to fabrication and which are acceptable by industry standards on the Date Of Substantial Completion).
- 4) Warranty period shall be thirty (30) years from the Date Of Substantial Completion.

B. Installation System:

1. Fabricator and/or installer standard form in which they agree to repair or replace components of metal-faced composite wall panel assemblies that fail in materials or workmanship within specified warranty period.
2. Weathertight warranties or other such guarantees regarding installation shall be the responsibility of the installing contractor.

C. Accessories:

Warranties or other such guarantees regarding accessories used during installation shall be the responsibility of the installing contractor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design:

Citadel Architectural Products; Local Rep: Spohn Associates, Andy Muhlada (P) 513-321-8200; amuhlada@spohnassociates.com

B. Substitutions:

1. Not permitted without approval of the architect 10 days prior to bid.
2. Items being submitted for consideration must be of the same function and meet the performance requirements set forth in this section.

- C. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.
 - 1. Product Data:
Submit product data including testing performed by a qualified agency indicating compliance with performance requirements specified in this section.
 - 2. Samples:
Submit two (2) samples 3" x 5" of each proposed product substitution.

2.2 WALL PANEL ASSEMBLY

- A. Metal Composite Material (MCM):
 - 1. Panel:
Envelope 2000[®] as manufactured by Citadel Architectural Products
 - a. Composition:
Face: .024" (min) prefinished smooth aluminum
Core: .105" thermoset phenolic resin
Back: .010" primed smooth aluminum
 - b. Thickness: 4mm (nominal)
 - c. Weight: 1.25 lbs/ft²
 - d. Tolerance:
Thickness: $\pm 1/32$ "
Length / Width: +0, -1/8"
Squareness: 1/64" per lineal ft
 - e. Performance:
 - 1) Surface Burning Characteristics:
Panel shall have a Class A rating with a Flame Spread Index less than 25, and a Smoke Developed Index less than 450.
Testing shall be in accordance with ASTM E84.
 - 2) Bond Integrity:
Panel shall have a minimum peel strength of 34.5 lb-in/lb.
Testing shall be in accordance with ASTM D1781.
 - 3) Ignition Temperature:
Panel shall have a minimum self-ignition temperature of 900° F.
Testing shall be in accordance with ASTM D1929.
 - 4) Impact Resistance:
Panel shall not have a deformation measuring larger than 0.186" in diameter or 0.007" in depth after being struck by a falling ball at 24 in-lb.
Testing shall be in accordance with ASTM D5420.
 - 5) Rate Of Burning:
Panel shall have a CC1 Classification indicating a burning extent of 1" (25.4mm) or less when tested at a nominal thickness of .060" (1.5mm) or thickness of intended use.
Testing shall be in accordance with ASTM D635.
 - 6) Tensile Strength:
Panel shall have a mean value of 1650 lbs.

Testing shall be in accordance with ASTM C297.

2. Finish:
 - a. Polyvinylidene Fluoride (PVDF):
 - 1) Type:
Kynar 500[®] coating using 70% resin.
Finish shall be in conformance with AAMA 2605.
 - 2) Color:
 - a) As selected by Architect; 'Arctic White' from manufacturer's color guide.
 - 3) Composition:
 - a) Two-Coat Colors:
0.2-mil primer coat, 0.8-mil color coat
- B. Installation System:
 1. Reveal (RV) System:
 - a. Description:
Field-assembled installation system consisting of metal composite material (MCM), trim moldings, silicone sealant, and accessories to provide a barrier system.
 - b. Performance:
 - 1) Air Infiltration:
Installation system shall not allow air infiltration in excess of 0.06 cfm/ft² at 1.57 psf.
Testing shall be in accordance with ASTM E283.
 - 2) Structural Performance:
Installation system shall have a design load of 35.0 psf applied in the positive and negative direction. There shall be no deflection in excess of L/175 of the span of any support member nor shall there be any failure of the system. At a structural test load equal to 1.5 times the specified design load, no support member shall have permanent deformation in excess of 1/1000 of its span nor shall there be any failure of the system.
Testing shall be in accordance with ASTM E330.
 - 3) Water Penetration:
Installation system shall not have uncontrolled water penetration to the room side at a static air pressure differential of 15.0 psf.
Testing shall be in accordance with ASTM E331.
 - c. Trim Moldings:
 - 1) Manufacturer's RV2000 system standard moldings.
- C. Accessories:
 1. Extrusions:
 - a. Shall conform with ASTM B211 and the manufacturer's recommendations.
 - b. Shall be applied in accordance with the panel manufacturer's installation guidelines.
 2. Sealants:

- a. Selected from the panel manufacturer's approved list of sealants.
- b. Shall be applied in accordance with both the panel manufacturer's installation guidelines and the sealant manufacturer's recommendations.
3. Fasteners:
 - a. Selected by contractor to suit project requirements.
 - b. Shall be applied using the recommended fastener schedule in accordance with panel manufacturer's installation guidelines.
 - c. Shall be coated to prevent corrosion and/or reaction with other materials.
 - d. Shall be concealed except where unavoidable. Exposed fasteners shall be finished to match adjoining metal.
4. Flashing:
 - a. Selected by contractor to suit project requirements.
 - b. Shall be installed in such a manner to maintain the integrity of the wall system against moisture intrusion.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrate to receive the work of this section to verify that the conditions are acceptable for installation.
 1. Substrate to receive panels shall be even, smooth, sound, clean, dry, and free from defects detrimental to work. Notify contractor in writing of conditions detrimental to proper and timely completion of the work.
 2. Substrate to receive panels shall be in vertical and horizontal alignment with no more deviation than 1/4" in 20'.
- B. Proceed with installation only after all unsatisfactory conditions have been corrected in a manner acceptable to installer. Starting work within a particular area will be construed as installer's acceptance of surface conditions.

3.2 PREPARATION

- A. Verify dimensions as required.
- B. Protect adjacent work areas and finished surfaces to prevent damage that otherwise might occur during the work of this section.

3.3 INSTALLATION

- A. Wall panel assembly shall be installed in accordance with the manufacturer's written installation guidelines and the approved set of shop drawings.
- B. Erect wall panel assembly level and true to the intended plane.
- C. Maximum deviation from vertical and horizontal alignment of erected wall panel assembly

shall be no more than 1/4" in 20'-0".

- D. Maximum deviation in panel flatness shall be 0.6% of the assembled units.
- E. Seal all joints as required using methods and materials as recommended by the panel manufacturer.

3.4 CLEANING

- A. Remove panel masking immediately after installation. Delay will result in difficulty with removal and possibly residue on the panel surface.
- B. Remove temporary coverings and protection to adjacent work areas.
- C. Remove and legally dispose of construction debris from project site.

END OF SECTION 07 4243

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SECTION 07 5423
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. Walkways.

B. Section includes installation of sound-absorbing insulation strips in ribs of roof deck. Sound-absorbing insulation strips are furnished under Section 05 3100 "Steel Decking."

C. Related Requirements:

1. Section 06 1000 "Rough Carpentry" for wood nailers, curbs, and blocking; and for wood-based, structural-use roof deck panels.
2. Section 07 2100 "Thermal Insulation" for insulation beneath the roof deck.
3. Section 07 6200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
4. Section 07 9200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

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. Walkways.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer Certificates:

B. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

B. Certified statement from existing roof membrane manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by 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.
- 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. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC POLYOLEFIN (TPO) ROOFING SYSTEM

- A. TPO Sheet: ASTM D6878/D6878M, scrim-reinforced, TPO sheet.
 - 1. Thickness: 60 mils (1.5 mm), nominal.
 - 2. Exposed Face Color: White.
- B. Manufacturers:
 - 1. Elevate Ultraply TPO
 - 2. Carlisle Companies
 - 3. GAF Materials Corporation

2.2 ACCESSORY ROOFING MATERIALS

- A. General: Accessory materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.
- B. Sheet Flashing: Manufacturer's standard unreinforced TPO sheet flashing, 55 mils (1.4 mm) thick, minimum, of same color as TPO sheet.
- C. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
- D. Bonding Adhesive: Manufacturer's standard.
- E. 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.

2.3 ROOF INSULATION

- A. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, felt or glass-fiber mat facer on both major surfaces.
 - 1. Compressive Strength: 20 psi (138 kPa).
 - 2. Size: 48 by 96 inches (1219 by 2438 mm).
 - 3. Thickness:
 - a. Base Layer: 1-1/2 inches (38 mm).
 - b. Upper Layer: Tapered.
- B. Tapered Insulation: Provide factory-tapered insulation boards.
 - 1. Material: Match roof insulation.
 - 2. Minimum Thickness: 1/4 inch (6.35 mm).
 - 3. Slope:
 - a. Roof Field: 1/4 inch per foot (1:48) unless otherwise indicated on Drawings.

2.4 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.

2.5 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway rolls, approximately 3/16 inch (5 mm) thick and acceptable to roofing system manufacturer.
 - 1. Size: Approximately 36 by 60 inches (914 by 1524 mm).

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.

3.2 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.

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.

3.4 INSTALLATION OF INSULATION

- A. Comply with roofing system and roof insulation manufacturer's written instructions for installing roof insulation.
 - 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 (305 mm) from previous layer of insulation.

3.5 INSTALLATION OF MECHANICALLY FASTENED ROOF MEMBRANE

- A. Mechanically fasten roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.

3.6 INSTALLATION OF INDUCTION-WELDED ROOF MEMBRANE

- A. Unroll roof membrane and allow to relax before installing.
- B. Accurately align roof membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer, with side laps shingled with slope of roof deck where possible.
- C. 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.

3.7 INSTALLATION OF BASE FLASHING

- A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to roofing system manufacturer's written instructions.

3.8 INSTALLATION OF WALKWAYS

- A. Flexible Walkways:
 - 1. Install flexible walkways at the following locations:
 - a. Locations indicated on Drawings.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will 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.

3.10 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.

3.11 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: 2 years.

- 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.

END OF SECTION 07 5423

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SECTION 07 6200
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Fabricated sheet metal items, including flashings, counterflashings, gutters, downspouts, exterior penetrations, and other items indicated in Schedule.
- 1.01.B. Sealants for joints within sheet metal fabrications.

1.02 REFERENCE STANDARDS

- 1.02.A. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- 1.02.B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- 1.02.C. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- 1.02.D. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
- 1.02.E. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement, Asbestos-Free; 2007 (Reapproved 2018).
- 1.02.F. CDA A4050 - Copper in Architecture - Handbook; current edition.
- 1.02.G. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

1.03 SUBMITTALS

- 1.03.A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- 1.03.B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
- 1.03.C. Samples: Submit two samples, 6 by 6 inches (152 by 152 mm) in size, illustrating metal finish color.

1.04 QUALITY ASSURANCE

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

1.05 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 SHEET MATERIALS

- 2.01.A. Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24-gauge, 0.0239-inch (0.61 mm) thick base metal.
- 2.01.B. Pre-Finished Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24-gauge, 0.0239-inch (0.61 mm) thick base metal, shop pre-coated with PVDF coating.
 - 1. Fluoropolymer Coating: High performance organic powder coating, AAMA 2604; multiple coat, thermally cured fluoropolymer finish system.
 - 2. Color: As selected by Architect from manufacturer's standard colors.
- 2.01.C. Anodized Aluminum: ASTM B209/B209M, 3005 alloy, H12 or H14 temper; 20-gauge, 0.032 inch (0.81 mm) thick; clear anodized finish.
- 2.01.D. Pre-Finished Aluminum: ASTM B209/B209M, 3005 alloy, H12 or H14 temper; 18-gauge, 0.040 inch (1.02 mm) 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 selected by Architect from manufacturer's standard colors.

2.02 FABRICATION

- 2.02.A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- 2.02.B. Form pieces in longest possible lengths.
- 2.02.C. Hem exposed edges on underside 1/2 inch (13 mm); miter and seam corners.
- 2.02.D. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
- 2.02.E. Fabricate corners from one piece with minimum 18-inch (450 mm) long legs; seam for rigidity, seal with sealant.
- 2.02.F. Fabricate flashings to allow toe to extend 2 inches (50 mm) over roofing gravel. Return and brake edges.

2.03 GUTTER AND DOWNSPOUTS (OUTLET TUBES)

- 2.03.A. Gutter: SMACNA (ASMM) Built-in gutter.
- 2.03.B. Downspouts: Gutter drain with outlet tube.
- 2.03.C. Gutter and Downspouts: Size indicated.
- 2.03.D. Accessories: Profiled to suit gutters and downspouts.
 - 1. Anchorage Devices: In accordance with SMACNA (ASMM) requirements.
 - 2. Gutter Supports: Framed sheathing.
 - 3. Gutter Liner: 60 mil reinforced TPO membrane.

2.04 Flashing

- 2.04.A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.

2.05 ACCESSORIES

- 2.05.A. Fasteners: Same material and finish as flashing metal, with soft neoprene washers.
- 2.05.B. Primer Type: Zinc chromate.
- 2.05.C. Concealed Sealants: Non-curing butyl sealant.
- 2.05.D. Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.
- 2.05.E. Asphalt Roof Cement: ASTM D4586/D4586M, Type I, asbestos-free.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

- 3.02.A. Install starter and edge strips, and cleats before starting installation.
- 3.02.B. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil, 0.015 inch (0.38 mm).

3.03 INSTALLATION

- 3.03.A. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted.
- 3.03.B. Apply plastic cement compound between metal flashings and felt flashings.
- 3.03.C. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.

3.04 SCHEDULE

- 3.04.A. Through-Wall Flashing in Masonry: Refer to Section 04 2613 Masonry Veneer
- 3.04.B. Gutter and Downspouts: Pre-finished aluminum, TPO membrane.
- 3.04.C. Coping, Cap, Parapet, Sill and Ledge Flashings: Pre-finished aluminum.
- 3.04.D. Flashings Associated with Shingle Roofing, including Valley, Hip, Ridge, Eave, Gutter Edge, Gable Edge, Chimney: Refer to Section 07 3113 Asphalt Shingles.
- 3.04.E. Counterflashings at Roofing Terminations (over roofing base flashings): Formed aluminum.
- 3.04.F. Roofing Penetration Flashings, for Pipes, Structural Steel, and Equipment Supports: Formed aluminum.

END OF SECTION 07 6200

SECTION 07 8400
FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Firestopping systems.
- 1.01.B. Firestopping of joints and penetrations in fire-resistance-rated and smoke-resistant assemblies, whether indicated on drawings or not, and other openings indicated.

1.02 RELATED REQUIREMENTS

- 1.02.A. Section 09 2116 - Gypsum Board Assemblies: Gypsum wallboard fireproofing.

1.03 REFERENCE STANDARDS

- 1.03.A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2022.
- 1.03.B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2023a.
- 1.03.C. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems; 2015 (Reapproved 2019).
- 1.03.D. ASTM E2174 - Standard Practice for On-Site Inspection of Installed Firestop Systems; 2020a.
- 1.03.E. ASTM E2393 - Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers; 2020a.
- 1.03.F. ASTM E2307 - Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus; 2023b.
- 1.03.G. ASTM E2837 - Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed between Rated Wall Assemblies and Nonrated Horizontal Assemblies; 2023a.
- 1.03.H. ITS (DIR) - Directory of Listed Products; Current Edition.
- 1.03.I. FM (AG) - FM Approval Guide; Current Edition.
- 1.03.J. UL 1479 - Standard for Fire Tests of Penetration Firestops; Current Edition, Including All Revisions.

1.03.K. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems; Current Edition, Including All Revisions.

1.03.L. UL (FRD) - Fire Resistance Directory; Current Edition.

1.04 SUBMITTALS

1.04.A. See Section 01 3000 - Administrative Requirements for submittal procedures.

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

1.04.C. Product Data: Provide data on product characteristics, performance ratings, and limitations.

1.04.D. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.

1.04.E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.04.F. Installer's qualification statement.

1.05 QUALITY ASSURANCE

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

1. Listing in UL (FRD), FM (AG), or ITS (DIR) will be considered as constituting an acceptable test report.

1.05.B. Installer Qualifications: Company specializing in performing the work of this section and:

1. Verification of minimum three years documented experience installing work of this type.

1.06 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

2.01.A. Firestopping Manufacturers:

1. 3M Fire Protection Products: www.3m.com/firestop/#sle.

2. Hilti, Inc: www.hilti.com/#sle.
3. Specified Technologies Inc: www.stifirestop.com/#sle.

2.02 MATERIALS

- 2.02.A. Firestopping Materials: Any materials meeting requirements.
- 2.02.B. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.
- 2.02.C. Fire Ratings: Refer to drawings for required systems and ratings.

2.03 FIRESTOPPING ASSEMBLY REQUIREMENTS

- 2.03.A. Perimeter Fire Containment Firestopping: Use system that has been tested according to ASTM E2307 to have fire resistance F Rating equal to required fire rating of floor assembly.
- 2.03.B. Head-of-Wall (HW) Joint System Firestopping at Joints Between Fire-Rated Wall Assemblies and Non-Rated Horizontal Assemblies: Use system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of wall assembly.
- 2.03.C. Floor-to-Floor (FF), Floor-to-Wall (FW), Head-of-Wall (HW), and Wall-to-Wall (WW) Joints, Except Perimeter, Where Both Are Fire-Rated: Use system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.
- 2.03.D. Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.

2.04 FIRESTOPPING SYSTEMS

- 2.04.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

3.01 EXAMINATION

- 3.01.A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

- 3.02.A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.
- 3.02.B. Remove incompatible materials that could adversely affect bond.

3.03 INSTALLATION

- 3.03.A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- 3.03.B. Do not cover installed firestopping until inspected by authorities having jurisdiction.
- 3.03.C. Install labeling required by code.

3.04 FIELD QUALITY CONTROL

- 3.04.A. Independent Testing Agency: Inspection agency employed and paid by Owner, will examine penetration firestopping in accordance with ASTM E2174 and ASTM E2393.
- 3.04.B. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

3.05 CLEANING

- 3.05.A. Clean adjacent surfaces of firestopping materials.

3.06 PROTECTION

- 3.06.A. Protect adjacent surfaces from damage by material installation.

END OF SECTION 07 8400

SECTION 07 9200
JOINT SEALANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Nonsag gunnable joint sealants.
- 1.01.B. Joint backings and accessories.

1.02 RELATED REQUIREMENTS

- 1.02.A. Section 09 2116 - Gypsum Board Assemblies: Sealing acoustical and sound-rated walls and ceilings.
- 1.02.B. Section 09 3000 - Tiling: Sealant between tile and plumbing fixtures and at junctions with other materials and changes in plane.

1.03 REFERENCE STANDARDS

- 1.03.A. ASTM C834 - Standard Specification for Latex Sealants; 2017 (Reapproved 2023).
- 1.03.B. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications; 2022.
- 1.03.C. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
- 1.03.D. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016 (Reapproved 2023).
- 1.03.E. SCAQMD 1168 - Adhesive and Sealant Applications; 1989, with Amendment (2022).

1.04 SUBMITTALS

- 1.04.A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- 1.04.B. Product Data: Submit manufacturer's technical datasheets for each product to be used; include the following:
 - 1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
 - 2. List of backing materials approved for use with the specific product.
 - 3. Backing material recommended by sealant manufacturer.
 - 4. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
 - 5. Substrates the product should not be used on.

- 1.04.C. Product Data for Accessory Products: Submit manufacturer's technical data sheet for each product to be used, including physical characteristics, installation instructions, and recommended tools.
- 1.04.D. Color Cards for Selection: Where sealant color is not specified, submit manufacturer's color cards showing standard colors available for selection.

PART 2 PRODUCTS

2.01 JOINT SEALANT APPLICATIONS

- 2.01.A. Scope:
 - 1. Exterior Joints:
 - a. Seal the following joints:
 - 1) Wall expansion and control joints.
 - 2) Joints between doors, windows, and other frames or adjacent construction.
 - 3) Joints between different exposed materials.
 - 2. Interior Joints:
 - a. Seal the following joints:
 - 1) Joints between door frames and window frames and adjacent construction.
 - 2) In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, and piping penetrations.
 - 3) In sound-rated wall and ceiling assemblies, seal joints between wall assemblies and ceiling assemblies; between wall assemblies and other construction; between ceiling assemblies and other construction.
 - 3. Do Not Seal:
 - a. Intentional weep holes in masonry.
 - b. Joints indicated to be covered with expansion joint cover assemblies.
 - c. Joints where sealant installation is specified in other sections.
 - d. Joints between suspended ceilings and walls.

2.02 JOINT SEALANTS - GENERAL

- 2.02.A. Sealants and Primers: Provide products having lower volatile organic compound (VOC) content than indicated in SCAQMD 1168.
- 2.02.B. Colors: As selected by Architect.

2.03 NONSAG JOINT SEALANTS

- 2.03.A. Nonstaining Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
 - 1. Movement Capability: Plus and minus 50 percent, minimum.

2. Color: To be selected by Architect from manufacturer's standard range.
3. Products:
 - a. Pecora Corporation: www.pecora.com/#sle.
 - b. Sika Corporation: www.usa.sika.com/#sle.
 - c. Tremco Commercial Sealants & Waterproofing; Spectrem 2 (Basis-of-Design): www.tremcosealants.com/#sle.

2.03.B. Mildew-Resistant Silicone Sealant: ASTM C920, Grade NS, Uses M and A; single component, mildew resistant; not expected to withstand continuous water immersion or traffic.

1. Color: White.
2. Products:
 - a. Pecora Corporation: www.pecora.com/#sle.
 - b. Sika Corporation: www.usa.sika.com/#sle.

2.03.C. Hybrid Silane Polyether Sealant: ASTM C920, Grade NS, Uses NT, M, G, A, and O; single component; not expected to withstand continuous water immersion.

1. Movement Capability: Plus and minus 35 percent.
2. Color: To be selected by Architect from manufacturer's standard range.
3. Products:
 - a. Tremco Incorporated, Dynamic FC, (Basis of Design).
 - b. Master Builders Solutions.

2.03.D. Acrylic Emulsion Latex: Water-based; ASTM C834, single component, nonstaining, nonbleeding, nonsagging; not intended for exterior use.

1. Color: To be selected by Architect from manufacturer's standard range.
2. Grade: ASTM C834; Grade 0 Degrees F (Minus 18 Degrees C).
3. Products:
 - a. Pecora Corporation: www.pecora.com/#sle.
 - b. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
 - c. Tremco Commercial Sealants & Waterproofing; Tremflex 834: (Basis-of-Design) www.tremcosealants.com/#sle.

2.04 ACCESSORIES

2.04.A. Sealant Backing Materials, General: Materials placed in joint before applying sealants; assists sealant performance and service life by developing optimum sealant profile and preventing three-sided adhesion; type and size recommended by sealant manufacturer for compatibility with sealant, substrate, and application.

2.04.B. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.

2.04.C. Joint Cleaner: Noncorrosive and nonstaining type, type recommended by sealant manufacturer; compatible with joint forming materials.

2.04.D. Primers: Type recommended by sealant manufacturer to suit application; nonstaining.

PART 3 EXECUTION

3.01 EXAMINATION

- 3.01.A. Verify that joints are ready to receive work.
- 3.01.B. Verify that backing materials are compatible with sealants.
- 3.01.C. Verify that backer rods are of the correct size.

3.02 PREPARATION

- 3.02.A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- 3.02.B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.
- 3.02.C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
- 3.02.D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.
- 3.02.E. Concrete Floor Joints That Will Be Exposed in Completed Work: Test joint filler in an inconspicuous area to verify that it does not stain or discolor slab.

3.03 INSTALLATION

- 3.03.A. Install this work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- 3.03.B. Provide joint sealant installations complying with ASTM C1193.
- 3.03.C. Install acoustical sealant application work in accordance with ASTM C919.
- 3.03.D. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer, except where specific dimensions are indicated.
- 3.03.E. Install bond breaker backing tape where backer rod cannot be used.
- 3.03.F. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
- 3.03.G. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.

- 3.03.H. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

END OF SECTION 07 9200

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SECTION 08 1113
HOLLOW METAL DOORS AND FRAMES

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. Standard and custom hollow metal doors and frames.
2. Steel sidelight, borrowed lite and transom frames.
3. Light frames and glazing installed in hollow metal doors.

B. Related Sections:

1. Division 01 Section "General Conditions".
2. Division 04 Section "Unit Masonry" for embedding anchors for hollow metal work into masonry construction.
3. Division 08 Section "Flush Wood Doors".
4. Division 08 Section "Glazing" for glass view panels in hollow metal doors.
5. Division 08 Section "Door Hardware".
6. Division 09 Sections "Exterior Painting" and "Interior Painting" for field painting hollow metal doors and frames.
7. Division 28 Section "Access Control" for access control devices installed at door openings and provided as part of a security access control system.

C. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI/SDI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.
2. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frames Anchors and Hardware Reinforcing.
3. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
4. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
5. ANSI/SDI A250.11 - Recommended Erection Instructions for Steel Frames.
6. ASTM A1008 - Standard Specification for Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

7. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
8. ASTM A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
9. ASTM C 1363 - Standard Test Method for Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.
10. ANSI/BHMA A156.115 - Hardware Preparation in Steel Doors and Frames.
11. ANSI/SDI 122 - Installation and Troubleshooting Guide for Standard Steel Doors and Frames.
12. ANSI/NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association.
13. ANSI/NFPA 105: Standard for the Installation of Smoke Door Assemblies.
14. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association.
15. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
16. UL 1784 - Standard for Air Leakage Tests of Door Assemblies.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, hardware reinforcements, profiles, anchors, fire-resistance rating, and finishes.
- B. Maintenance manual must be provided for tornado/hurricane storm shelter impact protective systems.
- C. Door hardware supplier is to furnish templates, template reference number and/or physical hardware to the steel door and frame supplier in order to prepare the doors and frames to receive the finish hardware items.
- D. Shop Drawings: Include the following:
 1. Elevations of each door design.
 2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 4. Locations of reinforcement and preparations for hardware.
 5. Details of anchorages, joints, field splices, and connections.
 6. Details of accessories.
 7. Details of moldings, removable stops, and glazing.
 8. Details of conduit and preparations for power, signal, and control systems.
- E. Samples for Verification:
 1. Samples are only required by request of the architect and for manufacturers that are not current members of the Steel Door Institute.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain hollow metal doors and frames through one source from a single manufacturer wherever possible.
- B. Quality Standard: In addition to requirements specified, furnish SDI-Certified manufacturer products that comply with ANSI/SDI A250.8, latest edition, "Recommended Specifications for Standard Steel Doors and Frames".
- C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to UL10C (neutral pressure at 40" above sill) or UL 10C.
 - 1. Oversize Fire-Rated Door Assemblies Construction: For units exceeding sizes of tested assemblies, attach construction label certifying doors are built to standard construction requirements for tested and labeled fire rated door assemblies except for size.
 - 2. Temperature-Rise Limit: Where indicated and at vertical exit enclosures (stairwell openings) and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
 - 3. Smoke Control Door Assemblies: Comply with NFPA 105.
 - a. Smoke "S" Label: Doors to bear "S" label, and include smoke and draft control gasketing applied to frame and on meeting stiles of pair doors.
- D. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257. Provide labeled glazing material.
- E. Storm Shelter Openings: Provide complete door systems for hurricane or tornado storm shelters, and other areas of refuge, complying and tested according to ICC 500 (2014/2020), ICC/NSSA Standard for the Design and Construction of Storm Shelters.
 - 1. Each unit to bear third party permanent label indicating compliance with the referenced testing standards.
- F. Pre-Submittal Conference: Conduct conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and procedures for installing hollow metal doors and frames and to verify installation of electrical knockout boxes and conduit at frames with electrified or access control hardware.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project site storage. Do not use non-vented plastic.

- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch high wood blocking. Do not store in a manner that traps excess humidity.
 - 1. Provide minimum 1/4-inch space between each stacked door to permit air circulation. Door and frames to be stacked in a vertical upright position.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.7 COORDINATION

- A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Building Information Modeling (BIM) Support: Utilize designated BIM software tools and obtain training needed to successfully participate in the Project BIM processes. All technical disciplines are responsible for the product data integration and data reliability of their Work into the coordinated BIM applications.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
- B. Warranty includes installation and finishing that may be required due to repair or replacement of defective doors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide steel doors and frames from a SDI Certified manufacturer:
 - 1. CECO Door Products (C).
 - 2. Curries Company (CU).

2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
- C. Frame Anchors: ASTM A 653/A 653M, Commercial Steel (CS), Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

2.3 HOLLOW METAL DOORS

- A. General: Provide 1-3/4 inch doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8 and ANSI/NAAMM HMMA 867.
- B. Exterior Doors (Energy Efficient): Face sheets fabricated of commercial quality hot-dipped zinc coated steel that complies with ASTM A924 A60. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model, ANSI/SDI A250.4 for physical performance level, and HMMA 867 for door construction.
 - 1. Design: Flush panel.
 - 2. Core Construction: Foamed in place polyurethane and steel stiffened laminated core with no stiffener face welds, in compliance with HMMA 867 "Laminated Core".
 - a. Provide 22-gauge steel stiffeners at 6 inches on-center internally welded at 5" on-center to integral core assembly, foamed in place polyurethane core chemically bonded to all interior surfaces. No stiffener face welding is permitted.
 - b. Thermal properties to rate at a fully operable minimum U-Factor 0.37 and R-Value 2.7, including insulated door, thermal-break frame and threshold.
 - c. Kerf Type Frames: Thermal properties to rate at a fully operable minimum U-Factor 0.38 and R-Value 2.6, including insulated door, kerf type frame, and threshold.
 - 3. Level/Model: Level 3 and Physical Performance Level A (Extra Heavy Duty), Minimum 16 gauge (0.053 inch - 1.3-mm) thick steel, Model 2.
 - 4. Vertical Edges: Vertical edges to be mechanically interlocked with hairline seam. Beveled Lock Edge, 1/8 inch in 2 inches (3 mm in 50 mm).
 - 5. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet. Doors with an inverted top channel to include a steel closure channel, screw attached, with the web of the channel flush with the face sheets of the door. Plastic or composite channel fillers are not acceptable.
 - 6. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9".
 - 7. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

- C. Interior Doors: Face sheets fabricated of commercial quality cold rolled steel that complies with ASTM A 1008/A 1008M. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
1. Design: Flush panel.
 2. Core Construction: Manufacturer's standard kraft-paper honeycomb, or one-piece polystyrene core, securely bonded to both faces.
 - a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
 3. Level/Model: Level 2 and Physical Performance Level B (Heavy Duty), Minimum 18 gauge (0.042-inch - 1.0-mm) thick steel, Model 2.
 4. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet.
 5. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9" or minimum 14 gauge continuous channel with pierced holes, drilled and tapped.
 6. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.
- D. Manufacturers Basis of Design:
1. Curries Company (CU) - Honeycomb Core - 707 Series.
 2. Curries Company (CU) - Energy Efficient - 777 Trio-E Series.

2.4 HOLLOW METAL DOOR FOR STORM SHELTERS

- A. General: Provide complete tornado or hurricane storm shelter resistant assemblies constructed, test, and listed/labeled to resist the design pressures for components and cladding and missile impact resistance as described in ICC 500 (2014/2020), ICC/NSSA Standard for the Design and Construction of Storm Shelters.
1. Door, tested and complying with ICC 500 (2014/2020) and FEMA P-361 (2015/2021), Design and Construction Guidance for Community Safe Rooms and supported by third party test results.
 2. Sheets fabricated on exterior openings from commercial quality hot dipped zinc coated steel complying with ASTM A924 A60. Gauges to be in accordance with manufacturers tested assemblies.
 3. Vertical Edges: Vertical edges to have the face sheets joined by a continuous weld extending the full height of the door. Welds are to be ground, filled and dressed smooth. Beveled Lock Edge, 1/8 inch in 2 inches (3 mm in 50 mm).
 4. Top Edge: Reinforce top of doors with a continuous steel channel extending the full width of the door and welded to the face sheet. Doors with an inverted top channel to include a steel closure channel, screw attached and welded in place with the web

of the channel flush with the face sheets of the door. Plastic or composite channel fillers are not acceptable.

5. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9".

B. Manufacturers Basis of Design:

1. CECO Door Products (C) - StormPro Series.
2. Curries Company (CU) - StormPro Series.

2.5 HOLLOW METAL FRAMES

A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.

B. Thermal Break Frames: Subject to the same compliance standards and requirements as standard hollow metal frames. Tested for thermal performance in accordance with NFRC 102, and resistance to air infiltration in accordance with NFRC 400. Where indicated provide thermally broken frame profiles available for use in both masonry and drywall construction. Fabricate with 1/16" positive thermal break and integral vinyl weatherstripping.

C. Exterior Frames: Fabricated of hot-dipped zinc coated steel that complies with ASTM A 653/A 653M, Coating Designation A60.

1. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
2. Frames: Minimum 14 gauge (0.067-inch -1.7-mm) thick steel sheet.
3. Manufacturers Basis of Design:

- a. Curries Company (CU) - Mercury 3 Thermal Break TQ Series.

D. Interior Frames: Fabricated from cold-rolled steel sheet that complies with ASTM A 1008/A 1008M.

1. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
2. Frames: Minimum 16 gauge (0.053-inch -1.3-mm) thick steel sheet.
3. Manufacturers Basis of Design:

- a. Curries Company (CU) - M Series.

E. Fire rated frames: Fabricate frames in accordance with NFPA 80, listed and labeled by a qualified testing agency, for fire-protection ratings indicated.

F. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 Table 4 with reinforcement plates from same material as frames.

2.6 FRAMES FOR SEVERE STORM SHELTERS

- A. General: Subject to the same compliance standards and requirements as standard hollow metal frames, provide complete tornado or hurricane resistant door and frame assemblies, for both single doors and paired openings, tested and labeled as complying with ICC 500-2014 supported by third party test results.
 - 1. Fabricate exterior frames from 14-gauge hot dipped zinc coated steel that comply with ASTM designations A924 A60.
 - 2. Manufacturers Basis-of-Design:
 - a. Curries Company (CU) – StormPro Series.

2.7 FRAME ANCHORS

- A. Jamb Anchors:
 - 1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, formed from A60 metallic coated material, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
 - 2. Stud Wall Type: Designed to engage stud and not less than 0.042 inch thick.
 - 3. Compression Type for Drywall Slip-on (Knock-Down) Frames: Adjustable compression anchors.
- B. Floor Anchors: Floor anchors to be provided at each jamb, formed from A60 metallic coated material, not less than 0.042 inches thick.
- C. Mortar Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.8 LOUVERS

- A. Metal Louvers: Unless otherwise indicated provide louvers to meet the following requirements.
 - 1. Blade Type: Vision proof inverted V or inverted Y.
 - 2. Metal and Finish: Galvanized steel, 0.040 inch thick, factory primed for paint finish with baked enamel or powder coated finish. Match pre-finished door paint color where applicable.
- B. Louvers for Fire Rated Doors: Metal louvers with fusible link and closing device, listed and labeled for use in doors with fire protection rating of 1-1/2 hours and less.
 - 1. Manufacturers: Subject to compliance with requirements, provide louvers to meet rating indicated.

2. Metal and Finish: Galvanized steel, 0.040 inch thick, factory primed for paint finish with baked enamel or powder coated finish. Match pre-finished door paint color where applicable.

2.9 LIGHT OPENINGS AND GLAZING

- A. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints at fabricator's shop. Fixed and removable stops to allow multiple glazed lites each to be removed independently. Coordinate frame rabbet widths between fixed and removable stops with the type of glazing and installation indicated.
- B. Moldings for Glazed Lites in Doors and Loose Stops for Glazed Lites in Frames: Minimum 20 gauge thick, fabricated from same material as door face sheet in which they are installed.
- C. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated. Provide fixed frame moldings and stops on outside of exterior and on secure side of interior doors and frames.
- D. Preformed Metal Frames for Light Openings: Manufacturer's standard frame formed of 0.048-inch-thick, cold rolled steel sheet; with baked enamel or powder coated finish; and approved for use in doors of fire protection rating indicated. Match pre-finished door paint color where applicable.

2.10 ACCESSORIES

- A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
- B. Grout Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.11 FABRICATION

- A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. When shipping limitations so dictate, frames for large openings are to be fabricated in sections for splicing or splining in the field by others.
- B. Tolerances: Fabricate hollow metal work to tolerances indicated in ANSI/SDI A250.8.
- C. Hollow Metal Doors:
 1. Exterior Doors: Provide optional weep-hole openings in bottom of exterior doors to permit moisture to escape where specified.

2. Glazed Lites: Factory cut openings in doors with applied trim or kits to fit. Factory install glazing where indicated.
3. Astragals: Provide overlapping astragals as noted in door hardware sets in Division 08 Section "Door Hardware" on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.

D. Hollow Metal Frames:

1. Shipping Limitations: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
2. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
 - a. Welded frames are to be provided with two steel spreaders temporarily attached to the bottom of both jambs to serve as a brace during shipping and handling. Spreader bars are for bracing only and are not to be used to size the frame opening.
3. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
4. High Frequency Hinge Reinforcement: Provide high frequency hinge reinforcements at door openings 48-inches and wider with mortise butt type hinges at top hinge locations.
5. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated for removable stops, provide security screws at exterior locations.
6. Mortar Guards: Provide guard boxes at back of hardware mortises in frames at all hinges and strike preps regardless of grouting requirements.
7. Electrical Knock Out Boxes: Factory weld 18 gauge electrical knock out boxes to frame for electrical hardware preps; including but not limited to, electric through wire transfer hardware, electrical raceways and wiring harnesses, door position switches, electric strikes, magnetic locks, and jamb mounted card readers as specified in hardware sets in Division 08 Sections "Door Hardware" and "Access Control Hardware".
 - a. Provide electrical knock out boxes with a dual 1/2-inch and 3/4-inch knockouts.
 - b. Conduit to be coordinated and installed in the field (Division 26) from middle hinge box and strike box to door position box.
 - c. Electrical knock out boxes to comply with NFPA requirements and fit electrical door hardware as specified in hardware sets in Division 08 Section "Door Hardware".
 - d. Electrical knock out boxes for continuous hinges should be located in the center of the vertical dimension on the hinge jamb.

8. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
 9. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches on-center and as follows:
 - 1) Two anchors per jamb up to 60 inches high.
 - 2) Three anchors per jamb from 60 to 90 inches high.
 - 3) Four anchors per jamb from 90 to 120 inches high.
 - 4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
 - b. Stud Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Three anchors per jamb up to 60 inches high.
 - 2) Four anchors per jamb from 60 to 90 inches high.
 - 3) Five anchors per jamb from 90 to 96 inches high.
 - 4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
 - 5) Two anchors per head for frames above 42 inches wide and mounted in metal stud partitions.
 10. Door Silencers: Except on weatherstripped or gasketed doors, drill stops to receive door silencers. Silencers to be supplied by frame manufacturer regardless if specified in Division 08 Section "Door Hardware".
 11. Bituminous Coating: Where frames are fully grouted with an approved Portland Cement based grout or mortar, coat inside of frame throat with a water based bituminous or asphaltic emulsion coating to a minimum thickness of 3 mils DFT, tested in accordance with UL 10C and applied to the frame under a 3rd party independent follow-up service procedure.
- E. Hardware Preparation: Factory prepare hollow metal work to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
 2. Reinforce doors and frames to receive non-template, mortised and surface mounted door hardware.
 3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
 4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

2.12 STEEL FINISHES

- A. Prime Finishes: Doors and frames to be cleaned, and chemically treated to insure maximum finish paint adhesion. Surfaces of the door and frame exposed to view to receive a factory applied coat of rust inhibiting shop primer.
 - 1. Shop Primer: Manufacturer's standard, fast-curing, lead and chromate free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; and compatible with substrate and field-applied coatings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. General Contractor to verify the accuracy of dimensions given to the steel door and frame manufacturer for existing openings or existing frames (strike height, hinge spacing, hinge back set, etc.).
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove welded in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Prior to installation, adjust and securely brace welded hollow metal frames for square, level, twist, and plumb condition.
- C. Tolerances shall comply with SDI-117 "Manufacturing Tolerances Standard Steel Doors and Frames."
- D. Drill and tap doors and frames to receive non-template, mortised, and surface-mounted door hardware.
- E. Verify tolerances against manufacturers installations instructions for tornado and hurricane storm shelter openings.

3.3 INSTALLATION

- A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

- B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11 and NFPA 80 at fire rated openings.
 - 1. Set frames accurately in position, plumbed, leveled, aligned, and braced securely until permanent anchors are set. After wall construction is complete and frames properly set and secured, remove temporary braces, leaving surfaces smooth and undamaged. Shim as necessary to comply with installation tolerances.
 - 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.
 - 3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar.
 - 4. Grout Requirements: Do not grout head of frames unless reinforcing has been installed in head of frame. Do not grout vertical or horizontal closed mullion members.

- C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
 - 1. Non-Fire-Rated Standard Steel Doors:
 - a. Jamb and Head: 1/8 inch plus or minus 1/16 inch.
 - b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
 - c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
 - d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.

 - 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

- D. Field Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.

3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

- B. Remove grout and other bonding material from hollow metal work immediately after installation.

- C. Prime-Coat and Painted Finish Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat, or painted finishes, and apply touchup of compatible air drying, rust-inhibitive primer, zinc rich primer (exterior and galvanized openings) or finish paint.

3.5 FIELD QUALITY CONTROL

- A. Field Inspection (Punch Report): Reference Division 01 Sections “Closeout Procedures”. Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
 - 1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

END OF SECTION 08 1113

SECTION 08 1416
FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Five-ply flush wood veneer-faced doors for transparent finish.
2. Factory finishing flush wood doors.
3. Factory fitting flush wood doors to frames and factory machining for hardware.

B. Related Requirements:

1. Section 08 1113 "Hollow Metal Doors and Frames" for wood doors in metal frames.
2. Section 08 7100 "Door Hardware" for door hardware for flush wood doors.
3. Section 08 8000 "Glazing" for glass view panels in flush wood doors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, profiles, fire-resistance ratings, and finishes.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:

1. Door schedule indicating door location, type, size, fire protection rating, and swing.
2. Door elevations, dimension and locations of hardware, lite and louver cutouts, and glazing thicknesses.
3. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
4. Dimensions and locations of blocking for hardware attachment.
5. Dimensions and locations of mortises and holes for hardware.
6. Clearances and undercuts.
7. Requirements for veneer matching.
8. Doors to be factory finished and application requirements.

C. Samples for Verification:

1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish.

1.3 CLOSEOUT SUBMITTALS

A. Special warranties.

1.4 QUALITY ASSURANCE

- A. Fire-Rated Door Inspector Qualifications: Inspector for field quality-control inspections of fire-rated door assemblies complies with qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:

1. DHI's Fire and Egress Door Assembly Inspector (FDAI) certification.

- B. Egress Door Inspector Qualifications: Inspector for field quality-control inspections of egress door assemblies complies with qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:

1. DHI's Fire and Egress Door Assembly Inspector (FDAI) certification.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in cardboard cartons and wrap bundles of doors in plastic sheeting.
- C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.6 FIELD CONDITIONS

- A. Environmental Limitations:

1. Do not deliver or install doors until building is enclosed and weathertight, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during remainder of construction period.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

- a. Delamination of veneer.
- b. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
- c. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.

2. Warranty also includes installation and finishing that may be required due to repair or replacement of defective doors.

3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain flush wood doors from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Wood Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated on Drawings, based on testing at positive pressure in accordance with UL 10C, or NFPA 252.

2.3 FLUSH WOOD DOORS, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with AWI/AWMAC/WT's "Architectural Woodwork Standards."
 - 1. Provide labels from AWI certification program indicating that doors comply with requirements of grades specified.

2.4 SOLID-CORE FIVE-PLY FLUSH WOOD VENEER-FACED DOORS FOR TRANSPARENT FINISH

- A. Interior Doors, Solid-Core Five-Ply Veneer-Faced Insert drawing designation:
 - 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. Oshkosh Door Company (Basis-of-Design)
 - b. Masonite Architectural - Aspiro
 - c. VT Industries, Inc.
 - 2. Performance Grade: ANSI/WDMA I.S. 1A Extra Heavy Duty.
 - 3. Architectural Woodwork Standards Grade: Premium.
 - 4. Faces: Single-plywood veneer not less than 1/50 inch thick.
 - a. Species: Red Oak.
 - b. Cut: Plain sliced.
 - c. Finish: Ginger – 1530.
 - d. Match between Veneer Leaves: Book match.
 - e. Assembly of Veneer Leaves on Door Faces: Running match.
 - 5. Exposed Vertical Edges: Same species as faces - Architectural Woodwork Standards edge Type A.

- a. Fire-Rated Single Doors: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed vertical edges.
 - b. Mineral-Core Doors: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
6. Core for Non-Fire-Rated Doors:
- a. ANSI A208.1, Grade LD-2 particleboard.
 - 1) Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.
 - a) 5-inch top-rail blocking, in doors indicated to have closers.
 - b) 5-inch bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
 - 2) Provide doors with glued-wood-stave, or WDMA I.S. 10 structural-composite-lumber cores instead of particleboard cores for doors scheduled to receive exit devices in Section 087100 "Door Hardware."
7. Core for Fire-Rated Doors: As required to achieve fire-protection rating indicated on Drawings.
- a. Blocking for Mineral-Core Doors: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated on Drawings as needed to eliminate through-bolting hardware.
8. Construction: Five plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.

2.5 LIGHT FRAMES AND LOUVERS

- A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.
1. Wood Species: Same species as door faces.
 2. Profile: Manufacturer's standard shape.

2.6 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated.
1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 2. Comply with NFPA 80 requirements for fire-rated doors.

- B. Factory machine doors for hardware that is not surface applied.
 - 1. Locate hardware to comply with DHI-WDHS-3.
 - 2. Comply with final hardware schedules, door frame Shop Drawings, ANSI/BHMA-156.115-W, and hardware templates.
 - 3. Coordinate with hardware mortises in metal frames, to verify dimensions and alignment before factory machining.
 - 4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.

- C. Openings: Factory cut and trim openings through doors.
 - 1. Light Openings: Trim openings with moldings of material and profile indicated.
 - 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 08 8000 "Glazing."

2.7 FACTORY FINISHING

- A. Comply with referenced quality standard for factory finishing.
 - 1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
 - 2. Finish faces, all four edges, edges of cutouts, and mortises.
 - 3. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.

- B. Factory finish doors.

- C. Transparent Finish:
 - 1. Architectural Woodwork Standards Grade: Premium.
 - 2. Architectural Woodwork Standards System-5, Varnish, Conversion.
 - 3. Staining: As selected by Architect from manufacturer's full range.
 - 4. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and installed door frames, with Installer present, before hanging doors.
 - 1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
 - 2. Reject doors with defects.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Hardware: For installation, see Section 08 7100 "Door Hardware."
- B. Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
- C. Install frames level, plumb, true, and straight.
 - 1. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.
 - 2. Anchor frames to anchors or blocking built in or directly attached to substrates.
 - a. Secure with countersunk, concealed fasteners and blind nailing.
 - b. Use fine finishing nails for exposed fastening, countersunk and filled flush with woodwork.
 - 1) For factory-finished items, use filler matching finish of items being installed.
 - 3. Install fire-rated doors and frames in accordance with NFPA 80.
 - 4. Install smoke- and draft-control doors in accordance with NFPA 105.
- D. Job-Fitted Doors:
 - 1. Align and fit doors in frames with uniform clearances and bevels as indicated below.
 - a. Do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors.
 - 2. Machine doors for hardware.
 - 3. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
 - 4. Clearances:
 - a. Provide 1/8 inch at heads, jambs, and between pairs of doors.
 - b. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated on Drawings.
 - c. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold unless otherwise indicated.
 - d. Comply with NFPA 80 for fire-rated doors.
 - 5. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
 - 6. Bevel fire-rated doors 1/8 inch in 2 inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.
- E. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

- F. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 08 1416

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SECTION 08 1473.20
WOOD SLIDING DOOR ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Interior Aluminum-Framed, Top-Hung Sliding Wood Door Assemblies and Related Hardware.

- B. Related Sections:

1. Division 01 Section "General Conditions".
2. Division 06 Section "Rough Carpentry".
3. Division 08 Section "Door Schedule".
4. Division 08 Section "Door Hardware Schedule".
5. Division 08 Section "Flush Wood Doors".

- C. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ICC/ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ICC/IBC - International Building Code.
3. NFPA 80 - Fire Doors and Windows.
4. NFPA 101 - Life Safety Code.
5. NFPA 105 - Installation of Smoke Door Assemblies.
6. Window and Door Manufacturers Association - WDMA I.S.1-A Architectural Wood Flush Doors.
7. State Building Codes, Local Amendments.

- D. Standards: Comply with the following industry standards:

1. UL 1784 Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives.

1.3 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference: Refer to Division 01 Section "Project Requirements".

1.4 SUBMITTALS

- A. Comply with Division 01 Section "Submittal Procedures".
- B. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, door hardware and accessories, and finishes.
- C. Shop Drawings: Show details of fabrication and installation, including the following:
 - 1. Assembly elevations and sections indicating dimensions, tolerances, materials, components, hardware, finishes, options, and accessories.
 - 2. Door hardware locations, mounting heights, quantities, and installation requirements.
 - 3. Frame anchorages and wall reinforcement requirements.
- D. Samples for Verification: For each type of exposed finish indicated, provide samples below as requested by Architect.
 - 1. Frame finish sample.
 - 2. Door veneer sample.
- E. Maintenance Data: For top-hung, sliding door assemblies include in maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Notify manufacturer immediately of any shipping damage.
- C. Storage and Handling Requirements:
 - 1. Store and handle materials in accordance with manufacturer's instructions.
 - 2. Keep materials in manufacturer's original, unopened containers and packaging until installation.
 - 3. Store materials in clean, dry area indoors.
 - 4. Protect materials and finish during storage, handling, and installation to prevent damage.

1.6 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: Manufacturer's written warranty agreeing to repair or replace components of the top-hung, sliding door assemblies that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to, the following:
 - 1. Structural failures.
 - 2. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 3. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - 4. Telegraphing of core construction in wood face veneers exceeding 0.01 inch in a 3-inch span.
 - 5. Failure of operating components to function normally.
- C. Warranty includes installation and finishing that may be required due to repair or replacement of defective doors.
- D. General Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Aluminum Frames: Aluminum cased opening perimeter frames manufactured with integral C-channel door cavity and acoustic seals.
- B. Closing Mechanism: Soft self-closing mechanism integrated with top track.
- C. Door Guide: Concealed type door guide.
- D. Accessibility Standards: Comply with applicable provisions in Accessibility Guidelines for Buildings and Facilities ICC (ANSI) A117.1 and requirements of authorities having jurisdiction.

2.2 MANUFACTURERS

- A. Subject to compliance with requirements, provide the named product, or the comparable product by one of the alternate specified manufacturers. Comparable products are subject to review and approval through the submittal process specified.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ASSA ABLOY
 - 2. AD Systems.

2.3 INTERIOR TOP-HUNG, SLIDING DOOR ASSEMBLIES

- A. Basis-of-Design Manufacturer:

1. ASSA ABLOY RITE SLIDE Sliding Door System (RS).
- B. Frame and Door Assembly Components:
1. Single Piece Box Top Track: Extruded aluminum track system with mounting brackets.
 2. Fascia: Extruded aluminum with matching integral end caps.
 3. Integral Soft-Closer: Soft and self-closing damper mechanism.
 4. Concealed Door Bottom Floor Guide.
 5. Seal Sets: Integral to frame.
 6. Operating Hardware.
- C. Specified Wall Thickness:
1. As indicated on Architectural Drawings.
- D. Fascia Profile:
1. Custom Fascia Profile:
 - a. Owner / Architect selection from manufacturer's standard profile options.
- E. Frame Finish:
1. Standard: Clear Anodized.
- F. Framing Anchors and Fastenings: Manufacturer's standard concealed anchors and fastenings.
- G. Flush Wood Door Construction:
1. Standard: WDMA I.S.1-A Performance Grade: Extra Heavy Duty; Aesthetic Grade: A Premium.
 2. Minimum Thickness: 1-3/4".
 3. Core Construction" Particleboard Core Door (PC). Wood fiber-based materials complying with ANSI A208.1 Particleboard standard. Grade LD-1.
 4. Face Veneer: As selected by Architect.
 5. Finish: Comply with referenced standard for factory finishing.
 - a. Match flush wood doors.
 6. LEED Standard: Minimum requirements of LEED MR4 and IEQ4.4.
 7. Door Glazing: As indicated on Architectural Elevations and Drawings.
 - a. Minimum 6" vertical stiles and 10" bottom rail required.
- H. Door Preparation. Doors leafs to be factory machined for hardware including pilot and function holes.

I. Door Hardware Components:

1. General: Heavy-duty, operating door hardware units in sizes, quantities, and types recommended by manufacturer for sliding door assemblies indicated.
2. Cylinders and Keying: Refer to Division 08 Section "Door Hardware".

2.4 FABRICATION

- A. General: Fabricate top-hung, sliding door assemblies in sizes, profiles, and configurations indicated on Architectural Schedules and Drawings.
- B. Factory prepare door assemblies for field installation of door hardware and accessories to greatest extent possible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify dimensions of wall openings.
- B. Examine wall openings and conditions, with Installer present, for plumb, level and square, and compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Sliding door operation will be adversely affected by out-of-tolerance framing.
- C. Examine surfaces to receive door bottom guide. Floor shall have no height variance throughout the complete sliding operation.
- D. Notify Architect of conditions that would adversely affect installation or subsequent use of sliding doors. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 DOOR, FRAME AND HARDWARE ASSEMBLY INSTALLATION

- A. General: Comply with manufacturer's written installation instructions and approved shop drawings.
- B. Install frame components and sliding doors plumb, level, square, and in proper alignment.
- C. Anchor sliding door assemblies securely in place to supports according to manufacturer's written installation instructions.

3.3 ADJUSTING AND CLEANING

- A. Adjust sliding doors and hardware for smooth operation in accordance with manufacturer's written instructions without binding and with tight fit at contact points and seals. Sliding doors to close against walls without gaps.

- B. Repair minor damages to finish in accordance with manufacturer's written instructions and as approved by Architect.

3.4 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure sliding door assemblies are without damage or deterioration at the time of Substantial Completion.

3.5 DOOR HARDWARE SETS

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

- 1. Refer to Section 08 7100, Door Hardware Sets, for hardware sets.

END OF SECTION 08 1473.20

SECTION 08 3613
SECTIONAL DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sectional-door assemblies.
- B. Related Requirements:
 - 1. Section 05 5000 "Metal Fabrications" for miscellaneous steel supports.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type and size of sectional door and accessory.
 - 1. Include construction details, material descriptions, dimensions of individual components, profile door sections, and finishes.
 - 2. For power-operated doors, include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
- B. Shop Drawings: For each installation and for components not dimensioned or detailed in manufacturer's product data.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
 - 4. Include diagrams for power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied finishes.
 - 1. Include Samples of accessories involving color selection.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sectional doors to include in maintenance manuals.
- B. Manufacturer's warranty.
- C. Finish warranty.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of sectional doors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Failure of components or operators before reaching required number of operation cycles.
 - c. Faulty operation of hardware.
 - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use; rust through.
 - e. Delamination of exterior or interior facing materials.
 - 2. Warranty Period: Five years from date of Substantial Completion.
- B. Finish Warranty: Manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Warranty Period: Ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS, GENERAL

- A. Source Limitations: Obtain sectional doors from single source from single manufacturer.

1. Obtain operators and controls from sectional door manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Provide sectional doors that comply with performance requirements specified without failure from defective manufacture, fabrication, installation, or other defects in construction and without requiring temporary installation of reinforcing components.
- B. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.
 1. Design Wind Load: Uniform pressure (velocity pressure) of 20 lbf/sq. ft., acting inward and outward.
 2. Testing: In accordance with ASTM E330/E330M or DASMA 108 for garage doors and complying with DASMA 108 acceptance criteria.
 3. Deflection Limits: Design sectional doors to withstand design wind loads without evidencing permanent deformation or disengagement of door components.
 - a. Deflection of door sections in horizontal position (open) shall not exceed 1/120 of door width.
 - b. Deflection of horizontal track assembly shall not exceed 1/240 of door height.
 4. Operability under Wind Load: Design sectional doors to remain operable under uniform pressure (velocity pressure) of 20 lbf/sq. ft. (960 Pa) wind load, acting inward and outward.
- C. Windborne-Debris Impact Resistance: Provide sectional doors complying with the following requirements:
 1. Garage-Door Glazed Openings: Pass DASMA 115.
- D. Seismic Performance: Provide sectional doors that withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.

2.3 SECTIONAL-DOOR ASSEMBLY

- A. Aluminum Sectional Door: Provide sectional door formed with hinged sections and fabricated so that finished door assembly is rigid and aligned with tight hairline joints; free of warp, twist, and deformation; and complies with requirements in DASMA 102.
 1. Manufacturers: Subject to compliance with requirements, provide wide frame and/or heavy-duty products by one of the following:
 - a. Overhead Door (Model 521) – Basis-of-Design.
 - b. Clopay Building Products (900 Series).
 - c. C.H.I. Overhead Doors (Model 3297).

- B. Operation Cycles: Door components and operators capable of operating for not less than 50,000 operation cycles. One operation cycle is complete when door is opened from closed position to the open position and returned to closed position.
- C. Air Infiltration: Maximum rate of 0.8 cfm/sq. ft. at 15 and 25 mph when tested in accordance with ASTM E283 or DASMA 105.
- D. R-Value: 4.5 deg F x h x sq. ft. BTU.
- E. Aluminum Sections: ASTM B221 (ASTM B221M) extruded-aluminum stile and rail members of alloy and temper standard with manufacturer for type of use and finish indicated; in minimum thickness required to comply with requirements; with rail and stile dimensions and profiles indicated on Drawings; and with overlapped or interlocked weather- and pinch-resistant seal at meeting rails.
 - 1. Door-Section Thickness: 1-3/4 inches - 2 inches. Fill aluminum door frame sections with polyurethane insulation.
 - 2. Section Reinforcing: Continuous horizontal and diagonal reinforcement as required to stiffen door and for wind loading. Ensure that reinforcement does not obstruct vision lites.
 - a. Hardware Locations: Provide reinforcement for hardware attachment.
 - 3. Solid Aluminum Panels: ASTM B209 (ASTM B209M), alloy and temper standard with manufacturer for use and finish indicated.
 - a. Description: 1/2-inch-thick overall insulated panel composed of 0.050-inch aluminum interior and exterior panels with an extruded polystyrene (EPS) core.
 - b. Attachment to Frame: Sealed with glazing tape and aluminum glazing bead.
 - c. Aluminum Surface: Smooth.
- F. Track: Manufacturer's standard-lift track system. Provide complete system including brackets, bracing, and reinforcement to ensure rigid support of ball-bearing roller guides. Refer to Drawings for track location.
 - 1. Material: Galvanized steel, ASTM A653/A653M, minimum G60 (Z180) zinc coating.
 - 2. Size: As recommended in writing by manufacturer for door size, weight, track configuration and door clearances indicated on Drawings.
 - 3. Track Reinforcement and Supports: Provide galvanized-steel members to support track without sag, sway, and vibration during opening and closing of doors. Slot vertical sections of track spaced 2 inches (51 mm) apart for door-drop safety device.
 - a. Vertical Track: Incline vertical track to ensure weathertight closure at jambs. Provide continuous angle attached to track and wall.

- b. Horizontal Track: Provide continuous reinforcing angle from curve in track to end of track, attached to track and supported at points by laterally braced attachments to overhead structural members.
 - c. High lift clearance track to follow the roof headroom.
- G. Weatherseals: Replaceable, adjustable, continuous, compressible weather-stripping gaskets of flexible vinyl, rubber, or neoprene fitted to bottom, top, and, jambs of door. Provide combination bottom weatherseal and sensor edge for bottom seal.
- H. Hardware: Heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless steel, or other corrosion-resistant fasteners, to suit door type.
 - 1. Hinges: Heavy-duty, galvanized-steel hinges of not less than 0.079-inch (2.01-mm) nominal coated thickness at each end stile and at each intermediate stile, in accordance with manufacturer's written recommendations for door size.
 - a. Attach hinges to door sections through stiles and rails with bolts and lock nuts or lock washers and nuts. Use rivets or self-tapping fasteners where access to nuts is impossible.
 - b. Provide double-end hinges where required for doors more than 16 ft. (4.88 m) wide unless otherwise recommended by door manufacturer in writing.
 - 2. Rollers: Heavy-duty rollers with steel ball bearings in case-hardened steel races, mounted to suit slope of track. Extend roller shaft through both hinges where double hinges are required. Match roller-tire diameter to track width.
 - a. Roller-Tire Material: Case-hardened steel.
 - 3. Push/Pull Handles: Equip each door with galvanized-steel lifting handles on each side of door, finished to match door.
- I. Counterbalance Mechanism:
 - 1. Torsion Spring: Adjustable-tension torsion springs complying with requirements of DASMA 102 for number of operation cycles indicated, mounted on torsion shaft.
 - 2. Cable Drums and Shaft for Doors: Cast-aluminum cable drums mounted on torsion shaft and grooved to receive door-lifting cables as door is raised.
 - a. Mount counterbalance mechanism with manufacturer's standard ball-bearing brackets at each end of torsion shaft.
 - b. Provide one additional midpoint bracket for shafts up to 16 ft. (4.88 m) long and two additional brackets at one-third points to support shafts more than 16 ft. (4.88 m) long unless closer spacing is recommended in writing by door manufacturer.
 - 3. Cables: Galvanized-steel, multistrand, lifting cables with cable safety factor of at least 5 to 1.

4. Cable Safety Device: Include a spring-loaded steel or bronze cam mounted to bottom door roller assembly on each side and designed to automatically stop door if lifting cable breaks.
5. Bracket: Provide anchor support bracket as required to connect stationary end of spring to the wall and to level the shaft and prevent sag.
6. Bumper: Provide spring bumper at each horizontal track to cushion door at end of opening operation.

J. Electric Door Operator: Electric door operator assembly of size and capacity recommended by door manufacturer for door and operation cycles specified, with electric motor and factory-rewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation. **Provide automatic closing with a 30 second delay.**

1. Comply with NFPA 70.
2. Control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6; with NFPA 70, Class 2 control circuit, maximum 24 V ac or dc.
3. Basis-of-Design Product: Subject to compliance with requirements, provide the following:
 - a. Liftmaster, Model GH or equal by The Chamberlain Group.
 - b. Overhead Door RSX Commercial Operator.
4. Safety: Listed in accordance with UL 325 by a qualified testing agency for commercial or industrial use.
5. Usage Classification: Standard duty, up to 25 cycles per hour and up to 90 cycles per day.
6. Operator Type: Jackshaft, side mounted
7. Motor: Reversible-type with controller (disconnect switch) for exterior, dusty, wet, or humid motor exposure. Use adjustable motor-mounting bases for belt-driven operators.
 - a. Motor Size: As required to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
 - b. Electrical Characteristics:
 - 1) Refer to Drawings.
8. Limit Switches: Equip motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.
9. Obstruction Detection: Automatic external entrapment protection consisting of automatic safety sensor capable of protecting full width of door opening. Activation of device upon sensing an obstruction and immediately stops and reverses downward door travel.

- a. Monitored Entrapment Protection: Photoelectric light curtain sensor designed to interface with door-operator control circuit to detect damage to or disconnection of sensor and complying with requirements in UL 325.
 - 1) Provide Liftmaster LC36M or MLC-K36 by MillerEdge.
 - 2) Install per manufacturer's instructions.
 10. Control Station: Coordinate mounting with Drawings at two locations indicated, three-position (open, close, and stop) control.
 - a. Operation: Push button.
 - b. Interior-Mounted Unit: Full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
 - c. Control Panel: Coordinate mounting and location with electrician for inclusion in the Apparatus Bay Control Panel.
 - d. Automatic closing with 30 second delay.
 11. Emergency Manual Operation: Chain type designed so required force for door operation does not exceed 25 lbf.
 12. Emergency Operation Disconnect Device: Hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
 13. Motor Removal: Design operator so motor can be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.
 14. Portable, Radio-control System: Consisting of the following:
 - a. Three-channel universal coaxial receiver to open, close, and stop door.
 - b. Provide one unit per door.
 15. Provide a door position switch on each track/operator for the purposes of sending a signal to the apparatus ignition activated bay exhaust systems.
- K. Metal Finish: Comply with NAAMM/NOMMA's "Metal Finishes Manual for Architectural and Metal Products (AMP 500-06)" for recommendations for applying and designating finishes.
1. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install sectional doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; in accordance with manufacturer's written instructions.
- B. Tracks:
 - 1. Fasten vertical track assembly to opening jambs and framing with fasteners spaced not more than 24 inches apart.
 - 2. Hang horizontal track assembly from structural overhead framing with angles or channel hangers attached to framing by welding or bolting, or both. Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track and door-operating equipment.
- C. Accessibility: Install sectional doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.
- D. Power-Operated Doors: Install automatic garage doors openers in accordance with UL 325.

3.3 STARTUP SERVICES

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
 - 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

- A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.
- B. Lubricate bearings and sliding parts as recommended by manufacturer.

- C. Adjust doors and seals to provide weather-resistant fit around entire perimeter.
- D. Touchup Painting Galvanized Material: Immediately after welding galvanized materials, clean welds and abraded galvanized surfaces and repair galvanizing to comply with ASTM A780/A780M.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain sectional doors.

END OF SECTION 08 3613

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SECTION 08 4313
ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Aluminum-framed storefront, with vision glass.
- 1.01.B. Aluminum doors and frames.
- 1.01.C. Weatherstripping.
- 1.01.D. Door hardware.

1.02 RELATED REQUIREMENTS

- 1.02.A. Section 07 9200 - Joint Sealants: Sealing joints between frames and adjacent construction.
- 1.02.B. Section 08 7100 - Door Hardware: Hardware items other than specified in this section.
- 1.02.C. Section 08 8000 - Glazing: Glass and glazing accessories.

1.03 REFERENCE STANDARDS

- 1.03.A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2015.
- 1.03.B. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document); 2015.
- 1.03.C. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections; 2009.
- 1.03.D. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- 1.03.E. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- 1.03.F. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- 1.03.G. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2019.

- 1.03.H. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014 (Reapproved 2021).

1.04 ADMINISTRATIVE REQUIREMENTS

- 1.04.A. Coordinate with installation of other components that comprise the exterior enclosure.

1.05 SUBMITTALS

- 1.05.A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- 1.05.B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, and internal drainage details.
- 1.05.C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.
- 1.05.D. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.
- 1.05.E. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.
- 1.05.F. Manufacturer's qualification statement.
- 1.05.G. Installer's qualification statement.
- 1.05.H. Specimen warranty.

1.06 QUALITY ASSURANCE

- 1.06.A. Manufacturer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.
 - 1. Provide certified glass products through ANSI accredited certifications that include plant audits and independent laboratory performance testing.
 - a. Insulating Glass Certification Council (IGCC).
 - b. Safety Glazing Certification Council (SGCC).
- 1.06.B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- 1.07.A. Handle products of this section in accordance with AAMA CW-10.

- 1.07.B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.08 FIELD CONDITIONS

- 1.08.A. Do not install sealants when ambient temperature is less than 40 degrees F (5 degrees C). Maintain this minimum temperature during and 48 hours after installation.

1.09 WARRANTY

- 1.09.A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- 1.09.B. Provide five-year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.
- 1.09.C. Provide five-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- 2.01.A. Aluminum-Framed Storefronts:
1. Kawneer North America; Trifab VersaGlaze 451T Framing System: (450 for interior units) www.kawneer.com/#sle. (Basis-of-Design)
 2. Oldcastle Building Envelope: www.oldcastlebe.com/#sle.
 3. YKK AP America, Inc: www.ykkap.com/commercial/#sle.

2.02 BASIS OF DESIGN -- FRAMING FOR INSULATING GLAZING

- 2.02.A. Center-Set Style, Thermally-Broken:
1. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep (51 mm wide by 114 mm deep).

2.03 BASIS OF DESIGN -- SWINGING DOORS

- 2.03.A. Medium Stile, Insulating Glazing, Thermally-Broken:
1. Thickness: 1-3/4 inches (43 mm).

2.04 ALUMINUM-FRAMED STOREFRONT

- 2.04.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 (25 mm) 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: As selected by Architect from manufacturer's standard line.
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.
7. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F (95 degrees C) over a 12-hour period without causing detrimental effect to system components, anchorages, and other building elements.
8. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
9. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.

2.04.B. Performance Requirements

1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
 - a. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.
2. Air Leakage: 0.06 cfm/sq ft (0.3 L/sec sq m) maximum leakage of storefront wall area when tested in accordance with ASTM E283/E283M at 1.57 psf (75 Pa) pressure difference.
3. Condensation Resistance Factor of Framing: 50, minimum, measured in accordance with AAMA 1503.
4. Overall U-value Including Glazing: 0.45 Btu/sq ft in accordance with NFRC 100.

2.05 COMPONENTS

2.05.A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.

1. Glazing Stops: Flush.

2.05.B. Glazing: See Section 08 8000.

2.05.C. Swing Doors: Glazed aluminum.

1. Thickness: 1-3/4 inches (43 mm).
2. Top Rail: 4 inches (100 mm) wide.
3. Vertical Stiles: 4-1/2 inches (115 mm) wide.
4. Bottom Rail: 10 inches (254 mm) wide.
5. Glazing Stops: Square.
6. Finish: Same as storefront.

2.05.D. Operable Sash: Aluminum project-out awning; finished to match storefront; turn handle latch with manufacturer's standard insect screen.

2.06 MATERIALS

2.06.A. Extruded Aluminum: ASTM B221 (ASTM B221M).

2.06.B. Fasteners: Stainless steel.

2.06.C. Sill Flashing Sealant: Elastomeric, silicone or polyurethane, compatible with flashing material.

2.06.D. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

2.07 FINISHES

2.07.A. High Performance Organic Coating: AAMA 2604; multiple coats, thermally cured fluoropolymer system.

2.07.B. Color: As selected by Architect from manufacturer's standard range.

2.07.C. Touch-Up Materials: As recommended by coating manufacturer for field application.

2.08 HARDWARE

2.08.A. For each door, include weatherstripping, sill sweep strip, and threshold.

2.08.B. Other Door Hardware: See Section 08 7100.

2.08.C. Weatherstripping: Wool pile, continuous and replaceable; provide on all doors.

2.08.D. Sill Sweep Strips: Resilient seal type, retracting, of neoprene; provide on all doors.

2.08.E. Threshold: Extruded aluminum, one piece per door opening, ribbed surface; provide on all doors.

PART 3 EXECUTION

3.01 EXAMINATION

- 3.01.A. Verify dimensions, tolerances, and method of attachment with other work.
- 3.01.B. Verify that storefront wall openings and adjoining water-resistive and/or air barrier seal materials are ready to receive work of this section.

3.02 INSTALLATION

- 3.02.A. Install wall system in accordance with manufacturer's instructions.
- 3.02.B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- 3.02.C. Provide alignment attachments and shims to permanently fasten system to building structure.
- 3.02.D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- 3.02.E. Provide thermal isolation where components penetrate or disrupt building insulation.
- 3.02.F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form watertight dam.
- 3.02.G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.
- 3.02.H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- 3.02.I. Install operating sash.
- 3.02.J. Set thresholds in bed of sealant and secure.
- 3.02.K. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

- 3.03.A. Maximum Variation from Plumb: 0.06 inch per 3 feet (1.5 mm per m) non-cumulative or 0.06 inch per 10 feet (1.5 mm per 3 m), whichever is less.
- 3.03.B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch (0.8 mm).

3.04 ADJUSTING

3.04.A. Adjust operating hardware and sash for smooth operation.

3.05 CLEANING

3.05.A. Remove protective material from pre-finished aluminum surfaces.

3.05.B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths, and take care to remove dirt from corners and to wipe surfaces clean.

3.05.C. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

3.06 PROTECTION

3.06.A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION 08 4313

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SECTION 08 7100
DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes commercial door hardware for the following:
 - 1. Swinging doors.
 - 2. Sliding doors.
 - 3. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
 - 1. Mechanical door hardware.
 - 2. Electromechanical door hardware.
 - 3. Cylinders specified for doors in other sections.
- C. Related Sections:
 - 1. Division 08 Section "Hollow Metal Doors and Frames".
 - 2. Division 08 Section "Flush Wood Doors".
 - 3. Division 08 Section "Aluminum-Framed Entrances and Storefronts".
 - 4. Division 28 Section "Access Control Hardware Devices".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ICC/IBC - International Building Code.
 - 3. NFPA 70 - National Electrical Code.
 - 4. NFPA 80 - Fire Doors and Windows.
 - 5. NFPA 101 - Life Safety Code.
 - 6. NFPA 105 - Installation of Smoke Door Assemblies.
 - 7. State Building Codes, Local Amendments.
- E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:

1. ANSI/BHMA Certified Product Standards - A156 Series.
2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
3. ANSI/UL 294 - Access Control System Units.
4. UL 305 - Panic Hardware.
5. ANSI/UL 437- Key Locks.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing, fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Warranty information for each product.
 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
 - a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.
 - c. Wiring instructions for each electronic component scheduled herein.
 2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- E. Informational Submittals:
1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- 1.4 CLOSEOUT SUBMITTALS
- A. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.
 - B. Project Record Documents: Provide record documentation of as-built door hardware sets in digital format (.pdf, .docx, .xlsx, .csv) and as required in Division 01, Project Record Documents.
- 1.5 QUALITY ASSURANCE
- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
 - B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).

- C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.
- E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
 - 1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
- F. Each unit to bear third party permanent label indicating compliance with the referenced testing standards.
- G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
 - 1. Function of building, purpose of each area and degree of security required.
 - 2. Plans for existing and future key system expansion.
 - 3. Requirements for key control storage and software.
 - 4. Installation of permanent keys, cylinder cores and software.
 - 5. Address and requirements for delivery of keys.
- H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
 - 1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
 - 2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.

3. Review sequence of operation narratives for each unique access controlled opening.
4. Review and finalize construction schedule and verify availability of materials.
5. Review the required inspecting, testing, commissioning, and demonstration procedures

- I. At completion of installation, provide written documentation that components were applied according to manufacturer's instructions and recommendations and according to approved schedule.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.7 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.
- C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.8 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of the hardware.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 4. Electrical component defects and failures within the systems operation.
- C. Warranty Period: Unless otherwise indicated, warranty shall be one year from date of Substantial Completion.

1.9 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
- B. Storm Shelter Openings: Furnish a complete set of operational and maintenance instructions as needed for Owner's continued adjustment, maintenance, and repairs of door hardware as required by ICC 500 (2020), ICC/NSSA Standard for the Design and Construction of Storm Shelters.

PART 2 - PRODUCTS

2.1 BUTT HINGES

- A. Hinges: ANSI/BHMA A156.1 butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
 - 1. Quantity: Provide the following hinge quantity:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
 - 2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.

3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
4. Hinge Options: Comply with the following:
 - a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for all out-swinging lockable doors.
5. Manufacturers:
 - a. Hager Companies (HA) - BB Series, 5-knuckle.
 - b. Ives (IV) - 5BB Series, 5-knuckle.
 - c. McKinney (MK) - TA/T4A Series, 5-knuckle.

2.2 CONTINUOUS HINGES

- A. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 continuous geared hinge with minimum 0.120-inch thick extruded 6063-T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.
 1. Where specified, provide modular continuous geared hinges that ship in two or three pieces and form a single continuous hinge upon installation.
 2. Manufacturers:
 - a. Hager Companies (HA).
 - b. Ives (IV).
 - c. Select Hinges (SL).
- B. Pin and Barrel Continuous Hinges: ANSI/BHMA A156.26 Grade 1-600 pin and barrel continuous hinges with minimum 14 gauge Type 304 stainless steel hinge leaves, concealed stainless pin, and twin self-lubricated nylon bearings at each knuckle separation. Factory trim hinges to suit door height and prepare for electrical cut-outs.
 1. Manufacturers (Storm Shelter Assemblies):
 - a. Markar Products; ASSA ABLOY Architectural Door Accessories (MR).
 - b. No Substitution.

2.3 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.
 - 1. Manufacturers:
 - a. ASSA ABLOY ACCENTRA, formerly known as Yale (YA).
 - b. Match Existing, Field Verify.
- B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:
 - 1. Threaded mortise cylinders with rings and cams to suit hardware application.
 - 2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 - 3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
 - 4. Tubular deadlocks and other auxiliary locks.
 - 5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
 - 6. Keyway: Match Facility Standard.
- C. Keying System: Each type of lock and cylinders to be factory keyed.
 - 1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
 - 2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
 - 3. New System: Key locks to a new key system as directed by the Owner.
- D. Key Quantity: Provide the following minimum number of keys:
 - 1. Change Keys per Cylinder: Two (2)
 - 2. Master Keys (per Master Key Level/Group): Five (5).
 - 3. Construction Keys (where required): Ten (10).
- E. Construction Keying: Provide construction master keyed cylinders.
- F. Key Registration List (Bitting List):
 - 1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
 - 2. Provide transcript list in writing or electronic file as directed by the Owner.

2.4 KEY CONTROL

- A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

1. Manufacturers:

- a. Lund Equipment (LU).
- b. MMF Industries (MM).
- c. Telkee (TK).

2.5 CYLINDRICAL LOCKS AND LATCHING DEVICES

- A. Cylindrical Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.2, Series 4000, Operational Grade 1 Certified Products Directory (CPD) listed cylindrical locksets. Listed manufacturers shall meet all functions and features as specified herein.

1. Manufacturers:

- a. ASSA ABLOY ACCENTRA, formerly known as Yale (YA) - 5400LN Series.
- b. No Substitution.

2.6 MULTI-POINT LOCKS AND LATCHING DEVICES

- A. Multi-Point Locksets, Storm Shelter: Provide ANSI/BHMA A156.37, Series 1000, Operational Grade 1 and Security Grade 1 Certified Products Directory (CPD) listed multi-point locksets. Listed manufacturers shall meet all functions and features as specified herein.

1. Provide locksets with functions and features as follows:

- a. Where required by code, provide knurling or abrasive coating on all levers leading to hazardous areas.
- b. Meets UL and CUL Standard 10C Positive Pressure, Fire Test of Door Assemblies with levers that meet A117.1 Accessibility Code.
- c. Meets Florida Building Code FL2998 and UL Certification Directory ZHEM.R21744 for latching hardware for hurricane requirements.
- d. Approved for usage as part of a complete ICC 500 (2014/2020) and FEMA P-361 (2015/2021) door, frame, and hardware assemblies for storm shelter components.
- e. Lever torque to retract all bolts less than 28 in.lb.
- f. Cycle tested to 1,000,000 cycles.
- g. Seven-year limited warranty for mechanical functions.

2. Manufacturers:

- a. Corbin Russwin Hardware (RU) - FE6600 Series.
- b. Sargent Manufacturing (SA) - FM7300 Series.

2.7 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.8 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. Exit devices shall have a five-year warranty.
2. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
3. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
4. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.

5. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
 6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
 - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
 - b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.
 7. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
 8. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
 9. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
 10. Rail Sizing: Provide exit device rails factory sized for proper door width application.
 11. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed exit devices. Listed manufacturers shall meet all functions and features as specified herein.
1. Electromechanical exit devices shall have the following functions and features:
 - a. Universal Molex plug-in connectors that have standardized color-coded wiring and are field configurable in fail safe or fail secure and operate from 12vdc to 24vdc regulated.
 - b. EcoFlex or equivalent technology that reduces energy consumption up to 92% as certified by GreenCircle.
 - c. Options to be available for request-to-exit or enter signaling, latchbolt and touchbar monitoring.
 - d. Field configurable electrified trim to fail-safe or fail-secure that operates from 12-24VDC.
 - e. Five-year limited warranty for electromechanical features.
 2. Manufacturers:
 - a. ASSA ABLOY ACCENTRA, formerly known as Yale (YA) - 7000 Series.
 - b. dormakaba BEST (PR) - Apex 2000 Series.
 - c. Von Duprin (VD) - 33/99 Series.

- C. Conventional Push Rail Exit Devices (Commercial Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed exit devices. Listed manufacturers shall meet all functions and features as specified herein. Listed manufacturers shall meet all functions and features as specified herein.

1. Manufacturers:

- a. ASSA ABLOY ACCENTRA, formerly known as Yale (YA) - 6000 Series.
- b. dormakaba (K2) - QED110 Series.
- c. Von Duprin (VD) - 22 Series.

2.9 SURFACE DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

- B. Door Closers, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.

1. Large body cast iron surface mounted door closers shall have a 30-year warranty.
2. Manufacturers:
 - a. LCN Closers (LC) - 4040XP Series.

2.10 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 protection plates (kick, armor, or mop), fabricated from the following:
 - a. Stainless Steel: 300 grade, 050-inch thick.
5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:
 - a. Hager Companies (HA).
 - b. Rockwood (RO).
 - c. Trimco (TC).

2.11 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NFPA 252, Standard Methods of Fire Tests of Door Assemblies.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Manufacturers:
 1. National Guard Products (NG).
 2. Pemko (PE).
 3. Zero (ZE).

2.12 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.13 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
 - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. DHI TDH-007-20: Installation Guide for Doors and Hardware.
 - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 - 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Push Plates and Door Pulls: When through-bolt fasteners are in the same location as a push plate, countersink the fasteners flush with the door face allowing the push plate to sit flat against the door.
- E. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- F. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection (Punch Report): Reference Division 01 Sections “Closeout Procedures”. Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
 - 1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

1. Quantities listed are for each pair of doors, or for each single door.
2. The supplier is responsible for handing and sizing all products.
3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

B. Manufacturer's Abbreviations:

1. MK - McKinney
2. MR - Markar
3. PE - Pemko
4. RI - RITE Door
5. YA - ASSA ABLOY ACCENTRA
6. RU - Corbin Russwin
7. RS - RITE Slide
8. HS - HES
9. RO - Rockwood
10. RF - Rixson
11. LC - LCN Closers
12. SU - Securitron
13. AK - Alarm Controls
14. OT - Other

Hardware Sets

Set: 1.0

Doors: [117](#)

Description: FEMA/ICC 500 Storm Shelter - Single Use Restroom

1 Continuous Hinge	HG305 x Door Height	630	MR
1 Multi-Point Lock	FE6630 NSA M19V	626	RU
1 FEMA Closer	DC8210 A11 M54	689	RU
1 FEMA Kick Plate	K1050 WS 10" height x CSK x BEV	US32D	RO
1 Gasketing	S773D (Head & Jambs)		PE

Notes:

Door, frame and hardware are supplied as a complete opening assembly. Hardware listed must be used with Curries or CECO "StormPro" door package.

Bottom strike to be mounted directly to the concrete floor. Door will have a 3/8" undercut.

Set: 2.0

Doors: 109A, 109B, 109C, 115B

Description: Exterior HM - Panic Egress - Access Control Function

4 HW Hinge, Full Mortise (SS)	T4A3386 NRP (size per spec)	US32D	MK
1 Rim Exit Device, Nightlatch	6100ED 632F	630	YA
1 Rim Cylinder	Match Existing System	626	YA
1 Bridge Rectifier	2005M3		HS
1 Electric Strike - Exit Device	9500	630	HS
1 Closer w/ Stop	4040XP .SCUSH	.689	LC
1 Kick Plate	K1050 10" height x CSK x BEV	US32D	RO
1 Gasketing	303APKTST		PE
1 Rain Guard	346A		PE
1 Sweep	345APK TKSP		PE
1 Wiring Harness - Frame	QC-C3000P		MK
1 Kantech Reader	by Security Contractor	BLK	HD
1 Position Switch	DPS-M		SU
1 Power Supply	by Security Contractor		SU

Notes:

Entry by valid input at reader to release electric strike or manual key.
 Free egress at all times. Door position switch to monitor opening status.

Set: 3.0

Doors: 100

Description: Exterior Aluminum Storefront - Access Control x Lockdown Function

1 Continuous Hinge	CFMxxSLF-HD1-M PT		PE
1 Elec Rim Exit Device, EL/RX/NL	7200 B MELR 121NL	630	YA
1 Rim Cylinder	Match Existing System	626	YA
1 Pull	RM201 Mtg-Type 12XHD	US32D	RO
1 Conc Overhead Stop	6-336	630	RF
1 Closer (Top Jamb)	4040XP .LONG	.689	LC
1 Closer Mtg Plate	4040XP-18TJ	.689	LC
1 Seals, Sweeps & Astragal(s)	By Aluminum Door Mfr.		
1 Threshold	171A FHSL14SS		PE
1 Wiring Harness - Frame	QC-C3000P		MK
1 Wiring Harness - Door	QC-CxxxP length as req'd		MK
1 Kantech Reader	by Security Contractor	BLK	HD

1 Position Switch	DPS-M	SU
1 Pushbutton	PBA (toggle)	SU
1 Power Supply	AQD x amps/options req'd	SU

Notes:

Entry by valid input at reader to retract latch or manual key when locked. Free egress at all times.
 Push / Pull operation as required by timed unlock of electronic exit device.
 Push button switch located in Vestibule will cut power to electronic exit device to lock door in emergency. Door remains locked/unpowered until button is pushed again.
 Door position switch to monitor opening status. Exit device has RX option to signal egress.
 Coordinate with electrical and security contractors.

Set: 4.0

Doors: 112A, 112B

Description: Interior Aluminum - Push / Pull Function

1 Continuous Hinge	CFMxxSLF-HD1-M	PE
1 Push Pull Set	RM251	US32D RO
1 Closer - Pull Side	4040XP .REGARM .TBWMS	.689 LC
1 Door Stop	400 series as req'd	US32D RO
1 Seals, Sweeps & Astragal(s)	By Aluminum Door Mfr.	

Set: 5.0

Doors: 101A

Description: Panic Egress - Access Control Function x Remote Release

3 Hinge, Full Mortise	TA2714 NRP (size per spec)	US26D MK
1 Rim Exit Device, NL Lever	6100ED AU627F	630 YA
1 Rim Cylinder	Match Existing System	626 YA
1 Bridge Rectifier	2005M3	HS
1 Electric Strike - Exit Device	9500	630 HS
1 Closer - Push Side	4040XP .EDA .TBWMS	.689 LC
1 Kick Plate	K1050 10" height x CSK x BEV	US32D RO
1 Door Stop	400 series as req'd	US32D RO
3 Silencer	608/609 as req'd	RO
1 Wiring Harness - Frame	QC-C3000P	MK
1 Kantech Reader	by Security Contractor	BLK HD
1 Door Release	TS-18	AK
1 Power Supply	by Security Contractor	SU

Notes:

Entry by valid input at reader or Reception desk to release electric strike.
 Manual key override. Free egress at all times. Coordinate with electrical and security contractor.

Set: 6.0

Doors: 101B, 101C, 102A, 102B, 105, 106, 107, 114, 116, 119A

Description: Access Control Function x Closer - Inswing

3 Hinge, Full Mortise	TA2714 (size per spec)	US26D	MK
1 Storeroom Lock	AU 5405LN	626	YA
1 Electric Strike - Lock	4500C	630	HS
1 Bridge Rectifier	2005M3		HS
1 Closer - Pull Side	4040XP .REGARM .TBWMS	.689	LC
1 Kick Plate	K1050 10" height x CSK x BEV	US32D	RO
1 Door Stop	400 series as req'd	US32D	RO
3 Silencer	608/609 as req'd		RO
1 Wiring Harness - Frame	QC-C3000P		MK
1 Kantech Reader	by Security Contractor	BLK	HD
1 Power Supply	by Security Contractor		SU

Notes:

Entry by valid input at reader to release electric strike or manual key. Free egress at all times.
 Coordinate with electrical and security contractor.

Set: 7.0

Doors: 125

Description: Storeroom Function x Overhead Stop

3 Hinge, Full Mortise	TA2714 NRP (size per spec)	US26D	MK
1 Storeroom Lock	AU 5405LN	626	YA
1 Surf Overhead Stop	10-336	652	RF
3 Silencer	608/609 as req'd		RO

Set: 8.0

Doors: 113

Description: Storeroom Function

3 Hinge, Full Mortise	TA2714 (size per spec)	US26D	MK
1 Storeroom Lock	AU 5405LN	626	YA
1 Door Stop	400 series as req'd	US32D	RO
3 Silencer	608/609 as req'd		RO

Set: 9.0

Doors: 103, 121

Description: Office Function

3 Hinge, Full Mortise	TA2714 (size per spec)	US26D	MK
1 Entry Lock	AU 5407LN	626	YA
1 Door Stop	400 series as req'd	US32D	RO
3 Silencer	608/609 as req'd		RO

Set: 10.0

Doors: 118

Description: Classroom Function x Closer x Seals

3 Hinge, Full Mortise	TA2714 NRP (size per spec)	US26D	MK
1 Classroom Lock	AU 5408LN	626	YA
1 Closer - Push Side	4040XP .EDA .TBWMS	.689	LC
1 Kick Plate	K1050 10" height x CSK x BEV	US32D	RO
1 Door Stop	400 series as req'd	US32D	RO
1 Gasketing	S773D (Head & Jambs)		PE
1 Sweep	308APK TKSP		PE
1 Threshold	171A FHSL14SS		PE

Set: 11.0

Doors: 111

Description: Classroom Function

3 Hinge, Full Mortise	TA2714 (size per spec)	US26D	MK
1 Classroom Lock	AU 5408LN	626	YA
1 Door Stop	400 series as req'd	US32D	RO
3 Silencer	608/609 as req'd		RO

Set: 12.0

Doors: 104, 110

Description: Privacy Function x Closer - Restroom

3 Hinge, Full Mortise (SS)	TA2314 (size per spec)	US32D	MK
1 Privacy Lock	AU 5402LN	626	YA
1 Closer - Pull Side	4040XP .REGARM .TBWMS	.689	LC
1 Kick Plate	K1050 10" height x CSK x BEV	US32D	RO

1 Mop Plate	K1050 4" height x BEV x CSK	US32D	RO
1 Door Stop	400 series as req'd	US32D	RO
1 Gasketing	S773D (Head & Jambs)		PE
1 Coat Hook	806	US26D	RO

Set: 13.0

Doors: [123](#)

Description: Privacy Function

3 Hinge, Full Mortise	TA2714 (size per spec)	US26D	MK
1 Privacy Lock	AU 5402LN	626	YA
1 Door Stop	400 series as req'd	US32D	RO
1 Gasketing	S773D (Head & Jambs)		PE
1 Coat Hook	806	US26D	RO

Set: 14.0

Doors: [108](#), [115A](#)

Description: Passage Function

3 Hinge, Full Mortise	TA2714 (size per spec)	US26D	MK
1 Passage Latch	AU 5401LN	626	YA
1 Door Stop	400 series as req'd	US32D	RO
3 Silencer	608/609 as req'd		RO

Set: 15.0

Doors: [124A](#), [124B](#), [124C](#), [124D](#), [124E](#), [124F](#), [124G](#), [124H](#), [124J](#), [124K](#)

Description: Sliding Door - Privacy Function

1 Surface Sliding Door System	Rite Slide		RI
1 Privacy Lock - Sliding Door	S9540 x Frankfort	630	RS

Set: 16.0

Doors: [119B](#)

Description: Sliding Door - Passage Function

1 Surface Sliding Door System	Rite Slide		RI
1 Passage Latch - Sliding Door	S9610 x Frankfort	630	RS

Set: 17.0

Doors: OH1, OH29

Description: Miscellaneous Doors

1 All Hardware

By Door System Mfr.

OT

END OF SECTION 08 7100

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SECTION 08 8000
GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Insulating glass units.
- 1.01.B. Glazing units.
- 1.01.C. Glazing compounds.

1.02 RELATED REQUIREMENTS

- 1.02.A. Section 07 2600 - Vapor Retarders.
- 1.02.B. Section 07 9200 - Joint Sealants: Sealants for other than glazing purposes.
- 1.02.C. Section 08 1113 - Hollow Metal Doors and Frames: Glazed lites in doors and borrowed lites.
- 1.02.D. Section 08 1416 - Flush Wood Doors: Glazed lites in doors.
- 1.02.E. Section 08 3613 - Sectional Doors: Glazed lites in doors.
- 1.02.F. Section 08 4313 - Aluminum-Framed Storefronts: Glazing provided as part of storefront assembly.

1.03 REFERENCE STANDARDS

- 1.03.A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; Current Edition.
- 1.03.B. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test; 2015 (Reaffirmed 2020).
- 1.03.C. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers; 2005 (Reapproved 2019).
- 1.03.D. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
- 1.03.E. ASTM C1036 - Standard Specification for Flat Glass; 2021.
- 1.03.F. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2018.
- 1.03.G. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016 (Reapproved 2023).

- 1.03.H. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass; 2021a.
- 1.03.I. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings; 2016.
- 1.03.J. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2019.
- 1.03.K. GANA (SM) - GANA Sealant Manual; 2008.
- 1.03.L. NFRC 100 - Procedure for Determining Fenestration Product U-factors; 2023.
- 1.03.M. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence; 2023.
- 1.03.N. NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems; 2023.

1.04 ADMINISTRATIVE REQUIREMENTS

- 1.04.A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by each of the affected installers.

1.05 SUBMITTALS

- 1.05.A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- 1.05.B. Product Data on Insulating Glass Unit and Glazing Unit Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- 1.05.C. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
- 1.05.D. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

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

1.07 FIELD CONDITIONS

- 1.07.A. Do not install glazing when ambient temperature is less than 40 degrees F (4 degrees C).

1.08 WARRANTY

- 1.08.A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- 1.08.B. Insulating Glass Units: Provide a five (5) year manufacturer warranty to include coverage for seal failure, interpane dusting or misting, including providing products to replace failed units.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS - EXTERIOR GLAZING ASSEMBLIES

- 2.01.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. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
 - 2. 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.
 - 3. Glass thicknesses listed are minimum.
- 2.01.B. Weather-Resistive Barrier Seals: Provide completed assemblies that maintain continuity of building enclosure water-resistive barrier, vapor retarder, and/or air barrier.
 - 1. In conjunction with weather barrier related materials described in other sections, as follows:
 - a. Vapor Retarders: See Section 07 2600.
- 2.01.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.

2.02 GLASS MATERIALS

- 2.02.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 FT - Fully Tempered Type: Complies with ASTM C1048.
 - 3. Fully Tempered Safety Glass: Complies with ANSI Z97.1 or 16 CFR 1201 criteria for safety glazing used in hazardous locations.

2.03 INSULATING GLASS UNITS

2.03.A. Manufacturers:

1. Guardian Glass, LLC: www.guardianglass.com/#sle.
2. Pilkington North America Inc: www.pilkington.com/na/#sle. Pilkington North America Inc: www.pilkington.com/na/#sle.
3. PPG Industries, Inc.

2.03.B. Fabricator: Certified by glass manufacturer for type of glass, coating, and treatment involved and capable of providing specified warranty.

2.03.C. Insulating Glass Units: Types as indicated.

1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
2. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
3. 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.
 - b. Color: Black.
6. Purge interpane space with dry air, hermetically sealed.

2.03.D. 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: Annealed float glass, 1/4 inch (6.4 mm) thick, minimum.
 - a. Tint: As selected by Architect from manufacturer's full range.
 - b. Solarcool Bronze #2 – West and south windows.
 - c. Clear – Upper north and east windows.
4. Metal edge spacer.
5. Inboard Lite: Annealed float glass, 1/4 inch (6.4 mm) thick, minimum.
 - a. Tint: Clear.
 - b. Coating: Low-E, Pyrolytic or sputtered, on #3 surface.
6. Total Thickness: 1 inch (25.4 mm).
7. Thermal Transmittance (U-Value), Summer Daytime/Winter Nighttime: 0.29, nominal.
8. Visible Light Transmittance (VLT): 44 percent, nominal.
9. Solar Heat Gain Coefficient (SHGC): 0.52, nominal.
10. Glazing Method: Dry glazing method, gasket glazing.

2.03.E. Type IG-5 - Insulating Glass Units: Safety glazing.

1. Applications:
 - a. Glazed lites in exterior doors.
 - b. Glazed sidelights and panels next to doors.
 - c. Other locations required by applicable federal, state, and local codes and regulations.
 - d. Other locations indicated on drawings.
 2. Space between lites filled with argon.
 3. Glass Type: Same as Type IG-1 except use fully tempered float glass for both outboard and inboard lites.
 4. Total Thickness: 1 inch (25.4 mm).
 5. Metal edge spacer.
 6. Thermal Transmittance (U-Value), Summer Daytime/Winter Nighttime: 0.29, nominal.
 7. Visible Light Transmittance (VLT): 44 percent, nominal.
 8. Solar Heat Gain Coefficient (SHGC): 0.52, nominal.
 9. Glazing Method: Dry glazing method, gasket glazing.
- 2.03.F. Glass Type: Ceramic-coated, Low-E, insulating spandrel glass.
1. Overall Unit Thickness: 1 inch (25 mm).
 2. Thickness of Each Glass Lite: 6.0 mm.
 3. Outdoor Lite: Bronze Glass by PPG Industries, Inc., Pyrolytic Coated on second surface (2).
 4. Interspace Content: Air.
 5. Indoor Lite: Clear Float Glass, Sputter Coated on third surface (3).
 6. Low-E Coating: Solarban 60 Solar Control (Sputtered) by PPG Industries. Third surface.
 7. Opaque Coating Location: Fourth surface.

2.04 GLAZING UNITS

- 2.04.A. Type G-2 - Monolithic Interior Vision Glazing:
1. Applications: Interior glazing unless otherwise indicated.
 2. Glass Type: Annealed float glass.
 3. Tint: Clear.
 4. Thickness: 1/4 inch (6.4 mm), nominal.
- 2.04.B. Type G-3 - Monolithic Safety Glazing: Non-fire-rated.
1. Applications:
 - a. Glazed lites in doors, except fire doors.
 - b. Glazed sidelights to doors, except in fire-rated walls and partitions.
 - c. Other locations required by applicable federal, state, and local codes and regulations.
 - d. Other locations indicated on drawings.
 2. Glass Type: Fully tempered safety glass as specified.
 3. Tint: Clear.

4. Thickness: 1/4 inch (6.4 mm), nominal.

2.05 GLAZING COMPOUNDS

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

2.06 ACCESSORIES

- 2.06.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 (25 mm for each square meter) of glazing or minimum 4 inch (100 mm) by width of glazing rabbet space minus 1/16 inch (1.5 mm) by height to suit glazing method and pane weight and area.
- 2.06.B. Glazing Splines: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; color black.

PART 3 EXECUTION

3.01 VERIFICATION OF CONDITIONS

- 3.01.A. Verify that openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.
- 3.01.B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and support framing is ready to receive glazing system.
- 3.01.C. Proceed with glazing system installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- 3.02.A. Clean contact surfaces with appropriate solvent and wipe dry within maximum of 24 hours before glazing. Remove coatings that are not tightly bonded to substrates.
- 3.02.B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- 3.02.C. Prime surfaces scheduled to receive sealant where required for proper sealant adhesion.

3.03 INSTALLATION, GENERAL

- 3.03.A. Install glazing sealants in accordance with ASTM C1193, GANA (SM), and manufacturer's instructions.

3.03.B. Set glass lites in proper orientation so that coatings face exterior or interior as indicated.

3.04 INSTALLATION - DRY GLAZING METHOD (GASKET GLAZING)

3.04.A. Application - Exterior and/or Interior Glazed: Set glazing infills from either the exterior or the interior of the building.

3.04.B. Place setting blocks at 1/4 points with edge block no more than 6 inch (152 mm) from corners.

3.04.C. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.

3.04.D. Install removable stops without displacing glazing gasket; exert pressure for full continuous contact.

3.05 CLEANING

3.05.A. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.

3.05.B. Remove nonpermanent labels immediately after glazing installation is complete.

3.05.C. Clean glass and adjacent surfaces after sealants are fully cured.

3.05.D. Clean glass on both exposed surfaces not more than 4 days prior to Date of Substantial Completion in accordance with glass manufacturer's written recommendations.

3.06 PROTECTION

3.06.A. After installation, mark pane with an 'X' by using removable plastic tape or paste; do not mark heat absorbing or reflective glass units.

3.06.B. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

END OF SECTION 08 8000

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SECTION 09 2116
GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Metal stud wall framing.
- 1.01.B. Acoustic insulation.
- 1.01.C. Cementitious backing board.
- 1.01.D. Gypsum wallboard.
- 1.01.E. Joint treatment and accessories.

1.02 RELATED REQUIREMENTS

- 1.02.A. Section 06 1000 - Rough Carpentry: Wood blocking product and execution requirements.
- 1.02.B. Section 07 9200 - Joint Sealants: Sealing acoustical gaps in construction other than gypsum board or plaster work.

1.03 REFERENCE STANDARDS

- 1.03.A. AISI S220 - North American Standard for Cold-Formed Steel Nonstructural Framing; 2020.
- 1.03.B. AISI S240 - North American Standard for Cold-Formed Steel Structural Framing; 2015, with Errata (2020).
- 1.03.C. ANSI A108.11 - American National Standard Specifications for Interior Installation of Cementitious Backer Units; 2023.
- 1.03.D. ANSI A118.9 - American National Standard Specifications for Test Methods and Specifications for Cementitious Backer Units; 2023.
- 1.03.E. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members; 2015.
- 1.03.F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- 1.03.G. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories; 2020.

- 1.03.H. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2017 (Reapproved 2022).
- 1.03.I. ASTM C514 - Standard Specification for Nails for the Application of Gypsum Board; 2004 (Reapproved 2020).
- 1.03.J. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2023.
- 1.03.K. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.
- 1.03.L. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2023.
- 1.03.M. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2022.
- 1.03.N. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2022.
- 1.03.O. ASTM C1325 - Standard Specification for Fiber-Mat Reinforced Cementitious Backer Units; 2022, with Editorial Revision (2023).
- 1.03.P. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2017.
- 1.03.Q. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2021.
- 1.03.R. GA-216 - Application and Finishing of Gypsum Panel Products; 2021.

1.04 ADMINISTRATIVE REQUIREMENTS

- 1.04.A. Coordination: Coordinate the installation of gypsum board assemblies with size, location, and installation of service utilities.

1.05 SUBMITTALS

- 1.05.A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- 1.05.B. Product Data:
 - 1. Provide data on metal framing, gypsum board, accessories, and joint finishing system.
 - 2. Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

1.06 Delivery, Storage, and Handling

- 1.06.A. Store gypsum products and accessories indoors and keep above freezing. Elevate boards above floor, on nonwicking supports, in accordance with manufacturer's recommendations.
- 1.06.B. Store metal products to prevent corrosion.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

- 2.01.A. Provide completed assemblies complying with ASTM C840 and GA-216.

2.02 METAL FRAMING MATERIALS

- 2.02.A. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S220 or equivalent.
 - 1. Corrosion Protection Coating Designation: G40, or equivalent in accordance with AISI S220.
- 2.02.B. Manufacturers - Metal Framing, Connectors, and Accessories:
 - 1. ClarkDietrich: www.clarkdietrich.com/#sle.
 - 2. MarinoWARE: www.marinoware.com/#sle.
 - 3. SCAFCO Corporation: www.scafco.com/#sle.
- 2.02.C. Nonstructural Framing System Components: AISI S220; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/120 at 5 psf (L/120 at 240 Pa).
 - 1. Studs: C-shaped with knurled or embossed faces.
 - 2. Runners: U shaped, sized to match studs.
- 2.02.D. Partition Head to Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and screwed to secondary deflection channel set inside but unattached to top track.

2.03 BOARD MATERIALS

- 2.03.A. Manufacturers - Gypsum-Based Board:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Georgia-Pacific Gypsum: www.gpgypsum.com/#sle.
 - 3. USG Corporation: www.usg.com/#sle.
- 2.03.B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
 - 1. Application: Use Type X for vertical surfaces and ceilings, unless otherwise indicated.

2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - a. Mold resistant board is required as indicated on drawings.
3. Thickness:
 - a. Vertical Surfaces: 5/8 inch (16 mm).

2.03.C. Backing Board for Wet Areas: One of the following products:

1. Application: Surfaces behind tile in wet areas where indicated on the drawings.
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.
 - a. Thickness: 1/2 inch (13 mm).

2.03.D. Exterior Soffit Board: Exterior gypsum soffit board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.

1. Application: Ceilings and soffits in protected exterior areas, unless otherwise indicated.
2. Types: Type X, in locations indicated.
3. Type X Thickness: 5/8 inch (16 mm).
4. Edges: Tapered.

2.04 GYPSUM BOARD ACCESSORIES

- 2.04.A. Acoustic Insulation: ASTM C665; preformed mineral-fiber, friction fit type, unfaced; thickness 2 inches (50.8 mm).
- 2.04.B. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.
- 2.04.C. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
- 2.04.D. Screws for Fastening of Gypsum Panel Products to Cold-Formed Steel Studs Less than 0.033 inches (0.84 mm) in Thickness and Wood Members: ASTM C1002; self-piercing tapping screws, corrosion-resistant.
- 2.04.E. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch (0.84 to 2.84 mm) in Thickness: ASTM C954; steel drill screws, corrosion-resistant.
- 2.04.F. Nails for Attachment to Wood Members: ASTM C514.
- 2.04.G. Exterior Soffit Vents: One piece, perforated, ASTM B221 6063 T5 alloy aluminum, with edge suitable for direct application to gypsum board and manufactured especially for soffit application. Provide continuous vent.

PART 3 EXECUTION

3.01 EXAMINATION

- 3.01.A. Verify that project conditions are appropriate for work of this section to commence.

3.02 FRAMING INSTALLATION

- 3.02.A. Metal Framing: Install in accordance with ASTM C1007/AISI S220 and manufacturer's instructions.

- 3.02.B. Studs: Space studs at 16 inches on center (at 406 mm on center).

1. Extend partition framing to structure where indicated and to ceiling in other locations.
2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
3. Partitions Terminating at Structure: Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs with continuous bridging.

- 3.02.C. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.

- 3.02.D. Blocking: Install mechanically fastened steel sheet blocking for support of:

1. Wall-mounted cabinets.
2. Plumbing fixtures.
3. Toilet accessories.
4. Wall mounted accessories.

3.03 ACOUSTIC ACCESSORIES INSTALLATION

- 3.03.A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.

- 3.03.B. Acoustic Sealant: Install in accordance with manufacturer's instructions.

3.04 BOARD INSTALLATION

- 3.04.A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.

- 3.04.B. Single-Layer Nonrated: Install gypsum board parallel to framing, with ends and edges occurring over firm bearing.

1. Exception: Tapered edges to receive joint treatment at right angles to framing.

- 3.04.C. Exposed Gypsum Board in Interior Wet Areas: Seal joints, cut edges, and holes with water-resistant sealant.
- 3.04.D. Exterior Soffits: Install exterior soffit board perpendicular to framing, with staggered end joints over framing members or other solid backing.
 - 1. Seal joints, cut edges, and holes with water-resistant sealant.
- 3.04.E. Cementitious Backing Board: Install over steel framing members and plywood substrate where indicated, in accordance with ANSI A108.11 and manufacturer's instructions.
- 3.04.F. Installation on Metal Framing: Use screws for attachment of gypsum board.
- 3.04.G. Installation on Wood Framing: For nonrated assemblies, install as follows:
 - 1. Single-Layer Applications: Screw attachment.

3.05 INSTALLATION OF TRIM AND ACCESSORIES

- 3.05.A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
 - 1. Not more than 30 feet (10 meters) apart on walls and ceilings over 50 feet (16 meters) long.
 - 2. At exterior soffits, not more than 30 feet (10 meters) apart in both directions.
- 3.05.B. Corner Beads: Install at external corners, using longest practical lengths.
- 3.05.C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.
- 3.05.D. Exterior Soffit Vents: Install according to manufacturer's written instructions and in locations indicated on drawings. Provide vent area specified.

3.06 JOINT TREATMENT

- 3.06.A. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.
- 3.06.B. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
 - 1. Level 5: Walls and ceilings to receive semi-gloss or gloss paint finish and other areas specifically indicated.
 - 2. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
 - 3. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
 - 4. Level 1: Wall areas above finished ceilings, whether or not accessible in the completed construction.
- 3.06.C. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 - 1. Feather coats of joint compound so that camber is maximum 1/32 inch (0.8 mm).

- 3.06.D. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.
- 3.06.E. Fill and finish joints and corners of cementitious backing board as recommended by manufacturer.

3.07 TOLERANCES

- 3.07.A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet (3 mm in 3 m) in any direction.

3.08 Protection

- 3.08.A. Protect installed gypsum board assemblies from subsequent construction operations.

END OF SECTION 09 2116

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SECTION 09 3000
TILING

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Tile for floor applications.
- 1.01.B. Tile for wall applications.
- 1.01.C. Non-ceramic trim.

1.02 RELATED REQUIREMENTS

- 1.02.A. Section 07 9200 - Joint Sealants: Sealing joints between tile work and adjacent construction and fixtures.
- 1.02.B. Section 09 2116 - Gypsum Board Assemblies: Tile backer board.

1.03 REFERENCE STANDARDS

- 1.03.A. ANSI A108/A118/A136 - American National Standard Specifications for the Installation of Ceramic Tile (Compendium); 2019.
- 1.03.B. ANSI A108.1a - American National Standard Specifications for Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar; 2023.
- 1.03.C. ANSI A108.1b - Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set, Modified Dry-Set, or Improved Modified Dry-Set Cement Mortar; 2023.
- 1.03.D. ANSI A108.1c - Contractor's Option: Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set, Modified Dry-Set, or Improved Modified Dry-Set Cement Mortar; 2023.
- 1.03.E. ANSI A108.2 - American National Standard General Requirements: Materials, Environmental and Workmanship; 2019.
- 1.03.F. ANSI A108.4 - American National Standard Specifications for Installation of Ceramic Tile with Organic Adhesive or Water Cleanable Tile-Setting Epoxy Adhesive; 2023.
- 1.03.G. ANSI A108.5 - Setting of Ceramic Tile with Dry-Set Cement Mortar, Modified Dry-Set Cement Mortar, EGP (Exterior Glue Plywood) Modified Dry-Set Cement Mortar, or Improved Modified Dry-Set Cement Mortar; 2023.

- 1.03.H. ANSI A108.6 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and -Grout Epoxy; 2023.
- 1.03.I. ANSI A108.8 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant Furan Resin Mortar and Grout; 1999 (Reaffirmed 2019).
- 1.03.J. ANSI A108.9 - American National Standard Specifications for Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout; 2023.
- 1.03.K. ANSI A108.10 - American National Standard Specifications for Installation of Grout in Tilework; 2017 (Reaffirmed 2022).
- 1.03.L. ANSI A108.12 - Installation of Ceramic Tile with EGP (Exterior Glue Plywood) Modified Dry-Set Mortar; 2023.
- 1.03.M. ANSI A108.13 - American National Standard for Installation of Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone; 2005 (Reaffirmed 2021).
- 1.03.N. ANSI A108.19 - American National Standard Specifications for Interior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs by the Thin-Bed Method Bonded with Modified Dry-Set Cement Mortar or Improved Modified Dry-Set Cement Mortar; 2020.
- 1.03.O. ANSI A108.20 - American National Standard Specifications for Exterior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs; 2020.
- 1.03.P. ANSI A118.3 - American National Standard Specifications for Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy and Water Cleanable Tile-Setting Epoxy Adhesive; 2021.
- 1.03.Q. ANSI A137.1 - American National Standard Specifications for Ceramic Tile; 2022.
- 1.03.R. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation; 2024.
- 1.03.S. TCNA (HB-GP) - Handbook for Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs Installation; 2023.

1.04 ADMINISTRATIVE REQUIREMENTS

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

1.05 SUBMITTALS

- 1.05.A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- 1.05.B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.

1.05.C. Installer's Qualification Statement:

1.05.D. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods.

1.05.E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 6000 - Product Requirements, for additional provisions.
2. Extra Tile: 1 percent of each size, color, and surface finish combination, but not less than 25 of each type.

1.06 QUALITY ASSURANCE

1.06.A. Maintain one copy of ANSI A108/A118/A136, TCNA (HB), and TCNA (HB-GP) on-site.

1.06.B. Installer Qualifications:

1. Company specializing in performing tile installation, with minimum of five years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

1.07.A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

1.08.A. Do not install solvent-based products in an unventilated environment.

1.08.B. Maintain ambient and substrate temperature above 50 degrees F (10 degrees C) and below 100 degrees F (38 degrees C) during installation and curing of setting materials.

PART 2 PRODUCTS

2.01 TILE

2.01.A. Manufacturers: All products by the same manufacturer.

1. Dal-Tile Corporation: www.daltile.com/#sle.

2.01.B. Porcelain Tile, Type PT-1, PTW-1 and PTWB-1: ANSI A137.1 standard grade.

1. Products:
 - a. Dal-Tile Corporation; Material, size and color indicated on the drawings : www.daltile.com/#sle.

2.02 TRIM AND ACCESSORIES

- 2.02.A. Non-Ceramic Trim: , style and dimensions as indicated on drawings, set with tile mortar or adhesive.
1. Applications:
 - a. Open edges of wall and floor tile.
 - b. Transition between floor finishes of different heights.
 - c. Floor-to-wall joints.
 2. Products:
 - a. Schluter-Systems; Rondec, brushed aluminum: www.schluter.com/#sle.

2.03 SETTING MATERIALS

- 2.03.A. Provide setting and grout materials from same manufacturer.
- 2.03.B. Manufacturers:
1. LATICRETE International, Inc: www.laticrete.com/#sle.
- 2.03.C. Epoxy Adhesive and Mortar Bond Coat: ANSI A118.3.
1. Products:
 - a. LATICRETE International, Inc; LATICRETE LATAPOXY 300 Adhesive: www.laticrete.com/#sle.

2.04 GROUTS

- 2.04.A. Provide setting and grout materials from same manufacturer.
1. Color selected by Architect.

PART 3 EXECUTION

3.01 EXAMINATION

- 3.01.A. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.

3.02 PREPARATION

- 3.02.A. Protect surrounding work from damage.
- 3.02.B. Vacuum clean surfaces and damp clean.
- 3.02.C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.

3.03 INSTALLATION - GENERAL

- 3.03.A. Install tile and grout in accordance with applicable requirements of ANSI A108.1a through ANSI A108.20, manufacturer's instructions, and TCNA (HB) or TCNA (HB-GP) recommendations, as applicable.
- 3.03.B. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.
- 3.03.C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.
- 3.03.D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.
- 3.03.E. Form internal angles square and external angles square.
- 3.03.F. Install non-ceramic trim in accordance with manufacturer's instructions.
- 3.03.G. Sound tile after setting. Replace hollow sounding units.
- 3.03.H. Keep control and expansion joints free of mortar, grout, and adhesive.
- 3.03.I. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
- 3.03.J. Grout tile joints unless otherwise indicated. Use standard grout unless otherwise indicated.
- 3.03.K. At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.

3.04 INSTALLATION - WALL TILE

- 3.04.A. Over cementitious backer units on studs, install in accordance with TCNA (HB) Method W244, using membrane at toilet rooms.

3.05 CLEANING

- 3.05.A. Clean tile and grout surfaces.

3.06 PROTECTION

- 3.06.A. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION 09 3000

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SECTION 09 5100
ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Suspended metal grid ceiling system.
- 1.01.B. Acoustical units.

1.02 REFERENCE STANDARDS

- 1.02.A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- 1.02.B. ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2022.
- 1.02.C. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels; 2019.
- 1.02.D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- 1.02.E. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions; 2022.
- 1.02.F. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2023.

1.03 ADMINISTRATIVE REQUIREMENTS

- 1.03.A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
- 1.03.B. Do not install acoustical units until after interior wet work is dry.

1.04 SUBMITTALS

- 1.04.A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- 1.04.B. Product Data: Provide data on suspension system components and acoustical units.

- 1.04.C. Samples: Submit two samples 3 by 3 inch (76 by 76 mm) in size illustrating material and finish of acoustical units.
- 1.04.D. Samples: Submit two samples each, 6 inches (152 mm) long, of suspension system main runner, cross runner, and perimeter molding.
- 1.04.E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Acoustical Units: Quantity equal to 2 percent of total installed.

1.05 FIELD CONDITIONS

- 1.05.A. Maintain uniform temperature of minimum 60 degrees F (16 degrees C), and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- 2.01.A. Acoustic Tiles/Panels:
 - 1. Armstrong: www.armstrong.com/ceilings.
- 2.01.B. Suspension Systems:
 - 1. Same as for acoustical units.

2.02 ACOUSTICAL UNITS

- 2.02.A. Acoustical Units - General: ASTM E1264, Class A.
 - 1. Provide product type as indicated on the drawings.

2.03 SUSPENSION SYSTEM(S)

- 2.03.A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings and hold down clips as required.
 - 1. Materials:
 - a. Steel Grid: ASTM A653/A653M, G30 coating, unless otherwise indicated.
- 2.03.B. Exposed Suspension System: Hot-dipped galvanized steel grid with steel cap.
 - 1. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
 - 2. Profile: Tee; 15/16 inch (24 mm) face width.
 - 3. Finish: Baked enamel.
 - 4. Color: White.
 - 5. Products:
 - a. USG Corporation; Donn Brand DX 15/16" Acoustical Suspension

System: www.usg.com/ceilings/#sle.

2.04 ACCESSORIES

- 2.04.A. Support Channels and Hangers: Galvanized steel; size and type to suit application and ceiling system flatness requirement specified.
- 2.04.B. Hanger Wire: 12-gauge, 0.106 inch (2.69 mm) galvanized steel wire.
- 2.04.C. Hold-Down Clips: Manufacturer's standard clips to suit application. Where indicated on the drawings.
- 2.04.D. Perimeter Moldings: Same metal and finish as grid.
 - 1. Angle Molding: L-shaped, for mounting at same elevation as face of grid.
 - 2. Channel Molding: U-shaped, for hold-down type installations.
- 2.04.E. Suspended drywall grid system (lightwell).

PART 3 EXECUTION

3.01 EXAMINATION

- 3.01.A. Verify existing conditions before starting work.
- 3.01.B. Verify that layout of hangers will not interfere with other work.

3.02 Preparation

- 3.02.A. Install after major above-ceiling work is complete.
- 3.02.B. Coordinate the location of hangers with other work.
- 3.02.C. Layout openings for penetrations centered on penetrating items.

3.03 INSTALLATION - SUSPENSION SYSTEM

- 3.03.A. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions and as supplemented in this section.
- 3.03.B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- 3.03.C. Lay out system to a balanced grid design with edge units no less than 50 percent of acoustical unit size unless otherwise indicated.
- 3.03.D. Locate system on room axis according to reflected plan.
- 3.03.E. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.

1. Use longest practical lengths.

3.03.F. Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

3.03.G. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

3.03.H. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.

3.03.I. Support fixture loads using supplementary hangers located within 6 inches (152 mm) of each corner, or support components independently.

3.03.J. Do not eccentrically load system or induce rotation of runners.

3.04 INSTALLATION - ACOUSTICAL UNITS

3.04.A. Install acoustical units in accordance with manufacturer's instructions.

3.04.B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.

3.04.C. Fit border trim neatly against abutting surfaces.

3.04.D. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.

3.04.E. Cutting Acoustical Units:

1. Make field cut edges of same profile as factory edges.

3.04.F. Install hold-down clips on panels where indicated on the drawings.

3.05 TOLERANCES

3.05.A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet (3 mm in 3 m).

3.05.B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

3.06 CLEANING

3.06.A. See Section 01 7000 - Execution and Closeout Requirements for additional requirements.

3.06.B. Clean surfaces.

3.06.C. Replace damaged or abraded components.

END OF SECTION 09 5100

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SECTION 09 6500
RESILIENT FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Resilient tile flooring.
- 1.01.B. Resilient base.
- 1.01.C. Installation accessories.

1.02 RELATED REQUIREMENTS

- 1.02.A. Section 03 3000 - Cast-in-Place Concrete: Restrictions on curing compounds for concrete slabs and floors to receive adhesive-applied resilient flooring.

1.03 REFERENCE STANDARDS

- 1.03.A. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2023.
- 1.03.B. ASTM F1700 - Standard Specification for Solid Vinyl Floor Tile; 2020.
- 1.03.C. ASTM F1861 - Standard Specification for Resilient Wall Base; 2021.
- 1.03.D. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; 2023.

1.04 SUBMITTALS

- 1.04.A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- 1.04.B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- 1.04.C. Verification Samples: Submit two samples, 4 by 4 inch (101.6 by 101.6 mm) in size illustrating color and pattern for each resilient flooring product specified.
- 1.04.D. Concrete Subfloor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.
- 1.04.E. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.

1.04.F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 6000 - Product Requirements, for additional provisions.
2. Extra Wall Base: 10 linear feet (3 linear meters) of each type and color.
3. Extra Stair Materials: Quantity equivalent to 5 percent of each type and color.

1.05 QUALITY ASSURANCE

1.05.A. Installer Qualifications: Company specializing in installing specified flooring with minimum 5 years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

1.06.A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.

1.06.B. Store all materials off of the floor in an acclimatized, weather-tight space.

1.06.C. Maintain temperature in storage area between 55 degrees F (13 degrees C) and 90 degrees F (72 degrees C).

1.06.D. Protect roll materials from damage by storing on end.

1.06.E. Do not double stack pallets.

1.07 FIELD CONDITIONS

1.07.A. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F (21 degrees C) to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F (13 degrees C).

PART 2 PRODUCTS

2.01 TILE FLOORING

2.01.A. Linoleum Tile - Type MCT-1: Linoleum tile with color and pattern throughout thickness.

1. Manufacturers: Forbo.
2. Minimum Requirements: Comply with ASTM F1700, of Class corresponding to type specified.
3. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
4. Tile Size: 13.11" x 13.11" x 0.08"
5. Total Thickness: 0.08"
6. Color: As indicated on drawings.

2.02 RESILIENT BASE

- 2.02.A. Resilient Base: ASTM F1861, Type TS, rubber; style as scheduled.
1. Manufacturers:
 - a. Johnsonite, a Tarkett Company; Pinnacle Plus: www.johnsonite.com/#slc.
 2. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
 3. Height: 4 inches (100 mm) or as otherwise indicated on the drawings.
 4. Thickness: 0.125 inch (3.2 mm).
 5. Finish: Satin.
 6. Length: Roll.
 7. Color: As indicated on drawings.

2.03 ACCESSORIES

- 2.03.A. Subfloor Filler: White premix latex; type recommended by adhesive material manufacturer.
- 2.03.B. Primers, Adhesives, and Seam Sealer: Waterproof; types recommended by flooring manufacturer.
- 2.03.C. Moldings, Transition and Edge Strips: Same material as flooring.
1. Manufacturers:
 - a. Johnsonite, a Tarkett Company

PART 3 EXECUTION

3.01 EXAMINATION

- 3.01.A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
- 3.01.B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.
- 3.01.C. Cementitious Subfloor Surfaces: Verify that substrates are ready for resilient flooring installation by testing for moisture and alkalinity (pH).
1. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.

3.02 PREPARATION

- 3.02.A. Remove subfloor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with subfloor filler to achieve smooth, flat, hard surface.

3.02.B. Prohibit traffic until filler is fully cured.

3.02.C. Clean substrate.

3.03 Installation - General

3.03.A. Starting installation constitutes acceptance of subfloor conditions.

3.03.B. Install in accordance with manufacturer's written instructions.

3.03.C. Adhesive-Applied Installation:

1. Spread only enough adhesive to permit installation of materials before initial set.
2. Fit joints and butt seams tightly.
3. Set flooring in place, press with heavy roller to attain full adhesion.

3.03.D. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.

1. Resilient Strips: Attach to substrate using adhesive.

3.04 Installation - Tile Flooring

3.04.A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.

3.04.B. Install plank tile with a random offset of at least 6 inches (152 mm) from adjacent rows.

3.05 Installation - Resilient Base

3.05.A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches (45 mm) between joints.

3.05.B. Miter internal corners. At external corners, 'V' cut back of base strip to 2/3 of its thickness and fold. At exposed ends, use premolded units.

3.05.C. Install base on solid backing. Bond tightly to wall and floor surfaces.

3.05.D. Scribe and fit to door frames and other interruptions.

3.06 CLEANING

3.06.A. Remove excess adhesive from floor, base, and wall surfaces without damage.

3.06.B. Clean in accordance with manufacturer's written instructions.

3.07 PROTECTION

3.07.A. Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION 09 6500

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SECTION 09 6566
RESILIENT ATHLETIC FLOORING

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. Interlocking, rubber floor tile.
- B. Related Requirements:
 - 1. Section 09 6513 "Resilient Base and Accessories" for wall base and accessories installed with resilient athletic flooring.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each type, color, and pattern specified, 6-inch-square in size and of the same thickness indicated for the Work.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For resilient athletic flooring to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Floor Tile: Furnish no fewer than 1 box for each 50 boxes or fraction thereof, of each type, color, pattern, and size of floor tile installed.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storing.
- B. Store materials to prevent deterioration.

1.7 FIELD CONDITIONS

- A. Install flooring after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 INTERLOCKING, RUBBER TILE FLOOR TILE (RTF-1)

- A. Basis-of-Design: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by the following:
 - 1. Roppe: Recoil Fitness Flooring.
- B. Description: Athletic flooring consisting of modular rubber tiles with precision cut, interlocking edges, for free-lay installation.
- C. Material: Recycled-rubber compound.
- D. Traffic-Surface Texture: Nondirectional, stipple texture.
 - 1. Provide reversible tiles (with traffic-surface texture on both sides).
- E. Size: 34.25" x 34.25"
- F. Thickness: 3/8 inch.
- G. Color and Pattern: Refer to Material Legend on Drawings.

2.2 ACCESSORIES

- A. Trowelable Leveling and Patching Compound: Latex-modified, hydraulic-cement-based formulation approved by flooring manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances, moisture content, and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FLOORING INSTALLATION, GENERAL

- A. Comply with manufacturer's written installation instructions.
- B. Scribe, cut, and fit flooring to butt neatly and tightly to vertical surfaces, equipment anchors, floor outlets, and other interruptions of floor surface.
- C. Extend flooring into toe spaces, door reveals, closets, and similar openings unless otherwise indicated.
- D. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating subfloor markings on flooring. Use nonpermanent, nonstaining marking device.

3.3 FLOOR TILE INSTALLATION

- A. Lay out tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 - 1. Lay tiles square with room axis.
- B. Discard broken, cracked, chipped, or deformed tiles.
- C. Tile Matching: Match tiles for color and pattern by selecting tiles from cartons in same sequence as manufactured and packaged if so numbered.
- D. Free-Lay Tile: Place flooring at locations indicated with units securely interconnected and fully seated on substrate to form a smooth, level surface.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after completing flooring installation:
 - 1. Sweep and vacuum flooring thoroughly.
 - 2. Damp-mop flooring to remove marks and soil after time period recommended in writing by manufacturer.

- B. Protect flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods recommended in writing by manufacturer.
 - 1. Do not move heavy and sharp objects directly over flooring. Protect flooring with plywood or hardboard panels to prevent damage from storing or moving objects over flooring.

END OF SECTION 09 6566

SECTION 09 6813
TILE CARPETING

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Carpet tile, fully adhered.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS

- 1.03.A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- 1.03.B. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- 1.03.C. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.
- 1.03.D. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- 1.03.E. Concrete Subfloor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.
- 1.03.F. Installer's Qualification Statement.
- 1.03.G. Operation and Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.
- 1.03.H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Carpet Tiles: Quantity equal to 5 percent of total installed of each color and pattern installed.

1.04 QUALITY ASSURANCE

- 1.04.A. Installer Qualifications: Company specializing in installing carpet tile with minimum three years documented experience and approved by carpet tile manufacturer.

1.05 FIELD CONDITIONS

- 1.05.A. Store materials in area of installation for minimum period of 24 hours prior to installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- 2.01.A. Tile Carpeting:
 - 1. Shaw Contract

2.02 MATERIALS

- 2.02.A. Tile Carpeting, Type CPT-1: Tufted, manufactured in one color dye lot.
 - 1. Product: Refer to drawings for carpet style, size and color.
- 2.02.B. Tile Carpeting, Type MAT-1: Manufactured in one color dye lot.
 - 1. Product: Refer to drawings for carpet style, size and color.

2.03 ACCESSORIES

- 2.03.A. Edge Strips: Vinyl, color as selected by Architect.
- 2.03.B. Carpet Tile Adhesive: Recommended by carpet tile manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- 3.01.A. Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.
- 3.01.B. Verify that subfloor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to subfloor surfaces.

3.02 PREPARATION

- 3.02.A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- 3.02.B. Remove subfloor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with subfloor filler.
- 3.02.C. Vacuum clean substrate.

3.03 INSTALLATION

- 3.03.A. Starting installation constitutes acceptance of subfloor conditions.
- 3.03.B. Install carpet tile in accordance with manufacturer's instructions.
- 3.03.C. Blend carpet from different cartons to ensure minimal variation in color match.
- 3.03.D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.
- 3.03.E. Lay carpet tile in ashlar pattern, with pile direction parallel to next unit, set parallel to building lines.
- 3.03.F. Locate change of color or pattern between rooms under door centerline.
- 3.03.G. Fully adhere carpet tile to substrate.
- 3.03.H. Trim carpet tile neatly at walls and around interruptions.
- 3.03.I. Complete installation of edge strips, concealing exposed edges.

3.04 CLEANING

- 3.04.A. Remove excess adhesive without damage, from floor, base, and wall surfaces.
- 3.04.B. Clean and vacuum carpet surfaces.

END OF SECTION 09 6813

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SECTION 09 9113
EXTERIOR PAINTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Surface preparation.
- 1.01.B. Field application of paints.
- 1.01.C. Scope: Finish exterior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
- 1.01.D. Do Not Paint or Finish the Following Items:
 - 1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
 - 5. Floors, unless specifically indicated.
 - 6. Brick, glass unit masonry, architectural concrete, cast stone, integrally colored plaster and stucco.
 - 7. Glass.
 - 8. Concealed pipes, ducts, and conduits.

1.02 RELATED REQUIREMENTS

- 1.02.A. Section 05 5000 - Metal Fabrications: Shop-primed items.
- 1.02.B. Section 09 9123 - Interior Painting.

1.03 REFERENCE STANDARDS

- 1.03.A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; Current Edition.
- 1.03.B. ASTM D4258 - Standard Practice for Surface Cleaning Concrete for Coating; 2023.
- 1.03.C. ASTM D4259 - Standard Practice for Preparation of Concrete by Abrasion Prior to Coating Application; 2018.
- 1.03.D. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition.

1.03.E. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).

1.03.F. SSPC-SP 6 - Commercial Blast Cleaning; 2007.

1.04 SUBMITTALS

1.04.A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

1.04.B. Product Data: Provide complete list of products to be used, with the following information for each:

1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
2. MPI product number (e.g. MPI #47).
3. Cross-reference to specified paint system(s) product is to be used in; include description of each system.
4. Manufacturer's installation instructions.

1.04.C. Samples: Submit two paper chip samples, 8.5 x 11 inch (216 x 279 mm) in size illustrating range of colors and textures available for each surface finishing product scheduled.

1.04.D. Certification: By manufacturer that paints and finishes comply with VOC limits specified.

1.04.E. Manufacturer's Instructions: Indicate special surface preparation procedures.

1.04.F. Maintenance Data: Submit data including finish schedule showing where each product/color/finish was used, product technical data sheets, material safety data sheets (MSDS), care and cleaning instructions, touch-up procedures, repair of painted and finished surfaces, and color samples of each color and finish used.

1.04.G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 01 6000 - Product Requirements, for additional provisions.
2. Extra Paint and Finish Materials: 1 gallon (4 L) of each color; from the same product run, store where directed.
3. Label each container with color in addition to the manufacturer's label.

1.05 DELIVERY, STORAGE, AND HANDLING

1.05.A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

1.05.B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

- 1.05.C. Paint Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

1.06 FIELD CONDITIONS

- 1.06.A. Do not apply materials when surface and ambient temperatures are outside the paint product manufacturer's temperature ranges.
- 1.06.B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- 1.06.C. Do not apply exterior paint and finishes during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.
- 1.06.D. Minimum Application Temperatures for Latex Paints: 50 degrees F (10 degrees C) for exterior; unless required otherwise by manufacturer's instructions.
- 1.06.E. Provide lighting level of 80 ft candles (860 lx) measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- 2.01.A. Provide paints and finishes used in any individual system from the same manufacturer; no exceptions.
- 2.01.B. Paints:
 - 1. Base Manufacturer: Subject to compliance with requirements, provide products by the following.
 - 2. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
- 2.01.C. Primer Sealers: Same manufacturer as top coats.

2.02 PAINTS AND FINISHES - GENERAL

- 2.02.A. Paints and Finishes: Ready-mixed, unless required to be a field-catalyzed paint.
 - 1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. Supply each paint material in quantity required to complete entire project's work from a single production run.
 - 3. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is described explicitly in manufacturer's product instructions.
- 2.02.B. Volatile Organic Compound (VOC) Content:

1. Provide paints and finishes that comply with the most stringent requirements specified in the following:
 - a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.

2.02.C. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.

2.02.D. Colors: As indicated on drawings.

2.03 PAINT SYSTEMS - EXTERIOR

2.03.A. Paint E-OP - Exterior Surfaces to be Painted, Unless Otherwise Indicated: Including primed metal.

1. Two topcoats and one coat primer.
2. Topcoat(s): Exterior Latex; MPI #10, 11, 15, 119, or 214.
 - a. Products:
 - 1) Sherwin-Williams Pro Industrial Acrylic, Semi-Gloss.

2.04 PRIMERS

2.04.A. Primers: Provide the following unless other primer is required or recommended by manufacturer of topcoats.

1. Water Based Primer for Galvanized Metal; MPI #134.
 - a. Products:
 - 1) Sherwin-Williams Pro Industrial Pro-Cryl Universal Primer. (MPI #134)
2. Rust-Inhibitive Water Based Primer; MPI #107.
 - a. Products:
 - 1) Sherwin-Williams Pro Industrial Pro-Cryl Universal Primer. (MPI #107)

2.05 ACCESSORY MATERIALS

2.05.A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.

2.05.B. Patching Material: Latex filler.

2.05.C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

- 3.01.A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- 3.01.B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- 3.01.C. Test shop-applied primer for compatibility with subsequent cover materials.

3.02 PREPARATION

- 3.02.A. Clean surfaces thoroughly and correct defects prior to application.
- 3.02.B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- 3.02.C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces for finishing.
- 3.02.D. Seal surfaces that might cause bleed through or staining of topcoat.
- 3.02.E. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- 3.02.F. Galvanized Surfaces:
 - 1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
- 3.02.G. Ferrous Metal:
 - 1. Solvent clean according to SSPC-SP 1.
 - 2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
 - 3. Remove rust, loose mill scale, and other foreign substances using methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 Commercial Blast Cleaning. Protect from corrosion until coated.
- 3.02.H. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.03 APPLICATION

- 3.03.A. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- 3.03.B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

- 3.03.C. Apply each coat to uniform appearance.
- 3.03.D. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- 3.03.E. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 FIELD QUALITY CONTROL

- 3.04.A. See Section 01 4000 - Quality Requirements, for general requirements for field inspection.

3.05 CLEANING

- 3.05.A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.06 PROTECTION

- 3.06.A. Protect finishes until completion of project.
- 3.06.B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 09 9113

SECTION 09 9123
INTERIOR PAINTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Surface preparation.
- 1.01.B. Field application of paints.
- 1.01.C. Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.
 - 1. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
- 1.01.D. Do Not Paint or Finish the Following Items:
 - 1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
 - 5. Stainless steel, anodized aluminum, bronze, terne-coated stainless steel, and lead items.
 - 6. Floors, unless specifically indicated.
 - 7. Ceramic and other tiles.
 - 8. Brick, architectural concrete, cast stone, integrally colored plaster, and stucco.
 - 9. Glass.
 - 10. Acoustical materials, unless specifically indicated.
 - 11. Concealed pipes, ducts, and conduits.

1.02 RELATED REQUIREMENTS

- 1.02.A. Section 05 5000 - Metal Fabrications: Shop-primed items.
- 1.02.B. Section 09 9113 - Exterior Painting.

1.03 DEFINITIONS

- 1.03.A. Comply with ASTM D16 for interpretation of terms used in this section.

1.04 REFERENCE STANDARDS

- 1.04.A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; Current Edition.
- 1.04.B. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2024.
- 1.04.C. ASTM D4258 - Standard Practice for Surface Cleaning Concrete for Coating; 2023.
- 1.04.D. ASTM D4259 - Standard Practice for Preparation of Concrete by Abrasion Prior to Coating Application; 2018.
- 1.04.E. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition.
- 1.04.F. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).
- 1.04.G. SSPC-SP 6 - Commercial Blast Cleaning; 2007.

1.05 SUBMITTALS

- 1.05.A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- 1.05.B. Product Data: Provide complete list of products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g., "alkyd enamel").
 - 2. MPI product number (e.g., MPI #47).
 - 3. Cross-reference to specified paint system products to be used in project; include description of each system.
- 1.05.C. Samples: Submit two paper chip samples, 8.5 x 11 inch (216 x 279 mm) in size illustrating range of colors and textures available for each surface finishing product scheduled.
- 1.05.D. Manufacturer's Instructions: Indicate special surface preparation procedures.
- 1.05.E. Maintenance Data: Submit data including finish schedule showing where each product/color/finish was used, product technical data sheets, material safety data sheets (MSDS), care and cleaning instructions, touch-up procedures, repair of painted and finished surfaces, and color samples of each color and finish used.
- 1.05.F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Paint and Finish Materials: 1 gal (4 L) of each color; from the same product run, store where directed.
 - 3. Label each container with color in addition to the manufacturer's label.

1.06 QUALITY ASSURANCE

- 1.06.A. Applicator Qualifications: Company specializing in performing the type of work specified with minimum 5 years experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- 1.07.A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- 1.07.B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- 1.07.C. Paint Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

1.08 FIELD CONDITIONS

- 1.08.A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- 1.08.B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- 1.08.C. Do not apply materials when relative humidity exceeds 85 percent, at temperatures less than 5 degrees F (3 degrees C) above the dew point, or to damp or wet surfaces.
- 1.08.D. Minimum Application Temperatures for Paints: 50 degrees F (10 degrees C) for interiors unless required otherwise by manufacturer's instructions.
- 1.08.E. Provide lighting level of 80 fc (860 lux) measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- 2.01.A. Provide paints and finishes used in any individual system from the same manufacturer; no exceptions.
- 2.01.B. Paints:
 - 1. Base Manufacturer: Subject to compliance with requirements, provide products by the following.
 - 2. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
- 2.01.C. Primer Sealers: Same manufacturer as topcoats.

2.02 PAINTS AND FINISHES - GENERAL

2.02.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.

2.02.B. Volatile Organic Compound (VOC) Content:

1. Provide paints and finishes that comply with the most stringent requirements specified in the following:
 - a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.

2.02.C. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.

2.02.D. Colors: As indicated on drawings.

2.03 PAINT SYSTEMS - INTERIOR

2.03.A. Paint I-OP-MD-DT - Medium Duty Door/Trim: For surfaces subject to frequent contact by occupants, including metals:

1. Medium duty applications include doors and door frames.
2. Two topcoats and one coat primer.
3. Topcoat(s): High Performance Architectural Interior Latex; MPI #138, 139, 140, or 141.
 - a. Products:
 - 1) Sherwin-Williams Pro Industrial Pre-Catalyzed Waterbased Epoxy, Egg-Shel. (MPI #139)
4. Topcoat Sheen:
 - a. Eggshell: MPI gloss level 3; use this sheen at all locations.

2.03.B. Paint I-OP-MD-WC - Medium Duty Vertical and Overhead: Including gypsum board.

1. Two topcoats and one coat primer.
2. Topcoat(s): Institutional Low Odor/VOC Interior Latex; MPI #143, 144, 145, 146, 147, or 148.
 - a. Products:

- 1) Sherwin-Williams ProMar 200 Zero VOC Interior Latex, Low Sheen. (MPI #144)
3. Topcoat(s): Interior Light Industrial Coating, Water Based; MPI #151, 153, or 154. Where epoxy paint indicated on the drawings.
 - a. Products:
 - 1) Sherwin-Williams Pro Industrial Pre-Catalyzed Waterbased Epoxy, Semi-Gloss. (MPI #153)
4. Topcoat Sheen:
 - a. Eggshell: MPI gloss level 3; use this sheen at all locations.

2.04 PRIMERS

2.04.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.
 - a. Products:
2. Interior Rust-Inhibitive Water Based Primer; MPI #107.
 - a. Products:
 - 1) Sherwin-Williams Pro-Cryl Universal Primer. (MPI #107)
3. Interior Water Based Primer for Galvanized Metal; MPI #134 or #134 X-Green.
 - a. Products:
 - 1) Sherwin-Williams Pro-Cryl Universal Primer. (MPI #134)

2.05 ACCESSORY MATERIALS

2.05.A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.

2.05.B. Patching Material: Latex filler.

2.05.C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

- 3.01.A. Do not begin application of paints and finishes until substrates have been adequately prepared.
- 3.01.B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- 3.01.C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- 3.01.D. Test shop-applied primer for compatibility with subsequent cover materials.

- 3.01.E. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the following maximums:
1. Gypsum Wallboard: 12 percent.

3.02 PREPARATION

- 3.02.A. Clean surfaces thoroughly and correct defects prior to application.
- 3.02.B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- 3.02.C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- 3.02.D. Seal surfaces that might cause bleed through or staining of topcoat.
- 3.02.E. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.
- 3.02.F. Ferrous Metal:
1. Solvent clean according to SSPC-SP 1.
 2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.
 3. Remove rust, loose mill scale, and other foreign substances using methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 Commercial Blast Cleaning. Protect from corrosion until coated.
- 3.02.G. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.03 APPLICATION

- 3.03.A. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- 3.03.B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- 3.03.C. Apply each coat to uniform appearance in thicknesses specified by manufacturer.
- 3.03.D. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.
- 3.03.E. Sand metal surfaces lightly between coats to achieve required finish.
- 3.03.F. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

- 3.03.G. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 FIELD QUALITY CONTROL

- 3.04.A. See Section 01 4000 - Quality Requirements, for general requirements for field inspection.

3.05 CLEANING

- 3.05.A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.06 PROTECTION

- 3.06.A. Protect finishes until completion of project.
- 3.06.B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 09 9123

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SECTION 10 1419 - DIMENSIONAL LETTER SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dimensional characters.
 - a. Fabricated channel dimensional characters.
 - b. Illuminated, fabricated channel dimensional characters.

1.2 DEFINITIONS

- A. Illuminated: Illuminated by lighting source integrally constructed as part of the sign unit.

1.3 COORDINATION

- A. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For signs.
1. Include fabrication and installation details and attachments to other work.
 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
 3. Show message list, typestyles, graphic elements, and layout for each sign at least quarter size.
 4. Show locations of electrical service connections.
 5. Include diagrams for power, signal, and control wiring.
- C. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
1. Dimensional Characters: Full-size Sample of dimensional character.
 2. Full-size Samples, if approved, will be returned to Contractor for use in the Project.

D. Product Schedule: For dimensional letter signs. Use same designations indicated on Drawings or specified.

1. Include structural analysis calculations for signs indicated to comply with design loads; signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer of products or an entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify locations of electrical service embedded in permanent construction by other installers by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Separation or delamination of sheet materials and components.

2. Warranty Period: For the life of the business.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Signs and supporting elements shall withstand the effects of gravity and other loads within limits and under conditions indicated; to comply with requirements of authorities having jurisdiction.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- 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.

2.2 DIMENSIONAL CHARACTERS

- A. Fabricated Channel Characters: Metal face and side returns, formed free from warp and distortion; with uniform faces, sharp corners, and precisely formed lines and profiles; internally braced for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners; and as follows.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ace Sign Systems, Inc.
 - b. ASI Signage Innovations
 - c. Best Sign Systems
 - d. FastSigns
 2. Illuminated Characters: Backlighted character construction with LED lighting, including transformers, insulators, and other accessories for operability, with provision for servicing and concealing connections to building electrical system. Use tight or sealed joint construction to prevent unintentional light leakage. Space lamps apart from each other and away from character surfaces as needed to illuminate evenly.
 - a. Power: As indicated on electrical Drawings.
 - b. Weeps: Provide weep holes to drain water at lowest part of exterior characters. Equip weeps with permanent baffles to block light leakage without inhibiting drainage.
 3. Character Material: Sheet or plate aluminum.
 4. Material Thickness: 0.125 inch thick for face, 0.063" for returns.
 5. Character Height: As indicated on Drawings.
 6. Character Depth: As indicated on Drawings.
 7. Finishes:
 - a. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard, in color as selected by Architect from manufacturer's full range.
 8. Mounting: Concealed, painted aluminum back bar or bracket assembly.
 - a. Hold characters at 1-inch distance from wall surface.
 9. Typeface: Rockwell Bold. (Confirm with Owner.)

2.3 DIMENSIONAL CHARACTER MATERIALS

- A. Aluminum Sheet and Plate: ASTM B209 (ASTM B209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- B. Aluminum Extrusions: ASTM B221 (ASTM B221M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

2.4 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:
 - 1. Use concealed fasteners and anchors unless indicated to be exposed.
 - 2. Sign Mounting Fasteners:
 - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
 - b. Coordinate with metal siding manufacturer appropriate fastener type.
- B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.5 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 - 1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 - 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - 3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 - 4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 - 5. Internally brace dimensional characters for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
 - 6. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

2.6 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.7 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Verify that electrical service is correctly sized and located to accommodate signs.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF DIMENSIONAL CHARACTERS

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
 - 3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Mounting Methods:

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
 - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
 - b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 10 1419

SECTION 10 2600
WALL AND DOOR PROTECTION

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. Corner guards (CG-1).
- 2. Abuse-resistant wall coverings (VWP-1).

- B. Related Requirements:

- 1. Section 05 5000 "Metal Fabrications" for steel angle corner guards (CG-2).

1.3 ACTION SUBMITTALS

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

- 1. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.

- B. Shop Drawings: For each type of wall and door protection showing locations and extent.

- C. Samples for Verification: For each type of exposed finish on the following products, prepared on Samples of size indicated below:

- 1. Corner Guards: 6 inches long. Include example top caps.
- 2. Abuse-Resistant Wall Covering: 6 by 6 inches square.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of wall and door protection product to include in maintenance manuals.

- 1. Include recommended methods and frequency of maintenance for maintaining best condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to finishes and performance.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Vinyl wall protection sheets: Provide four (4) full sheets of each color provided.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store wall and door protection in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
 - 1. Maintain room temperature within storage area at not less than 70 deg F during the period plastic materials are stored.
 - 2. Keep plastic materials out of direct sunlight.
 - 3. Store plastic wall- and door-protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain all wall protection products from single source from single manufacturer.
- B. Manufacturer:
 - 1. InPro Corporation.
 - 2. C-S Group – Acrovyn.
 - 3. Koroseal Interior Products, LLC
 - 4. Pawling Corporation.

2.2 PERFORMANCE REQUIREMENTS

- A. Surface Burning Characteristics: Comply with ASTM E84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 450 or less.

2.3 CORNER GUARDS

- A. Surface-Mounted, Plastic-Cover Corner Guards (CG-1): Manufacturer's standard assembly consisting of snap-on, resilient plastic cover installed over retainer; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition.
 - 1. Manufacturers: Subject to compliance with requirements, provide the following:
 - a. InPro Corporation: 150 surface mount corner guard.
 - b. Height and Color: As indicated on Drawings.

2.4 ABUSE-RESISTANT WALL COVERINGS

- A. Abuse-Resistant Sheet Wall Covering (VWP-1): Fabricated from semirigid, plastic sheet wall-covering material.
 - 1. Size: As indicated on Drawings, largest sheet or roll practical.
 - 2. Sheet Thickness: 0.060 inch.
 - 3. Color and Texture: As indicated on Drawings.
 - 4. Height: As indicated on Drawings.
 - 5. Trim Moldings: Extruded rigid plastic that matches sheet wall covering color.
 - 6. Mounting: Adhesive.
 - 7. Sealant: Color match caulk as required and at joint between panels, in lieu of divider bar.

2.5 MISCELLANEOUS MATERIALS

- A. Fasteners: Aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.
- B. Adhesive: As recommended by protection product manufacturer.
- C. Caulk: Color match caulk as provided by protection product manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine walls to which wall and door protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.

1. For wall and door protection attached with adhesive, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Complete finishing operations, including painting and priming of walls, before installing wall protection.
- B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

- A. Installation Quality: Install wall and door protection according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
- B. Abuse-Resistant Wall Covering: Install top and edge moldings and corners as required for a complete installation. Joints between panels to be filled with color match caulk in lieu of joint molding.

3.4 CLEANING

- A. Immediately after completion of installation, clean plastic covers and accessories using a standard ammonia-based household cleaning agent.
- B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 10 2600

SECTION 10 2800
TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Commercial toilet accessories.
- 1.01.B. Commercial shower and bath accessories.
- 1.01.C. Under-lavatory pipe supply covers.
- 1.01.D. Diaper changing stations.
- 1.01.E. Utility room accessories.

1.02 RELATED REQUIREMENTS

- 1.02.A. Section 22 4000 - Plumbing Fixtures: Under-lavatory pipe and supply covers.

1.03 REFERENCE STANDARDS

- 1.03.A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- 1.03.B. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2022.
- 1.03.C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.
- 1.03.D. ASTM C1036 - Standard Specification for Flat Glass; 2021.
- 1.03.E. ASTM C1503 - Standard Specification for Silvered Flat Glass Mirror; 2024.
- 1.03.F. ASTM C1822 - Standard Specification for Insulating Covers on Accessible Lavatory Piping; 2021.
- 1.03.G. ASTM F2285 - Standard Consumer Safety Performance Specification for Diaper Changing Tables for Commercial Use; 2022.
- 1.03.H. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

1.04 ADMINISTRATIVE REQUIREMENTS

- 1.04.A. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

1.05 SUBMITTALS

- 1.05.A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- 1.05.B. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.
- 1.05.C. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- 2.01.A. Commercial Toilet, Shower, and Bath Accessories:
 - 1. American Specialties, Inc: www.americanspecialties.com/#sle.
 - 2. Bradley Corporation: www.bradleycorp.com/#sle.
 - 3. Bobrick Washroom Equipment, Inc. (Basis-of-Design).
- 2.01.B. Diaper Changing Stations:
 - 1. Koala Kare Products: www.koalabear.com/#sle.

2.02 MATERIALS

- 2.02.A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
 - 1. Grind welded joints smooth.
 - 2. Fabricate units made of metal sheet of seamless sheets with flat surfaces.
- 2.02.B. Keys: Provide 3 keys for each accessory to Owner; master key lockable accessories.
- 2.02.C. Stainless Steel Sheet: ASTM A666, Type 304.
- 2.02.D. Stainless Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.
- 2.02.E. Mirror Glass: Annealed float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.
- 2.02.F. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.

2.03 FINISHES

- 2.03.A. Stainless Steel: Satin finish, unless otherwise noted.

2.04 COMMERCIAL TOILET ACCESSORIES

- 2.04.A. Toilet Paper Dispenser: Double roll, surface mounted, for coreless type rolls.

1. Products:
 - a. American Specialties, Inc: www.americanspecialties.com/#sle.
 - b. Bobrick Washroom Equipment Inc., B-2888 (Basis-of-Design).
- 2.04.B. Paper Towel Dispenser: Folded paper type, stainless steel, surface-mounted, with viewing slots on sides as refill indicator and tumbler lock. (Provide 2 – Rooms 102 and 120).
 1. Capacity: 300 C-fold minimum.
 2. Products:
 - a. American Specialties, Inc: www.americanspecialties.com/#sle.
 - b. Bobrick Washroom Equipment, Inc., B262 and B26212, (Basis-of-Design).
- 2.04.C. Waste Receptacle: Wall-mounted, stainless steel, reinforced panel full height of door, continuously welded bottom pan and seamless exposed flanges.
 1. Liner: Removable rigid molded plastic receptacle.
 2. Products:
 - a. Bobrick Washroom Equipment, Inc., B-3644, (Basis-of-Design).
 - b. American Specialties, Inc.: www.americanspecialties.com/#sle.
- 2.04.D. Soap Dispenser: Liquid soap dispenser, wall-mounted, surface, with high impact-resistant ABS cover and working parts; push type soap valve, check valve, and window gauge refill indicator.
 1. Products:
 - a. Bobrick Washroom Equipment, Inc., B-42 (Basis-of-Design).
- 2.04.E. Mirrors: Stainless steel framed, 1/4 inch (6 mm) thick annealed float glass; ASTM C1036.
 1. Annealed Float Glass: Silvering, protective and physical characteristics in compliance with ASTM C1503.
 2. Size: As indicated on drawings.
 3. Frame: 0.05 inch (1.3 mm) angle shapes, with mitered and welded and ground corners, and tamperproof hanging system; satin finish.
 4. Products:
 - a. American Specialties, Inc: www.americanspecialties.com/#sle.
 - b. Bobrick Washroom Equipment, Inc., B-290, (Basis-of-Design).
- 2.04.F. Grab Bars: Stainless steel, smooth surface.
 1. Standard Duty Grab Bars:
 - a. Push/Pull Point Load: 250 pound-force (1112 N), minimum.
 - b. Dimensions: 1-1/4 inch (32 mm) outside diameter, minimum 0.05 inch (1.3 mm) wall thickness, exposed flange mounting, 1-1/2 inch (38 mm) clearance between wall and inside of grab bar.
 - c. Finish: Satin.
 - d. Length and Configuration: As indicated on drawings.
 - e. Products:
 - 1) American Specialties, Inc: www.americanspecialties.com/#sle.

- 2) Bobrick Washroom Equipment, Inc., B-6806, (Basis-of-Design).

2.05 COMMERCIAL SHOWER AND BATH ACCESSORIES

2.05.A. Shower Curtain Rod: Stainless steel tube, 1 inch (25 mm) outside diameter, 0.04 inch (1.0 mm) wall thickness, satin-finished, with 2.5 inch (63.5 mm) square minimum 0.04 inch (1.0 mm) thick satin-finished stainless steel flanges, for installation with exposed fasteners.

1. Products:
 - a. American Specialties, Inc: www.americanspecialties.com/#sle.
 - b. Bobrick Washroom Equipment, Inc., B-6107, (Basis-of-Design).

2.05.B. Shower Curtain:

1. Material: Opaque vinyl, 0.008 inch (0.2 mm) thick, matte finish, with antibacterial treatment, flameproof and stain-resistant.
2. Size: 72 by 72 inches (1830 by 1830 mm), hemmed edges.
3. Grommets: Stainless steel; pierced through top hem on 6-inch (150 mm) centers.
4. Color: White.
5. Shower Curtain Hooks: Chrome-plated or stainless steel spring wire designed for snap closure.
6. Products:
 - a. Bobrick Washroom Equipment, Inc., 204-3 and 204-1, (Basis-of-Design).

2.05.C. Robe Hook: Heavy-duty stainless steel, two-prong, and backplate for concealed attachment, satin finish.

1. Products:
 - a. Bobrick Washroom Equipment, Inc., B-211, (Basis-of-Design).

2.06 UTILITY ROOM ACCESSORIES

2.06.A. Combination Utility Shelf/Mop and Broom Holder: 0.05 inch (1.3 mm) thick stainless steel, Type 304, with 1/2 inch (12 mm) returned edges, 0.06 inch (1.6 mm) steel wall brackets.

1. Hooks: Three, 0.06 inch (1.6 mm) stainless steel rag hooks at shelf front.
2. Mop/broom holders: Four spring-loaded rubber cam holders at shelf front.
3. Length: 36 inches (900 mm).
4. Products:
 - a. American Specialties, Inc: www.americanspecialties.com/#sle.
 - b. Bobrick Washroom Equipment, Inc., B-224, (Basis-of-Design).

PART 3 EXECUTION

3.01 EXAMINATION

3.01.A. Verify existing conditions before starting work.

3.01.B. Verify exact location of accessories for installation.

3.02 PREPARATION

3.02.A. Provide templates and rough-in measurements as required.

3.03 INSTALLATION

3.03.A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.

3.03.B. Mounting Heights: As required by accessibility regulations, unless otherwise indicated or as indicated on the drawings.

3.04 PROTECTION

3.04.A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION 10 2800

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SECTION 10 4400
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Fire extinguishers.
- 1.01.B. Fire extinguisher cabinets.
- 1.01.C. Accessories.

1.02 REFERENCE STANDARDS

- 1.02.A. NFPA 10 - Standard for Portable Fire Extinguishers; 2022.

1.03 SUBMITTALS

- 1.03.A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- 1.03.B. Product Data: Provide extinguisher operational features.
- 1.03.C. Shop Drawings: Indicate locations of cabinets and cabinet physical dimensions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- 2.01.A. Fire Extinguishers:
 - 1. Activar Construction Products Group, Inc. –
JL Industries: www.activarcpg.com/#sle.
 - 2. Kidde, a unit of United Technologies Corp: www.kidde.com/#sle.
 - 3. Nystrom, Inc: www.nystrom.com/#sle.
 - 4. Potter-Roemer: www.potterroemer.com/#sle.
- 2.01.B. Fire Extinguisher Cabinets and Accessories:
 - 1. Activar Construction Products Group, Inc. –
JL Industries: www.activarcpg.com/#sle.
 - 2. Kidde, a unit of United Technologies Corp: www.kidde.com/#sle.
 - 3. Larsen's Manufacturing Co; Architectural Series, 2409-RM-VD,
(Basis-of-Design): www.larsensmfg.com/#sle.
 - 4. Nystrom, Inc: www.nystrom.com/#sle.
 - 5. Potter-Roemer: www.potterroemer.com/#sle.

2.02 FIRE EXTINGUISHERS

- 2.02.A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
- 2.02.B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
 - 1. Class: A:B:C type.
 - 2. Size: 10 pound (4.54 kg).
 - 3. Finish: Baked polyester powder coat, color as selected.
 - 4. Temperature range: Minus 40 degrees F (Minus 40 degrees C) to 120 degrees F (49 degrees C).

2.03 FIRE EXTINGUISHER CABINETS

- 2.03.A. Cabinet Construction: Non-fire rated.
 - 1. Formed stainless steel sheet; 0.036 inch (0.9 mm) thick base metal.
- 2.03.B. Cabinet Configuration: Semi-recessed type.
 - 1. Size to accommodate accessories.
 - 2. Trim: Flat rolled edge, with 2 1/2 inch (63.5 mm) wide face.
 - 3. Provide cabinet enclosure with right angle inside corners and seams, and with formed perimeter trim and door stiles.
- 2.03.C. Door: 0.036 inch (0.9 mm) metal thickness, reinforced for flatness and rigidity with nylon catch. Hinge doors for 180 degree opening with two butt hinges.
- 2.03.D. Door Glazing: Acrylic plastic, clear, 1/8 inch (3 mm) thick, flat shape and set in resilient channel glazing gasket.
- 2.03.E. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.
- 2.03.F. Fabrication: Weld, fill, and grind components smooth.
- 2.03.G. Finish of Cabinet Exterior Trim and Door: Primed for field paint finish.

2.04 ACCESSORIES

- 2.04.A. Lettering: "FIRE EXTINGUISHER" decal, or vinyl self-adhering, prespaced black lettering in accordance with authorities having jurisdiction (AHJ).
- 2.04.B. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher.
 - 1. Amerex Wall Bracket 801-00546.

PART 3 EXECUTION

3.01 EXAMINATION

3.01.A. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION

3.02.A. Install in accordance with manufacturer's instructions.

3.02.B. Install cabinets plumb and level in wall openings, to height as indicated on the drawings.

3.02.C. Secure rigidly in place.

3.02.D. Place extinguishers in cabinets.

END OF SECTION 10 4400

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SECTION 10 7516
GROUND-SET FLAGPOLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes ground-set flagpoles made from aluminum.
- B. Owner-Furnished Material: Flags.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, operating characteristics, fittings, accessories, and finishes for flagpoles.
- B. Shop Drawings: For each flagpole.
 - 1. Include the following:
 - a. Plans, elevations, and attachment details. Show general arrangement, jointing, fittings, accessories, grounding, anchoring, and support.
 - b. Section, and details of foundation system.
- C. Delegated Design Submittals: For flagpoles.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flagpoles to include in operation and maintenance manuals.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Spiral wrap flagpoles with heavy paper and enclose in a hard fiber tube or other protective container.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain flagpoles as complete units, including fittings, accessories, bases, and anchorage devices, from single source from single manufacturer.
- B. Subject to compliance with requirements, provide products by one of the following:
 - 1. American Flagpoles
 - 2. Baartol Company
 - 3. Concord American Flagpole
 - 4. Ewing Flagpole Co., Inc.
 - 5. Morgan-Francis Flagpoles and Accessories
 - 6. Pole-Tech Co., Inc.
 - 7. U.S. Flag & Flagpole Supply, LLC.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 4000 "Quality Requirements," to design flagpole assemblies.
- B. Structural Performance: Flagpole assemblies, including anchorages and supports, to withstand design loads indicated within limits and under conditions indicated.
 - 1. Wind Loads: Determine according to NAAMM FP 1001.
 - 2. Base flagpole design on polyester flags of maximum standard size suitable for use with flagpole or flag size indicated, whichever is more stringent.

2.3 ALUMINUM FLAGPOLES

- A. Aluminum Flagpoles: Cone-tapered flagpoles fabricated from seamless extruded tubing complying with ASTM B241/B241M, Alloy 6063, with a minimum wall thickness of 3/16 inch.
- B. Exposed Height: 30 feet.
- C. Diameter: As shown on Drawings. If not shown, flagpole to be 8" diameter.
- D. Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:
 - 1. Fabricate shop and field joints without using fasteners, screw collars, or lead calking.
 - 2. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.

- E. Sleeve for Aluminum Flagpole: Fiberglass or PVC pipe foundation sleeve, made to fit flagpole, for casting into concrete foundation.
 - 1. Flashing Collar: Same material and finish as flagpole.

2.4 FITTINGS

- A. Finial Ball: Flush-seam ball, sized as indicated or, if not indicated, to match flagpole-butt diameter.
 - 1. 0.063-inch spun aluminum, finished to match flagpole.
- B. External Halyard: Ball-bearing, nonfouling, revolving truck assembly of cast metal with continuous 5/16-inch diameter, braided polypropylene halyard and 9-inch cast-metal cleats with fasteners. Finish exposed metal surfaces to match flagpole.
 - 1. Halyards and Cleats: One at each flagpole.
 - 2. Halyard Flag Snaps: Stainless steel swivel snap hooks with neoprene or vinyl covers. Furnish two per halyard.

2.5 MISCELLANEOUS MATERIALS

- A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M.
- B. Drainage Material: Crushed stone or crushed or uncrushed gravel; coarse aggregate.
- C. Sand: ASTM C33/C33M, fine aggregate.
- D. Elastomeric Joint Sealant: Multicomponent nonsag urethane joint sealant complying with requirements in Section 07 9200 "Joint Sealants."
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.6 ALUMINUM FINISHES

- A. Natural Satin Finish: AA-M32, fine, directional, medium satin polish; buff complying with AA-M20; seal aluminum surfaces with clear, hard-coat wax.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare uncoated metal flagpoles that are set in foundation tubes by painting below-grade portions with a heavy coat of bituminous paint.

- B. Foundation Excavation: Excavate to neat clean lines in undisturbed soil. Remove loose soil and foreign matter from excavation and moisten earth before placing concrete. Place and compact drainage material at excavation bottom.
- C. Provide forms where required due to unstable soil conditions and for perimeter of flagpole base at grade. Secure and brace forms to prevent displacement during concreting.
- D. Foundation Tube: Place foundation tube, center, and brace to prevent displacement during concreting. Place concrete. Plumb and level foundation tube and allow concrete to cure.
- E. Sleeves: Locate and secure sleeves in forms by bracing to reinforcement and forms.
- F. Place concrete, as specified in Section 03 3000 "Cast-in-Place Concrete." Compact concrete in place by using vibrators. Moist-cure exposed concrete for no fewer than seven days or use nonstaining curing compound.
- G. Trowel exposed concrete surfaces to a smooth, dense finish, free of trowel marks, and uniform in texture and appearance. Provide positive slope for water runoff to perimeter of concrete base.

3.2 FLAGPOLE INSTALLATION

- A. General: Install flagpoles where indicated and according to Shop Drawings and manufacturer's written instructions.
- B. Foundation Tube: Place flagpole in tube, seated on bottom plate between steel centering wedges, and install hardwood wedges to secure flagpole in place. Place and compact sand in foundation tube and remove hardwood wedges. Seal top of foundation tube with a 2-inch layer of elastomeric joint sealant and cover with flashing collar.
- C. Baseplate: Cast anchor bolts in concrete foundation. Install baseplate on washers placed over leveling nuts on anchor bolts and adjust until flagpole is plumb. After flagpole is plumb, tighten retaining nuts and fill space under baseplate solidly with nonshrink, nonmetallic grout. Finish exposed grout surfaces smooth and slope 45 degrees away from edges of baseplate.

END OF SECTION 10 7516

SECTION 12 3600
COUNTERTOPS

PART 1 GENERAL

1.01 SECTION INCLUDES

- 1.01.A. Countertops for architectural cabinet work.
- 1.01.B. Wall-hung counters and vanity tops.
- 1.01.C. Sinks molded into countertops.

1.02 RELATED REQUIREMENTS

- 1.02.A. Section 06 4100 - Architectural Wood Casework

1.03 REFERENCE STANDARDS

- 1.03.A. ANSI A208.1 - American National Standard for Particleboard; 2022.
- 1.03.B. ANSI A208.2 - Medium Density Fiberboard (MDF) for Interior Applications; 2022.
- 1.03.C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.
- 1.03.D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- 1.03.E. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
- 1.03.F. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.
- 1.03.G. IAPMO Z124 - Plastic Plumbing Fixtures; 2022, with Editorial Revision.
- 1.03.H. ISFA 2-01 - Classification and Standards for Solid Surfacing Material; 2013.
- 1.03.I. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.
- 1.03.J. PS 1 - Structural Plywood; 2023.

1.04 SUBMITTALS

- 1.04.A. See Section 01 3000 - Administrative Requirements for submittal procedures.

1.04.B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Specimen warranty.

1.04.C. Shop Drawings: Complete details of materials and installation; combine with shop drawings of cabinets and casework specified in other sections.

1.04.D. Verification Samples: For each finish product specified, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.

1.04.E. Test Reports: Chemical resistance testing, showing compliance with specified requirements.

1.04.F. Maintenance Data: Manufacturer's instructions and recommendations for maintenance and repair of countertop surfaces.

1.05 QUALITY ASSURANCE

1.05.A. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

1.06.A. Store products in manufacturer's unopened packaging until ready for installation.

1.06.B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.07 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.01 COUNTERTOPS

2.01.A. Quality Standard: Premium Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.

2.01.B. Plastic Laminate Countertops: High-pressure decorative laminate (HPDL) sheet bonded to substrate.

1. Laminate Sheet: NEMA LD 3, Grade HGS, 0.048 inch (1.2 mm) nominal thickness.

- a. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - b. Finish: As indicated on the drawings.
 - c. Surface Color and Pattern: As indicated on drawings.
 2. Exposed Edge Treatment: Molded rubber edge with T-spline, sized to completely cover edge of panel.
 - a. Color: As selected by Architect from the manufacturer's full line.
 3. Back and End Splashes: Same material, same construction.
 4. Fabricate in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 11 - Countertops, Premium Grade.
- 2.01.C. Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.
1. Flat Sheet Thickness: 1/2 inch (12 mm), minimum.
 2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
 - a. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - b. Sinks and Bowls: Separate units for undercounter mounting; minimum 3/4 inch (19 mm) wall thickness; comply with IAPMO Z124.
 - 1) Manufacturer, model and size as indicated on the drawings.
 - c. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.
 - d. Color and Pattern: As indicated on drawings.
 3. Other Components Thickness: 1/2 inch (12 mm), minimum.
 4. Exposed Edge Treatment: Built up to minimum 1-1/2 inch (38 mm) thick; radiused edge; use marine edge at sinks.
 5. Back and End Splashes: Same sheet material, radiused top; minimum 4 inches (102 mm) high or as indicated on the drawings.
 6. Fabricate in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 11 - Countertops, Premium Grade.

2.02 MATERIALS

- 2.02.A. Plywood for Supporting Substrate: PS 1 Exterior Grade, A-C veneer grade, minimum 5-ply; minimum 3/4 inch (19 mm) thick; join lengths using metal splines. Use at sink locations.

- 2.02.B. Particleboard for Supporting Substrate: ANSI A208.1 Grade 2-M-2, 45 pcf (20 kg/cu m) minimum density; minimum 3/4 inch (19 mm) thick; join lengths using metal splines.
- 2.02.C. Medium Density Fiberboard for Supporting Substrate: ANSI A208.2.
- 2.02.D. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.
- 2.02.E. Joint Sealant: Mildew-resistant silicone sealant, clear.

2.03 FABRICATION

- 2.03.A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
 - 1. Join lengths of tops using best method recommended by manufacturer.
 - 2. Fabricate to overhang fronts and ends of cabinets 1 inch (25 mm) except where top butts against cabinet or wall.
 - 3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.
- 2.03.B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
 - 1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
 - 2. Height: 4 inches (102 mm), unless otherwise indicated.
- 2.03.C. Solid Surfacing: Fabricate tops and wall panels up to 144 inches (3657 mm) long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.
 - 1. Integral sinks: Shop-mount securely to countertop with adhesives, using flush configuration, as per manufacturer's instructions, and as detailed on drawings.
- 2.03.D. Wall-Mounted Counters: Provide brackets and braces as indicated on drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- 3.01.A. Do not begin installation until substrates have been properly prepared.
- 3.01.B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- 3.01.C. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

3.02 PREPARATION

- 3.02.A. Clean surfaces thoroughly prior to installation.
- 3.02.B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- 3.03.A. Install vanities in accordance with manufacturer's instructions and approved shop drawings
- 3.03.B. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
- 3.03.C. Attach plastic laminate countertops using screws with minimum penetration into substrate board of 5/8 inch (16 mm).
- 3.03.D. Attach wood countertops using screws with minimum penetration into substrate board of 5/8 inch (16 mm).
- 3.03.E. Attach stainless steel countertops using stainless steel fasteners and clips.
- 3.03.F. Seal joint between back/end splashes and vertical surfaces.

3.04 TOLERANCES

- 3.04.A. Variation From Horizontal: 1/8 inch in 10 feet (3 mm in 3 m), maximum.
- 3.04.B. Offset From Wall, Countertops: 1/8 inch (3 mm) maximum; 1/16 inch (1.5 mm) minimum.
- 3.04.C. Field Joints: 1/8 inch (3 mm) wide, maximum.

3.05 CLEANING

- 3.05.A. Clean countertops surfaces thoroughly.

3.06 PROTECTION

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

END OF SECTION 12 3600

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DIVISION 21 FIRE SUPPRESSION

21 0000 General Requirements for Fire Suppression Systems

- 21 0001 Basic Fire Suppression Requirements
- 21 0004 Firestopping for Fire Suppression Systems

21 0500 Common Work Results for Fire Suppression

- 21 0519 Gauges
- 21 0529 Pipe Hangers and Supports
- 21 0530 Equipment Bases and Supports
- 21 0553 Identification for Fire Suppression Systems

21 1000 Water Based Fire Suppression Systems

- 21 1313 Wet-Pipe Sprinkler Systems
- 21 1316 Dry-Pipe Sprinkler Systems

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SECTION 21 0001 – BASIC FIRE SUPPRESSION REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes the following:
1. General Requirements
 2. Definitions
 3. Scope of Work
 4. Drawings and Specifications
 5. Reference Standards
 6. Allowances, Unit Prices and Alternates
 7. Site Visit
 8. Permits and Regulations
 9. Project Management and Coordination
 10. Workmanship
 11. Protection
 12. Painting
 13. Cleaning
 14. Equipment Selection
 15. Shop Drawings
 16. Final Inspection and Punch List
 17. Operation and Maintenance Manuals
 18. Record Drawings
 19. Warranties
 20. Project Closeout
 21. Operation and Adjustment of Equipment
 22. Operating Demonstration and Instruction

1.2 GENERAL REQUIREMENTS

- A. All provisions of Division 00 Front End Documents and Division 01 General Requirements apply to work specified in this Division.
- B. Specification provisions of other relevant Divisions shall apply where applicable work is required to be performed under this Fire Suppression work.
- C. A complete and functional Fire Suppression system installation shall be provided under this Division. Should overlap of work among trades become evident, this shall be called to the attention of the architect. In such event, none of the trades or their suppliers shall assume that he relieved of the work which is specified under his branch until instructions in writing are received from the Architect.

- D. The Fire Suppression, Plumbing, HVAC and Electrical drawings and specifications assign work (labor and/or materials) to be provided by the General, Fire Suppression, Plumbing, HVAC or Electrical Contractor or their sub-contractors. Understanding that the contractors for mechanical and electrical work are sub-contractors to the (General) Contractor, such assignments are not intended to restrict the General Contractor in assignment of work among the sub-contractor to accommodate trade agreements and practices or the normal conduct of the construction work.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SCOPE OF WORK

- A. The scope of the Fire Suppression work includes furnishing, installing, testing and warranty of all Fire Suppression work shown on the Fire Suppression drawings and specified herein, including Division 00, division 01, Division 21 and applicable provisions of other relevant Divisions.

1.5 DRAWINGS AND SPECIFICATIONS

- A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word “proved,” as used, shall mean “furnish and install.” If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect for approval before proceeding with the work.
- B. Make all necessary field measurements to insure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.
- C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having pipe and fittings fabricated and

delivered in advance of making actual measurements shall be sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

- D. The Architect shall reserve the right to make minor adjustment in locations of system runs and components where he considers such adjustments desirable in the interest of concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties.
- E. Equipment, or piping shall not be installed or run above electrical switchgear or panelboards, nor in or above the access space in the immediate vicinity of the electrical switchgear/panelboards, in accordance with NEC Article 384.
- F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect's decision shall be final in regard to the arrangement of ductwork, piping, etc., where conflict arises.
- G. Provides offsets in system runs, additional fittings, necessary drains and minor valves, traps, and devices required to complete the installation, or for the proper operation of the system. Each Contractor shall exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.
- H. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect. In such event, none of the trades or their suppliers shall assume that he is relieved of the work which is specified under his branch until instructions in writing are received from the Architect.

1.6 REFERENCE STANDARDS

- A. Where standards (NFPA, NEC, ADTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the authority having jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

1.7 ALLOWANCES, UNIT PRICES AND ALTERNATES

- A. Refer to Sections 012100 Allowances, 012200 Unit Prices and 012300 Alternates.

1.8 SITE VISIT

- A. Refer to Sections 017300 Execution.
- B. Each bidder shall visit the project site to understand the existing conditions and compare the conditions with information shown on the drawings. Report immediately to the Architect any issues or discrepancies which are discovered that affect the bid. Changes to contract price will not be considered for site condition issues that are readily apparent from a thorough site review.

1.9 PERMITS, REGULATIONS AND INSPECTION

- A. Work must conform to applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawing and specifications shall govern. Install no work contrary to minimum legal standards.
- B. The fire suppression contractor shall be responsible to prepare a permit set of documents to file for and obtain all required permits from the governing inspection agencies. Include payment of all permit and inspection fees applicable to the work in this Division.
- C. All work shall be subject to inspection and approval of Federal, State and local agencies as may be appropriate as well as the Architect and Engineer.
- D. Furnish for the Owner certificates of approval from the governing inspection agencies as a condition for final payment.

1.10 PROJECT MANAGEMENT AND COORDINATION

- A. Refer to Section 013100 Project Management and Coordination.
- B. The HVAC Contractor shall initially prepare and be responsible for ¼” scale coordination drawings. These drawings shall be reproduced and distributed to the Fire Suppression, Plumbing and Electrical Contractors for their input and revisions. Work together with all contractors to obtain finish coordinated drawings. No work shall be installed until all contractors have approved and signed-off with their approval and drawings have been submitted and reviewed by the Engineer.

1.11 WORKMANSHIP

- A. Refer to Section 014000 Quality Requirements.
- B. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Architect shall have the right to stop the work if highest quality workmanship is not maintained.
- C. Fire suppression design and work shall be performed by licensed Fire Suppression Contractors in accordance with requirements of the jurisdiction.

1.12 PROTECTION

- A. Each Contractor shall be entirely responsible for all material and equipment furnished in connection with his work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect.

- B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide plastic sheeting, drop cloths or similar barriers where dust and debris is generated, to protect adjacent areas.
- C. Contractor shall protect all equipment and materials from detrimental effects of weather or construction activity. All items shall be stored and secured in a protected location away from the daily work area. Equipment or materials shall be placed on raised skids to protect from surface moisture. Where appropriate, provide plastic sheeting or similar vapor barrier underneath the stored products to reduce the effects of ground moisture or curing concrete on the local humidity levels. Where unfinished ferrous products or finished ferrous products with raw edges are stored, provide local, dry heat to maintain ambient relative humidity levels below 65% RH to prevent rust.
- D. All equipment shall retain the original packaging until required to be removed for installation or operation. Open ends of ducts, piping, conduit, etc. shall be capped or sealed and ventilation openings into equipment shall be wrapped and sealed in plastic sheeting to prevent dust or dirt entry both when stored and after installation but still open to the effects of construction activity. Stored items as well as installed equipment shall be covered with plastic sheeting at all times until placed in service or until dust generating activity in the area has ceased.

1.13 PAINTING

- A. In addition to any painting specified for various individual items of equipment, the following painting shall be included in Division 21:
 - 1. Ferrous metal which is no factory or shop painted or galvanized and which remains exposed to view in the finished areas of the building / building including finished areas, mechanical rooms, storage rooms, and other unfinished areas shall be given a prime coat of paint.
 - 2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint.
 - 3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch-up.
- B. Paint, surface preparation and application shall conform to applicable portions of the Painting section of Division 09 Finishes. All rust must be removed before application of paint.

1.14 CLEANING

- A. Debris, dust, dirt, etc shall be removed daily, particular attention shall be paid to areas that the Owner is continuing to occupy or use; any mess created in corridors, stairwells and egress paths that are maintained during construction shall be cleaned immediately.
- B. The Owners dumpsters and trash receptacles shall not be used. If a dumpster is required, it shall be provided by the contractor and located where approved by the Owner. Coordinate dumpster

requirements with other contractors.

- C. Before turning an area back over to the Owner, thoroughly clean the space to leave the area in a similar condition before the start of the project where finishes are to remain. The contractor shall also clean duct interiors and interior components of new or existing air handling system equipment if dirt, dust or debris have generated in the course of work have accumulated on these surfaces.

1.15 EQUIPMENT SELECTION

- A. Materials and equipment furnished under this contract shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer. The selection of materials and equipment to be furnished under this contract shall be governed by the following:
 - 1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specifications, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturer's listed.
 - 2. Where the words "or approved equal:" appear after a manufacturer's name, specific approval must be obtained from the Architect during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.
 - 3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.
- B. Substitute equipment of equal quality and capacity will be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.
- C. Before bidding equipment, and again in the preparation of shop drawings the Contractor and his supplier shall verify that adequate space is available for entry and installation of the item of equipment, including associated piping and accessories. Also verify that adequate space is available for servicing of the equipment.
- D. If extensive changes in pipe, duct or equipment layout or electrical wiring and equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in the contract.

1.16 SHOP DRAWINGS

- A. Refer to Section 01600 Product Requirements.

- B. Shop drawings for equipment fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. Failure to do so may be cause for rejection of shop drawings.
- C. The review of shop drawings by the Architect or Engineer shall not relieve the Contactor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer’s attention in a separate clearly stated notification at the time of submittal for the Engineer’s review.
- D. Shop drawings for the following Fire Suppression equipment and materials shall be submitted:
 - 1. Pipe, fittings and joining methods for the various systems.
 - 2. Firestopping systems for pipe penetrations.
 - 3. Pipe hangers.
 - 4. Valves.
 - 5. Gauges.
 - 6. Sprinkler heads and accessories.
 - 7. Wet pipe and dry pipe components.
 - 8. Sprinkler system installation drawings per NFPA 13, applicable calculations and water supply flow curve.

1.17 FINAL INSPECTION AND PUNCH LIST

- A. Refer to Section 017700 Closeout Procedures.

1.18 OPERATING AND MAINTENANCE MANUALS

- A. Refer to Section 017823 Operation and Maintenance Data.
- B. All shop drawing and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, the Contractor shall prepare a chart listing all items of equipment which are furnished under his contract and indicating the nature of maintenance required, the recommended frequency of checking these points and the type of lubricating media or replacement material required.
- C. These shall be assembled into three-ring loose lead binders or other appropriate binding and also combined into a single electronic file in .PDF format. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Architect or Engineer for review. Upon approval, manuals shall be turned over to the Owner.

1.19 RECORD DRAWINGS

- A. Refer to Section 017839 Project Record Drawings.
- B. Each Contractor shall maintain a separate set of prints of the contract documents and shall show all changes or variations, in a manner to be clearly discernible, which are made during construction. Upon completion of the work, these drawing shall be turned over to the Architect.

1.20 WARRANTIES

- A. Refer to Section 017700 Closeout Procedures.
- B. This Contractor shall warrant all workmanship, equipment and material entering into this contract for a period of one year of date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect. Any materials or equipment proving to be defective during this warranty period shall be made good by this Contractor without expense to the Owner.
- C. This provision is intended specifically to cover deficiencies in contract completion or performance which are discovered after systems are placed in operation. Also included shall be supplementary assistance in balancing, adjusting or providing operating instructions as the need develops, and replacing overload heater elements in starters where necessary to keep systems in operation. Heater element sizes shall not exceed the motor manufacturer's recommendations.
- D. This provision shall not be construed to include maintenance items such as replacing filters, re-tightening or repacking glands, greasing, oiling belt tightening and cleaning strainers after these have been done for final close-out.
- E. Provisions of this warranty shall be considered supplementary to warranty provisions under General Conditions.

1.21 PROJECT CLOSEOUT

- A. Refer to Section 017700 Closeout Procedures.

1.22 OPERATIONS AND ADJUSTMENT OF EQUIPMENT

- A. As the fire suppression systems are placed in operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing air and water systems, adjusting fan speeds, belts, pulleys, tightening packing glands, and adjusting all operating equipment.
- B. Test relief valves, air vents and regulating valves to insure proper operation.

1.23 OPERATING DEMONSTRATION AND INSTRUCTIONS

- A. Refer to Section 017900 Demonstration and Training as well as individual Division 21 Sections for requirements.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION – NOT APPLICABLE

END OF SECTION 21 0001

SECTION 21 0004 – FIRESTOPPING FOR FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

1.2 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
- B. Rated Systems: Firestopping assemblies shall be tested and rated in accordance with ASTM E814 (ANSI/UL 1479) Fire Tests of Through-Penetration Fire Stops (minimum positive pressure of .01 inches of water column) and E119 (ANSI/UL 263) Fire Tests of Building Construction and Materials Time-Temperature Curve. Firestopping shall provide an “F” fire rating equal to that of the construction being penetrated. Firestop systems shall meet all requirements of the Ohio Building Code.
- C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- D. For through-penetration firestop systems exposed to view or above ceilings in air return plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each through-penetration firestop system, submit documentation, including illustrations, from a qualified testing and inspecting agency, showing each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Firestopping materials shall be manufactured and/or supplied by:
1. Hilti, Inc.
 2. Johns Manville.
 3. Nelson Firestop Products.
 4. Specified Technologies Inc.
 5. 3M; Fire Protection Products Division.
 6. Tremco; Sealant/Weatherproofing Division.

2.2 FIRESTOPPING

- A. Materials shall be in the form of caulk, putty, sealant, intumescent material, wrap strip, fire blocking, ceramic wool and other materials required for the UL listed assemblies. These shall be installed in conjunction with sleeves and materials for fill and damming.

PART 3 - EXECUTION

3.1 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

- A. General: Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer's instructions.
- B. Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.
- C. Provide firestop system for every pipe at penetration of all fire resistance rated walls and horizontal assemblies.
- D. Provide rigid supports for pipes on both sides of the fire resistance rated wall or assembly where required as part of the fire stop assembly.
- E. Coordinate opening size and additional framing requirement with the General Contractor for each opening to meet the firestop installation requirements.
- F. Annular space of penetrations of non-fire-resistant-rated floor, floor/ceiling assemblies, or the ceiling membrane of a non-fire-resistant rated roof/ceiling assembly shall be filled with an approved firestopping material to resist the free passage of flame and products of combustion.
- G. Smoke Barriers: Penetrations shall be sealed with a firestopping system to prevent the passage of smoke.
- H. Smoke Partitions: Penetrations shall be sealed with a caulking material to prevent the passage of smoke. Non-rated smoke partitions do not require a fire stopping system.

END OF SECTION 21 0004

SECTION 21 0519 - GAUGES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Gauges.

1.2 SUBMITTALS

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

B. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

- A. Pressure gauges, including compound gauges and vacuum gauges, shall be Bourdon tube type with 4-1/2" dial and cast aluminum case, equal to Trerice 600C Series. Accuracy shall be 1% at mid-range.
- B. Pressure gauges for low pressure application, calibrated in inches of water gauge, ounces per sq. in. or 0-5 psi, as appropriate, shall be equal to Trerice 860.
- C. Pressure gauges at pumps shall be liquid filled Bourdon tube type with 4" dial and stainless steel case and internals, equal to Trerice 700 Series.
- D. A brass cock or bronze ball valve and a pressure snubber shall be furnished with each pressure gauge.
- E. Ranges of pressure gauges shall be selected to be consistent with anticipated pressures. Range shall be approximately twice the normal system working pressure at the gauge location.

2.2 TEST PLUGS

- A. Pressure-temperature test plugs for insertion of pressure gauge or thermometer shall be a brass fitting with neoprene or Nordel self-sealing insert and knurled brass cap with plastic capture tab. Fittings shall be equal to Peterson "PT". Furnish two thermometers and two pressure gauges with integral insertion stem appropriate for use with the test plugs.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Pressure gauges shall be installed where shown on the drawings, where required by applicable codes and also at:
- B. Gauges shall be positioned to be read with unobstructed view from the floor. Pressure-temperature test plugs shall be installed where shown, located in a position to be most readable.

END OF SECTION 21 0519

SECTION 21 0529 – PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
1. Steel pipe hangers and supports.
 2. Trapeze pipe hangers.
 3. Hanger Rods and Attachments.
 4. Pipe Riser Supports
 5. Base Mounted Pipe Supports

1.2 DEFINITIONS

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 SUBMITTALS

- A. Product Data: For the following:
1. Steel pipe hangers and supports.

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS

- A. Hangers and supports for piping shall be equal to the Anvil catalog numbers as follows:
1. Pear shaped band hanger with adjustable swivel ring type per NFPA standards, lock nut and rod attachment, carbon steel with galvanized finish, Anvil fig. 69.

2.2 HANGER RODS AND ATTACHMENTS

- A. Hanger rods shall be solid steel, threaded-end or all-thread rod, of diameter listed below. A hanger attachment device (for attachment to the structure) and locking nut at the hanger attachment shall be provided on each hanger.

<u>Pipe Size</u>	<u>Min. Rod Dia.</u>
4" and smaller	3/8"
5" to 6"	1/2"

- B. Hanger rod attachment devices for attachment to the structure shall be:
 - 1. Pre-set concrete inserts.
 - 2. After-set steel expansion type concrete inserts.
 - 3. Beam clamps for steel construction equal to Anvil Fig. 92, 93, or 94. Utilize swivel type in sloped steel construction to provide vertical support of pipe without bending hanger rods.
 - 4. Channel support system equal to Unistrut or Hilti.

2.3 PIPE RISER SUPPORTS

- A. Riser clamps shall be:
 - 1. Carbon steel, epoxy coated or galvanized finish- Anvil Fig. 261.

2.4 BASE MOUNTED PIPE SUPPORTS

- A. Base mounted pipe supports shall be factory or shop prime coat painted equal to Anvil Fig. numbers as follows:
 - 1. Adjustable pipe saddle support and yoke– Fig. 265.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Spacing of hangers shall be as follows:
 - 1. Steel pipe - Vertical:
 - a. At the base and 15 ft. maximum spacing unless otherwise shown.
 - 2. Steel pipe - Horizontal:
 - a. 2” size and smaller – 8 ft. intervals
 - b. 2-1/2” thru 6” – 10 ft. intervals
 - c. 8” and larger – 12 ft.. intervals.
- B. In piping systems with rolled or cut groove end pipe and mechanical joint couplings, pipe hangers shall be provided on horizontal piping at normal specified intervals and, in addition, so that no pipe shall be left unsupported between any two couplings nor left unsupported whenever a change in direction takes place. Added supports may be omitted on “rigid” couplings such as Victaulic Style 07 Zero-Flex. Vertical piping shall be supported at normal specified intervals or every other pipe length, which ever is more frequent. The base of the riser or base fitting shall be supported.
- C. Attachment of pipe hangers to the structure shall be with:

1. Pre-set concrete inserts in concrete construction of 4” minimum depth.
 2. After-set concrete inserts, in 4” minimum depth concrete, set in drilled holes. Powder actuated driven fasteners are not permitted.
 3. Provide anchoring where steel beam clamps are attached to sloping surfaces of beam flanges and where otherwise required to insure permanent attachment.
 4. Side beam bracket in wood construction, secured to the wood joist with lag screws set in drilled pilot holes.
 5. Attachment to steel deck is prohibited. Span from steel structural members with supplementary steel shapes where direct attachment to structural members is not practical.
- D. Attachment to manufactured trusses and other engineered structural members and supports shall be done in strict accordance with the structural manufacturer’s recommendations. Refer to the architectural and structural drawings for type of engineered structural systems being used. Connections to these structural members shall be made with connection devices and methods approved by the structural manufacturer. Provide additional supports with supplemental steel shapes when spacing between structural members exceeds specified distances.
- E. Pipe hangers shall be adjusted to proper elevation and all hanger rods set in a vertical position.
- F. Extended legs of pipe riser clamps shall be shortened as needed to maintain concealment of the clamp within finished spaces. Insure that adequate support is still maintained.

END OF SECTION 21 0529

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SECTION 21 0530- EQUIPMENT BASES AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:

1. Equipment Supports

1.2 DEFINITIONS

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- B. Design seismic-restraint equipment support and obtain approval from authorities having jurisdiction.

1.4 SUBMITTALS

- A. Product Data: For the following:
1. Equipment hangers and supports.
 2. Equipment bases.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 CONCRETE BASES

- A. Concrete bases and pads with anchor bolts cast-in-place. Bases shall be formed on all sides and hand troweled to a smooth, dense finish with neatly chamfered corners. Large concrete pads on grade shall be constructed with reinforcing steel or reinforcing roadway mesh.

2.2 STEEL SUPPORTS

- A. Structural steel angles, beams or channels, unistrut type channels or pipe. Supports shall be fabricated into a rigid framework with welded or bolted connections and cross-bracing or sway bracing. Supports shall be set on slab with base plates, or attached to the building structure as required. Brackets for relatively lightweight equipment may be attached to the wall. Equipment shall be set on and attached to the framework.
- B. Solid steel hanger rods supported from the structure above similar to pipe hangers. Provide sway bracing for equipment supported in this manner.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- B. Field Welding: Comply with AWS D1.1.
- C. Concrete bases for plumbing equipment are included in the Fire Suppression Contract. The Fire Suppression Contractor shall provide exact dimensions, locations and other detail for the specific equipment provided. The Fire Suppression Contractor shall set anchor bolts as required for the equipment.

END OF SECTION 21 0530

SECTION 21 0553 - IDENTIFICATION FOR FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Valve Tags

1.2 SUBMITTAL

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

1.3 QUALITY ASSURANCE

A. Labels, tags and markers shall comply with ANSI A13.1 for lettering size, colors and length of color field.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Each item or major equipment shall be labeled. This shall include dry-pipe valves and other similar equipment.

B. Labeling shall be:

1. Permanently attached plastic laminated signs with 1” high lettering. Signs on exterior equipment shall be brass.

2.2 PIPE LABELS

A. Pipe markings shall be applied to all piping.

B. Labeling shall be:

1. Plastic semi-rigid snap-on type, manufacturer’s standard pre-printed color coded pipe markers extending fully around the pipe and insulation or pressure-sensitive vinyl pipe markers similar to above.

2.3 VALVE TAGS

- A. Each shutoff valve, other than at equipment, shall be identified with a stamped tag. Valves and tagging shall be scheduled, typewritten on 8-1/2” x 11” paper, tabulating valve number, piping system, abbreviation, location of valve (room or area) and service (e.g. – south wing reheat boxes).
- B. Valve tags shall be engraved plastic laminate with solid brass S hook. Tags shall be engraved with “F” for Fire Suppression and the designated number.

2.4 ACCEPTABLE MANUFACTURERS

- A. Labels, markings and tags shall be manufactured by W.H. Brady, Seton, Allen or Industrial Safety Supply.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Identification marking and tagging shall be applied after painting has been completed.
- B. Coordinate names, abbreviations and other designations used with corresponding designations shown, specified or scheduled on drawings. Verify with Owners’ desired identification marking system.
- C. The Plumbing, Fire Suppression and HVAC Contractors shall coordinate labeling, marking and tagging to attain coordinated and consistent systems of identification.
- D. Equipment labeling shall consist of unit designation as shown on the drawings.
- E. Pipe markers shall be placed at 25 ft. centers in mechanical rooms and concealed spaces and at 50 ft. centers in other exposed locations.
- F. Refer to appropriate sections of this specification for installation of underground line marker tape.
- G. Valve tags shall be placed on each valve except those intended for isolation of individual items of equipment. Valve tag schedules shall be prepared as specified above.

END OF SECTION 21 0553

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Fire-protection valves.
 - 3. Alarm devices.
 - 4. Pressure gages.

1.2 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.3 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- B. Design sprinkler system(s), by a State certified designer, using performance requirements and design criteria indicated.
 - 1. Margin of Safety for Available Water Flow and Pressure: 20 percent, including losses through water-service piping, valves, and backflow preventers.
- C. System shall conform to the requirements of NFPA 13 and OBC chapter 9 and other requirements of the authority having jurisdiction.
- D. Sprinkler system design shall be approved by authorities having jurisdiction.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Approved Sprinkler Piping Drawings and Calculations: Working plans and hydraulic calculations, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- C. Welding certificates.

- D. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- E. Field quality-control reports.
- F. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Design Responsibility: Preparation of working plans, calculations, and field test reports by a certified sprinkler designer.
- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- 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. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."
 - 2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to piping schedule on the Drawings for piping material and applications.

2.2 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
 - 1. Valves shall be UL listed or FM approved.
 - 2. Minimum Pressure Rating: 175 psig.
 - 3. Acceptable Manufacturers: Subject to compliance with requirements:
 - a. Anvil International, Inc.
 - b. Kennedy Valve; a division of McWane, Inc.
 - c. Stockholm Valve and Fittings.
 - d. Tyco Fire & Building Products LP.

- e. Victaulic Company.
 - f. Watts Water Technologies, Inc.
- B. Check Valves 2 1/2” and larger:
- 1. Standard: UL 312.
 - 2. Type: Swing check.
 - 3. Body Material: Cast iron.
 - 4. Disc Material: Bronze
 - 5. End Connections: Flanged or grooved.
- C. Check Valves 2” and smaller:
- 1. Standard: UL 312.
 - 2. Type: Swing check.
 - 3. Body Material: Bronze.
 - 4. Disc Material: Composition faced
 - 5. End Connections: Threaded.
- D. OS&Y Gate Valves 2” and smaller:
- 1. Standard: UL 262.
 - 2. Body Material: Bronze.
 - 3. End Connections: Threaded.
- E. OS&Y Gate Valves: 2 1/2” and larger
- 1. Standard: UL 262.
 - 2. Body Material: Cast or ductile iron.
 - 3. End Connections: Flanged or grooved.
- F. Indicating-Type Butterfly Valves:
- 1. Standard: UL 1091.
 - 2. Pressure Rating: 175 psig minimum.
 - 3. Valves 2” and Smaller:
 - a. Valve Type: Ball or butterfly.
 - b. Body Material: Bronze.
 - c. End Connections: Threaded.
 - 4. Valves 2-1/2” and Larger:
 - a. Valve Type: Butterfly.
 - b. Body Material: Cast or ductile iron.
 - c. End Connections: Flanged, grooved, or wafer.
 - 5. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch indicating device.
- G. Trim and Drain Ball Valves:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Body Material: Bronze.
3. End Connections: Threaded.

2.3 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.
6. Acceptable manufacturers:
 - a. Globe Fire Sprinkler Corporation.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
 - e. Viking Corporation.

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 gages, retarding chamber, and fill-line attachment with strainer.
4. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.

2.4 SPRINKLER SPECIALTY PIPE FITTINGS

A. Flow Detection and Test Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig .
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: Threaded.
6. Acceptable Manufacturers
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.

B. Branch Line Testers:

1. Standard: UL 199.

2. Pressure Rating: 175 psig minimum.
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.
8. Acceptable Manufacturers:
 - a. Elkhart Brass Mfg. Company, Inc.
 - b. Fire-End & Croker Corporation.
 - c. Potter Roemer.

C. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig.
3. Body Material: Cast- or ductile-iron housing with sight glass.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.
6. Acceptable Manufacturers:
 - a. Tyco Fire & Building Products LP.
 - b. Victaulic Company.
 - c. Viking Corporation.

2.5 SPRINKLERS

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.
3. Acceptable Manufacturers:
 - a. Globe Fire Sprinkler Corporation.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
 - e. Viking Corporation.

B. Automatic Sprinklers:

1. Nonresidential Applications: UL 199.
2. Characteristics: Quick-response type with 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.

C. Sprinkler Finishes:

1. Rough brass.
2. Chrome plated.
3. Painted.

- D. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications.
 - 1. Exposed Pendent Sprinklers: Chrome -plated steel, one piece, flat.
 - 2. Concealed Recessed Sprinklers: White -plated steel, two piece, with 1-inch vertical adjustment and a flat cover plate.
 - 3. Sidewall Mounting: Chrome -plated steel one piece, flat.
- E. Spare sprinklers. Furnish spare sprinklers and sprinkler wrench in accordance with the requirements of NFPA 25. spare sprinklers shall include each type and temperature rating in a proportional amount equal of those installed. Provide a wall mounted cabinet for sprinklers and wrench.

2.6 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. 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 that sends signal if removed.
 - 4. Type: Paddle operated.
 - 5. Pressure Rating: 250 psig.
 - 6. Design Installation: Horizontal or vertical.
 - 7. Manufacturers:
 - a. ADT Security Services, Inc.
 - b. McDonnell & Miller; ITT Industries.
 - c. Potter Electric Signal Company.
 - d. System Sensor; a Honeywell company.
 - e. Viking Corporation.
 - f. Victaulic Company.
- C. Valve Supervisory Switches:
 - 1. Standard: UL 346.
 - 2. Type: Electrically supervised.
 - 3. Components: Single-pole, double-throw switch with normally closed contacts.
 - 4. Design: Signals that controlled valve is in other than fully open position.
 - 5. Manufacturers:
 - a. Fire-Lite Alarms, Inc.; a Honeywell company.
 - b. Kennedy Valve; a division of McWane, Inc.
 - c. Potter Electric Signal Company.
 - d. System Sensor; a Honeywell company.

2.7 PIPE ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. One-Piece, Cast-Brass Escutcheons: Polished chrome-plated finish with set-screws.
- C. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with chrome-plated finish.
- D. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.8 SLEEVES

- A. Cast-Iron Wall Pipe Sleeves: Cast or fabricated of cast iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, standard weight, zinc coated, plain ends.

PART 3 - EXECUTION

3.1 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building.
- B. Install shutoff valve, alarm check valve, pressure gage, drain, and other accessories indicated at connection to water-service piping.

3.2 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Locate sprinkler piping in areas protected from freezing.
- C. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes 2" and smaller.

- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having 2-1/2" and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install alarm devices in piping systems.
- J. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- K. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than 1/4" and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Fill sprinkler system piping with water.

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. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- D. 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.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated.

- G. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- H. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- I. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 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. 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.

3.5 SPRINKLER INSTALLATION

- A. Refer to the drawing for the locations of various types of sprinklers.
- B. Install sprinklers in suspended ceilings in center of acoustical ceiling panels or at the quarter points along the long axis for rectangular panels.
- C. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- D. Install sprinkler guards on sprinklers in gymnasiums.

3.6 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, and walls.
- B. Sleeves are not required for core-drilled holes in cast walls or floors.
- C. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- D. Install sleeves in new partitions, slabs, and walls as they are built.

- E. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."
- F. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."
- G. Seal space outside of sleeves in concrete slabs and walls with grout.
- H. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestop materials and installations in Division 07 Section "Penetration Firestopping."

3.7 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform 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. Coordinate with fire-alarm tests. Operate as required.
 - 5. Verify that equipment hose threads are same as local fire-department equipment.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Turn spare sprinklers, wrench and cabinet over to owner

3.9 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.10 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: Concealed sprinklers.

- B. Provide sprinkler types in subparagraphs below with finishes indicated.
 - 1. Concealed Sprinklers: Rough brass, with factory-painted white flat cover plate.
 - 2. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 21 1313

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SECTION 211316 - DRY-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Fire-department connections.
4. Sprinkler specialty pipe fittings.
5. Sprinklers.
6. Alarm devices.
7. Pressure gages.

1.2 SYSTEM DESCRIPTIONS

- A. Dry-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing compressed air. Opening of sprinklers releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into piping and discharges from sprinklers that are open.

1.3 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Sprinkler system design shall be approved by authorities having jurisdiction.
1. Margin of Safety for Available Water Flow and Pressure: 20 percent, including losses through water-service piping, valves, and backflow preventers.
 2. Sprinkler Occupancy Hazard Classifications:

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For dry-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
1. Wiring Diagrams: For power, signal, and control wiring.

- C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Qualification Data: For qualified Installer and professional engineer.
- E. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- G. Field quality-control reports.
- H. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
- 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. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."
 - 2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 TRIM AND DRAIN VALVES

- A. General Requirements:
 - 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.

2. Minimum Pressure Rating: 175 psig.

B. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Conbraco Industries, Inc.; Apollo Valves.
 - c. Fire-End & Croker Corporation.
 - d. Fire Protection Products, Inc.
 - e. Flowserve.
 - f. FNW.
 - g. Jomar International Ltd.
 - h. Kennedy Valve; a division of McWane, Inc.
 - i. Kitz Corporation.
 - j. Legend Valve.
 - k. Milwaukee Valve Company.
 - l. NIBCO INC.
 - m. Potter Roemer.
 - n. Red-White Valve Corporation.
 - o. Tyco Fire & Building Products LP.
 - p. Victaulic Company.
 - q. Watts Water Technologies, Inc.

2.3 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Dry-Pipe Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFAC Inc.
 - b. Globe Fire Sprinkler Corporation.
 - c. Reliable Automatic Sprinkler Co., Inc.
 - d. Tyco Fire & Building Products LP.
 - e. Venus Fire Protection Ltd.
 - f. Victaulic Company.
 - g. Viking Corporation.
2. Standard: UL 260

3. Design: Differential-pressure type.
4. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
5. Air Compressor:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Gast Manufacturing Inc.
 - 2) General Air Products, Inc,
 - 3) Viking Corporation.
 - b. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 - c. Motor Horsepower: Fractional.
 - d. Power: 120-V ac, 60 Hz, single phase.

C. Flow Detection and Test Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AGF Manufacturing Inc.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

D. Branch Line Testers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elkhart Brass Mfg. Company, Inc.
 - b. Fire-End & Croker Corporation.
 - c. Potter Roemer.
2. Standard: UL 199.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.

7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

E. Sprinkler Inspector's Test Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AGF Manufacturing Inc.
 - b. Triple R Specialty.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
 - e. Viking Corporation.
2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

2.4 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Globe Fire Sprinkler Corporation.
2. Reliable Automatic Sprinkler Co., Inc.
3. Tyco Fire & Building Products LP.
4. Venus Fire Protection Ltd.
5. Victaulic Company.
6. Viking Corporation.

B. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
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. Non-residential Applications: UL 199.
2. 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. Sprinkler Finishes:

1. Chrome plated.

2.5 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Valve Supervisory Switches:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fire-Lite Alarms; a Honeywell company.
 - b. Kennedy Valve; a division of McWane, Inc.
 - c. Potter Electric Signal Company.
 - d. System Sensor; a Honeywell company.
 - 2. Standard: UL 346.
 - 3. Type: Electrically supervised.
 - 4. Components: Single-pole, double-throw switch with normally closed contacts.
 - 5. Design: Signals that controlled valve is in other than fully open position.

2.6 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AMETEK, Inc.; U.S. Gauge Division.
 - 2. Ashcroft, Inc.
 - 3. Brecco Corporation.
 - 4. WIKA Instrument Corporation.
- B. Standard: UL 393.
- C. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- D. Pressure Gage Range: 0 to 250 psig minimum.
- E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.
- F. Air System Piping Gage: Include "AIR" or "AIR/WATER" label on dial face.

2.7 ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. One-Piece, Cast-Brass Escutcheons: Polished chrome-plated finish with setscrews.
- C. One-Piece, Stamped-Steel Escutcheons: Chrome-plated finish with setscrew or spring clips.
- D. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

2.8 SLEEVES

- A. Cast-Iron Wall Pipe Sleeves: Cast or fabricated of cast iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, standard weight, zinc coated, plain ends.

2.9 GROUT

- A. Standard: ASTM C 1107, Grade B, post-hardening, and volume adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Non shrink and recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements in NFPA 13 for installation of sprinkler piping.
- C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install unions adjacent to each valve in pipes 2" and smaller.
- E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having 2-1/2" and larger end connections.
- F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- G. Install sprinkler piping with drains for complete system drainage.
- H. Install alarm devices in piping systems.
- I. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements in NFPA 13 for hanger materials.

- J. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than 1/4" and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal and install where they will not be subject to freezing.
- K. Drain dry-pipe sprinkler piping.
- L. Pressurize and check dry-pipe sprinkler system piping and air compressors.

3.2 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- D. 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.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- F. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- G. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.3 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. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
2. Dry-Pipe Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
 - a. Install air compressor and compressed-air supply piping.

3.4 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:
 1. Piping with fitting or sleeve protruding from wall.
 2. Bare piping at wall and floor penetrations in finished Spaces:
 3. Bare piping at ceiling penetrations in finished spaces:
 4. Bare piping in unfinished service spaces:
 5. Bare piping in equipment rooms
 6. Bare piping at floor penetrations in equipment rooms.

3.5 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. Perform 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.
- B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.7 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.8 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: Upright sprinklers with exposed piping below the ceiling.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
 - 1. Upright Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 21 1316

DIVISION 22 PLUMBING

22 0000 General Requirements for Plumbing Systems

- 22 0001 Basic Plumbing Requirements
- 22 0004 Firestopping for Plumbing Systems
- 22 0005 Excavation, Backfill and Surface Restoration

22 0500 Common Work Results for Plumbing

- 22 0513 Electrical Requirements for Plumbing Equipment
- 22 0519 Meters and Gauges
- 22 0520 Common Piping Materials and Methods
- 22 0523 General Duty Valves
- 22 0529 Pipe Hangers and Supports
- 22 0530 Equipment Bases and Supports
- 22 0553 Identification for Plumbing Systems

22 0700 Plumbing Insulation

- 22 0719 Pipe Insulation

22 1000 Plumbing Piping and Pumps

- 22 1116 Domestic Water Piping
- 22 1119 Domestic Water Piping Specialties
- 22 1123 Domestic Water Pumps
- 22 1316 Sanitary Waste and Vent Piping
- 22 1319 Sanitary Waste Piping Specialties
- 22 1416 Interior Storm Piping
- 22 1423 Storm Drainage Piping Specialties

22 3000 Plumbing Equipment

- 22 3333 Electric Storage Water Heaters

224000 Plumbing Fixtures

- 22 4200 Plumbing Fixtures

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SECTION 22 0001 – BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes the following:
1. General Requirements
 2. Definitions
 3. Scope of Work
 4. Drawings and Specifications
 5. Reference Standards
 6. Allowances, Unit Prices and Alternates
 7. Site Visit
 8. Permits, Regulations and Inspections
 9. Project Management and Coordination
 10. Temporary Utilities
 11. Workmanship
 12. Protection
 13. Painting
 14. Record Drawings
 15. Cleaning
 16. Miscellaneous Equipment Connections
 17. Equipment Selection
 18. Shop Drawings
 19. Final Inspection and Punch List
 20. Operation and Maintenance Manuals
 21. Warranties
 22. Project Closeout
 23. Operation and Adjustment of Equipment
 24. Operating Demonstration and Instruction

1.2 GENERAL REQUIREMENTS

- A. All provisions of Division 00 Front End Documents and Division 01 General Requirements apply to work specified in this Division.
- B. Specification provisions of other relevant Divisions shall apply where applicable work is required to be performed under this Plumbing work.
- C. A complete and functional Plumbing system installation shall be provided under this Division. Should overlap of work among trades become evident, this shall be called to the attention of the architect. In such event, none of the trades or their suppliers shall assume that he relieved of the work which is specified under his branch until instructions in writing are received from the Architect.

- D. The Mechanical and Electrical drawings and specifications assign work (labor and/or materials to be provided by the General, Plumbing, Fire Suppression, HVAC or Electrical Contractor or their sub-contractors. Understanding that the contractors for mechanical and electrical work are sub-contractors to the (General) Contractor, such assignments are not intended to restrict the Contractor in assignment of work among the sub-contractor to accommodate trade agreements and practices or the normal conduct of the construction work.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SCOPE OF WORK

- A. The scope of the Plumbing work includes furnishing, installing, testing and warranty of all Plumbing work shown on the Plumbing drawings and specified herein, including Division 00, Division 01, Division 22 and applicable provisions of other relevant Divisions..

1.5 DRAWINGS AND SPECIFICATIONS

- A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word “provide,” as used, shall mean “furnish and install.” If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect for approval before proceeding with the work.
- B. Make all necessary field measurements to insure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.
- C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having pipe and fittings fabricated and delivered in advance of making actual measurements shall be sufficiently in advance as to not

cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

- D. The Architect shall reserve the right to make minor adjustment in locations of system runs and components where he considers such adjustments desirable in the interest of concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties.
- E. Equipment or piping shall not be installed or run above electrical switchgear or panelboards, nor in or above the access space in the immediate vicinity of the electrical switchgear/panelboards, in accordance with NEC Article 384.
- F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect's decision shall be final in regard to the arrangement of ductwork, piping, etc., where conflict arises.
- G. Provides offsets in system runs, additional fittings, necessary drains and minor valves, traps, and devices required to complete the installation, or for the proper operation of the system. Each Contractor shall exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.
- H. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect. In such event, none of the trades or their suppliers shall assume that he is relieved of the work which is specified under his branch until instructions in writing are received from the Architect.

1.6 REFERENCE STANDARDS

- A. Where standards (NFPA, NEC, ADTM, UL, ASPE, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the authority having jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

1.7 ALLOWANCES, UNIT PRICES AND ALTERNATES

- A. Refer to Sections 01200 Allowances, 012200 Unit Prices and 012300 Alternates.

1.8 SITE VISIT

- A. Refer to Section 017300 Execution.
- B. Each bidder shall visit the project site to understand the existing conditions and compare the conditions with information shown on the drawings. Report immediately to the Architect any issues or discrepancies which are discovered that affect the bid. Changes to contract price will not be considered for site condition issues that are readily apparent from a thorough site review.

1.9 PERMITS, REGULATIONS AND INSPECTION

- A. Work must conform to applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawing and specifications shall govern. Install no work contrary to minimum legal standards.
- B. Except where the permit application is made by the Architect or the Engineer, the Plumbing contractor shall be responsible to file for and obtain all required permits from the governing inspection agencies for the plumbing work. Where the Architect or Engineer is the Architect or Engineer of record, they will furnish sealed and signed drawings and specifications required by the permit authorities.
- C. Include payment of all permit and inspection fees applicable to the work in this Division.
- D. All work shall be subject to inspection and approval of Federal, State and local agencies as may be appropriate as well as the Architect and Engineer.
- E. Furnish for the Owner certificates of approval from the governing inspection agencies as a condition for final payment.

1.10 PROJECT MANAGEMENT AND COORDINATION

- A. Refer to Section 013100 Project Management and Coordination.
- B. The HVAC Contractor shall initially prepare and be responsible for ¼” scale coordination drawings. These drawings shall be reproduced and distributed to the Plumbing, Fire Suppression and Electrical Contractors for their input and revisions. Assure that all contractors work together to obtain finish coordinated drawings and no work being installed until all contractors have approved and signed-off with their approval and drawings have been submitted and reviewed by the Engineer.

1.11 TEMPORARY UTILITIES

- A. Refer to Section 015000 – Temporary Facilities and Controls for division of responsibilities for temporary utilities.
- B. Install new water service and piping from the new service as soon as practicable to facilitate water supply for construction purposes. Provide a water meter, piping and hoses bibbs with vacuum breaker at the site as directed by the General Contractor. Protect meter and piping from physical damage and freezing.
- C. Cost of water use for construction is not included in Division 22.
- D. Remove construction water meter and piping when no longer required.

1.12 WORKMANSHIP

- A. Refer to Section 014000 Quality Requirements.

- B. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Architect shall have the right to stop the work if highest quality workmanship is not maintained.
- C. Plumbing work shall be performed by licensed Plumbing Contractors in accordance with requirements of the jurisdiction.

1.13 PROTECTION

- A. Each Contractor shall be entirely responsible for all material and equipment furnished in connection with his work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect.
- B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide plastic sheeting, drop cloths or similar barriers where dust and debris is generated, to protect adjacent areas.
- C. Contractor shall protect all equipment and materials from detrimental effects of weather or construction activity. All items shall be stored and secured in a protected location away from the daily work area. Equipment or materials shall be placed on raised skids to protect from surface moisture. Where appropriate, provide plastic sheeting or similar vapor barrier underneath the stored products to reduce the effects of ground moisture or curing concrete on the local humidity levels. Where unfinished ferrous products or finished ferrous products with raw edges are stored, provide local, dry heat to maintain ambient relative humidity levels below 65% RH to prevent rust.
- D. All equipment shall retain the original packaging until required to be removed for installation or operation. Open ends of piping, conduit, etc. shall be capped or sealed and ventilation openings into equipment shall be wrapped and sealed in plastic sheeting to prevent dust or dirt entry both when stored and after installation but still open to the effects of construction activity. Stored items as well as installed equipment shall be covered with plastic sheeting at all times until placed in service or until dust generating activity in the area has ceased.

1.14 PAINTING

- A. In addition to any painting specified for various individual items of equipment, the following painting shall be included in Division 22:
 - 1. Ferrous metal which is no factory or shop painted or galvanized and which remains exposed to view in the finished areas of the building / building including finished areas, mechanical rooms, storage rooms, and other unfinished areas shall be given a prime coat of paint.
 - 2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint.

3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch-up.
- B. Paint, surface preparation and application shall conform to applicable portions of the Painting section of Division 9 of the Specifications. All rust must be removed before application of paint.
- C. Finish painting is included in the General Contract except where otherwise required under remodeling work. Refer to the Cutting and Patching paragraph in this Section for finishing requirements

1.15 RECORD DRAWINGS

- A. Refer to Section 017839 Project Record drawings.
- B. Each Contractor shall maintain a separate set of prints of the contract documents and shall show all changes or variations, in a manner to be clearly discernible, which are made during construction. Upon completion of the work, these drawing shall be turned over to the Architect.

1.16 CLEANING

- A. Debris, dust, dirt, etc shall be removed daily, particular attention shall be paid to areas that the Owner is continuing to occupy or use; any mess created in corridors, stairwells and egress paths that are maintained during construction shall be cleaned immediately.
- B. The Owners dumpsters and trash receptacles shall not be used. If a dumpster is required, it shall be provided by the contractor and located where approved by the Owner. Coordinate dumpster requirements with other contractors.
- C. Before turning an area back over to the Owner, thoroughly clean the space to leave the area in a similar condition before the start of the project where finishes are to remain.

1.17 MISCELLANEOUS EQUIPMENT CONNETIONS

- A. Certain categories of fixtures and equipment, including kitchen equipment, sterilizers, washers, laundry and laboratory equipment, require piping connections and duct connections as shown on the drawings. Equipment will be furnished and set in places by the equipment supplier.
- B. Make all final connections to these fixture and equipment, as indicated and in accordance with the manufacturer's recommendations. All piping connections shall be valved and final connections made with unions.
- C. Fixtures and equipment, unless otherwise noted, will be furnished complete with the basic plumbing supply and waste trim. The trim will generally be furnished "loose" and shall be installed under this work. Countertop sinks furnished "loose" shall also be installed by the Plumbing Contractor.

- D. Provide supplies, supply stops, traps, shut-off valves, fixture drains, continuous wastes and indirect wastes. Provide a water-hammer arrestor on the system side of each automatic (quick-closing) valve on water supply lines. Items not specifically described elsewhere in these specifications shall be of the same manufacturer as similar items specified in conjunction with the plumbing fixtures.
- E. Supply piping and devices where exposed to view in the finished space, shall be chrome plated and insulation shall be omitted.
- F. Roughing-in drawings shall be obtained for the various fixtures and items of equipment as the time approaches when such information is required; allow a reasonable period, from the time of notice, to obtain this information.
- G. Connections to equipment shall be in accordance with manufacturers' installation guidelines. Any additional accessories recommended by the manufacturer such as gauges, shut-off valves, unions at connection points, etc., shall be provided by this Contractor.

1.18 EQUIPMENT SELECTION

- A. Materials and equipment furnished under this contract shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.
- B. The selection of materials and equipment to be furnished under this contract shall be governed by the following:
 - 1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specifications, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturers listed.
 - 2. Where the words "or approved equal: appear after a manufacturer's name, specific approval must be obtained from the Architect during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.
 - 3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.
- C. Substitute equipment of equal quality and capacity will be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.
- D. Before bidding equipment, and again in the preparation of shop drawings the Contractor and his supplier shall verify that adequate space is available for entry and installation of the item of equipment, including associated piping and accessories. Also verify that adequate space is available for servicing of the equipment.

- E. If extensive changes in pipe, or equipment layout or electrical wiring and equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in the contract.

1.19 SHOP DRAWINGS

- A. Refer to Section 016000 Product Requirements.
- B. Shop drawings for equipment fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. Failure to do so may be cause for rejection of shop drawings.
- C. The review of shop drawings by the Architect or Engineer shall not relieve the Contactor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer's attention in a separate clearly stated notification at the time of submittal for the Engineer's review.
- D. Shop drawings for the following Plumbing equipment and materials shall be submitted:
 - 1. Pipe, fittings and joining methods for the various systems.
 - 2. Firestopping systems for pipe penetrations.
 - 3. Pipe hangers and saddles.
 - 4. Seismic restraint drawings calculations, and related devices.
 - 5. Valves.
 - 6. Flexible connectors.
 - 7. Gauges.
 - 8. Vibration isolators.
 - 9. Pipe insulation
 - 10. Supply system specialties.
 - 11. Backflow preventers
 - 12. Drainage system specialties
 - 13. Oil interceptor
 - 14. Plumbing fixtures and trim
 - 15. Water heating equipment

1.20 OPERATING AND MAINTENANCE MANUALS

- A. Refer to Section 017823 Operation and Maintenance Data.
- B. All shop drawing and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, the Contractor shall prepare a chart listing all items of equipment which are furnished under his contract and indicating the nature of maintenance required, the recommended frequency of checking these points and the type of lubricating media or replacement material required.
- C. These shall be assembled into three-ring loose lead binders or other appropriate binding and also combined into a single electronic file in .PDF format. An index and tabbed sheets to

separate the sections shall be included. These shall be submitted to the Architect or Engineer for review. Upon approval, manuals shall be turned over to the Owner.

1.21 WARRANTIES

- A. This Contractor shall warrant all workmanship, equipment and material entering into this contract for a period of one year of date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect. Any materials or equipment proving to be defective during this warranty period shall be made good by this Contractor without expense to the Owner.
- B. This provision is intended specifically to cover deficiencies in contract completion or performance which are discovered after systems are placed in operation. Also included shall be supplementary assistance in balancing, adjusting or providing operating instructions as the need develops, and replacing overload heater elements in starters where necessary to keep systems in operation. Heater element sizes shall not exceed the motor manufacturer's recommendations.
- C. This provision shall not be construed to include maintenance items such as replacing filters, and cleaning strainers after these have been done for final close-out.
- D. Provisions of this warranty shall be considered supplementary to warranty provisions under General Conditions.

1.22 PROJECT CLOSEOUT

- A. Refer to Section 017700 Closeout Procedures.

1.23 OPERATIONS AND ADJUSTMENT OF EQUIPMENT

- A. As each piping system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing the domestic hot water return system,
- B. Caution: Verify that all bearings are lubricated, all motors are operating in the right direction, and correct overload heater elements are provided on all motors. Do not depend wholly on the electrician's judgment in these matters. Follow specific instructions in regard to lubrication. Do not oil or grease presealed ball bearings unless upon manufacturer's specific instructions.
- C. Test relief valves, air vents and regulating valves to insure proper operation.

1.24 OPERATING DEMONSTRATION AND INSTRUCTIONS

- A. Refer to Section 017900 Demonstration and Training as well as individual Division 22 Sections for requirements.
- B. The Contractor shall set the various systems into operation and demonstrate to the Owner and Architect that the systems function properly and that the requirements of the Contract are fulfilled.

- C. The Contractor shall provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.
- D. A minimum of 4 hours shall be allowed for instructions to personnel selected by the Owner. Instructions shall include not less than the following:
 - 1. Show locations of items of equipment and their purpose.
 - 2. Review binder containing instructions and equipment and systems data.
 - 3. Coordinate written and verbal instructions so that personnel understand each.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION– NOT APPLICABLE

END OF SECTION 22 0001

SECTION 22 0004 – FIRESTOPPING FOR PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes through-penetration firestopping systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

1.2 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
- B. Rated Systems: Firestopping assemblies shall be tested and rated in accordance with ASTM E814 (ANSI/UL 1479) Fire Tests of Through-Penetration Fire Stops (minimum positive pressure of .01 inches of water column) and E119 (ANSI/UL 263) Fire Tests of Building Construction and Materials Time-Temperature Curve. Firestopping shall provide an “F” fire rating equal to that of the construction being penetrated. Firestop systems shall meet all requirements of the Ohio Building Code.
- C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
 - 1. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.
 - 2. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
- D. For through-penetration firestop systems exposed to view or above ceilings in air return plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each through-penetration firestop system, submit documentation, including illustrations, from a qualified testing and inspecting agency, showing each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Firestopping materials shall be manufactured and/or supplied by:
1. Hilti, Inc.
 2. Johns Manville.
 3. Nelson Firestop Products.
 4. Specified Technologies Inc.
 5. 3M; Fire Protection Products Division.
 6. Tremco; Sealant/Weatherproofing Division.

2.2 FIRESTOPPING

- A. Materials shall be in the form of caulk, putty, sealant, intumescent material, wrap strip, fire blocking, ceramic wool and other materials required for the UL listed assemblies. These shall be installed in conjunction with sleeves and materials for fill and damming.

PART 3 - EXECUTION

3.1 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

- A. General: Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer's instructions.
- B. Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.
- C. Provide firestop system for every pipe at penetration of all fire resistance rated walls and horizontal assemblies.
- D. Coordinate opening size and additional framing requirement with the General Contractor for each opening to meet the firestop installation requirements.
- E. Annular space of penetrations of non-fire-resistant-rated floor, floor/ceiling assemblies, or the ceiling membrane of a non-fire-resistant rated roof/ceiling assembly shall be filled with an approved firestopping material to resist the free passage of flame and products of combustion.
- F. Smoke Barriers:
1. Penetrations shall be sealed with a firestopping system to prevent the passage of smoke.
- G. Smoke Partitions:
1. Penetrations shall be sealed with a caulking material to prevent the passage of smoke. Non-rated smoke partitions do not require a fire stopping system.

END OF SECTION 22 0004

SECTION 22 0005 – EXCAVATION, BACKFILL AND SURFACE RESTORATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Excavating and backfilling for utility trenches.
 - 2. Excavating and backfill for in-ground tanks provided by Division 22.

1.2 DEFINITIONS

- A. Backfill: Soil material used to fill an excavation.
 - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.
- C. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- D. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions changes in the Work.
 - 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- E. Fill: Soil materials used to raise existing grades.
- F. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- G. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below topsoil materials.
- H. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.

1.4 GENERAL

- A. Excavate for all in-grade, under-floor piping, underground, exterior piping, underground tanks and incidental work which are included in the Plumbing contract. Backfill to finish grade or to levels consistent with the General Contractor's and Site Contractor's activities. Cut existing street, drive, and parking lot paving, walks, curbs and other permanent hard surfaces which are to be encountered. Repair or restore exterior surfaces to original condition where such are not affected by Division 2 – Site Work. Cut existing floor slabs and replace slabs in conformance to 22 0002.
- B. Excavation and trench wall supporting, cribbing, sloping and stepping of excavations required for safety shall be done in accordance with OSHA and local requirements. Pumping of water from excavations and trenches which may be required during construction shall be included in this contract.
- C. Contact the Ohio Utilities Protection Service (1-800-362-2764) well in advance of the start of any excavation to determine if any of the utility companies or departments have underground utilities in or near the project area.
- D. Contact local water and sewer departments, gas company, electric company, telephone company, etc., regarding the possibility of encountering existing utilities. The integrity of all existing utilities shall be respected.
- E. Existing utilities encountered during excavation work shall be protected in a manner acceptable to the utility owner. Any utilities that are damaged shall be repaired or replaced by the Contractor to the full satisfaction of the utility owner.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Bedding Course: Naturally or artificially graded natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.
- B. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

PART 3 - EXECUTION

3.1 EXCAVATION FOR UTILITY TRENCHES

- A. Trenches for interior and exterior piping shall be over-excavated and the pipe shall be laid on 6” minimum depth sand bed.
- B. Backfilling of excavations and trenches inside the building and outside under paved or other hard surfaced areas, shall be with graded pea gravel, graded coarse sand or compacted, crushed limestone, 3/4” maximum size, to prevent undue settlement. Backfill material for plastic piping shall be pea gravel or sand. Other excavations and trenches shall be backfilled with similar materials up to 18” above the top of the piping. The remainder shall be with similar materials or with excavated material having no large clods, stones or rocks.
- C. Maintain in place adequate barricades, guards, planking, plating signage, warning lights, etc., at and around excavations.
- D. Backfill shall be mechanically compacted in layers not over 6” deep. Water settling will not be permitted. Where excavations have not been properly filled or where settlement occurs, they shall be refilled, compacted, smoothed off, and finally made to conform to the initial requirements. Excess excavated materials shall be removed from the site or disposed of as directed by the General Contractor. Refer to Division 31 Earthwork for compaction requirements.
- E. Concrete floor slabs, paving, sidewalks, curbs sodded and other finished surfaces which have been damaged or removed in order to install the underground work shall be replaced but this Contractor equal to original conditions. Refer to Division 32 for Surface Restoration requirements. This requirement is not applicable in areas where the General Contractor or the Site Contractor is obligated to provide new surfaces.
- F. Excavation, backfill, surface repair and traffic control within the public right-of-way shall be in accordance with governing agency rules and regulations. Any fee for activity in the roadways shall be included in this contract so that no additional cost will accrue to the Owner.
- G. All exterior underground piping shall be protected against future excavation damage by placing a plastic tape warning marker in each trench during backfill. Tape shall be 6’ wide with black letters identifying the piping service. Tape shall be equal to that manufactured by Seton. Install tape full length of the trench approximately 18’ above and on the centerline of the pipe.

END OF SECTION 22 0005

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SECTION 22 0513 - ELECTRICAL REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements for electrical work for Plumbing equipment including single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation and other electrical equipment, devices, fuses, wire, conduit and installation methods.

1.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.
- B. Refer to the Plumbing drawings and the Electrical drawings for requirements related to each trade. Coordinate all aspects of electrical components and wiring to complete the systems.

1.3 QUALITY ASSURANCE

- A. Equipment, devices shall be designed, constructed and installed in accordance with applicable standards of NEMA and the National Electric Code. Equipment shall be tested and listed by UL or other approved agency and installed in accordance with all instructions included as part of such listing.
- B. Electrical equipment, devices, fuses, wire, conduit and methods shall comply with applicable provisions of Division 26 - Electrical.

PART 2 - PRODUCTS

2.1 Motors

- A. General duty motors shall be induction type 1750 rpm NEMA Design "B" with copper windings, Class B or F insulation, and motor enclosure to suit the application. Service factor shall be 1.15 minimum.
- B. Two-speed motors shall be two-winding type with six leads unless otherwise specified.

- C. Motors for other than general duty application shall be furnished to suit the application and operating environment.
- D. Premium efficiency motors shall be equal to Century “E + 3”, General Electric “Energy Saver Premium Efficiency”, Baldor “Super E Premium Efficient” or Reliance “Premium Energy Efficient” series. Motor efficiencies shall be tested and conform to NEMA Standard Publication MG-1 and IEEE 112 Test Method B.
- E. Motors used with variable frequency controllers shall be rated for inverter service in accordance with NEMA Standard Publication MG-1, Part 31 and designed with Class F or H insulation, but with a Class B temperature rise.
- F. Motor sizes shown on the drawings are to be considered minimum. Motors furnished shall be sized so as to not operate in the service factor range. Motors for direct driven pumps and fans shall be selected so as to not operate in the service factor range at any point on the curve.
- G. The Plumbing Contractor and equipment suppliers shall compare the electrical power requirements of the intended equipment with power feeders to the equipment shown on the Electrical drawings. Verify adequacy and compatibility of voltage, phase, wiring, capacity, number and size of conductors (versus equipment connection points), fusing and other information on the electrical and mechanical drawings to that required for the equipment. If the selected equipment requires revision of the electrical, added cost must be borne by the Plumbing Contractor.

2.2 STARTERS

- A. Magnetic starters shall comply with provisions of Division 26 - Electrical Specifications and shall be NEMA construction (IEC rated not acceptable) with thermal overload element on each phase, 115 volt control voltage and hand-off-automatic switch, where appropriate.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Motor connections of factory assembled equipment shall be made with flexible conduit except for plug-in electric cord connections.
- B. All power wiring shall be run in conduit. Control wiring shall be run in conduit except where open wiring is permitted in other applicable specification sections.
- C. Fuses shall be furnished and installed in fuse clips of equipment and switches provided by the Plumbing Contractors.

END OF SECTION 22 0513

SECTION 22 0519 - METERS AND GAUGES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Thermometers.
 - 2. Gauges.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 THERMOMETERS

- A. Thermometers shall be 9” blue reading organic spirit filled tube column type with cast aluminum case with epoxy finish, acrylic window, aluminum scale with white background and black markings, 1% accuracy, adjustable angle hinge assembly and 3.5” aluminum insertion stem, equal to Terrice BX91403.
- B. Provide a separable socket insertion thermowell shall be furnished with each thermometer. An extension neck, with appropriate increase in thermometer stem length, shall also be furnished where insulation thickness exceeds 2”.
- C. Ranges of thermometers shall be selected from standard Fahrenheit scales to be consistent with anticipated temperatures, typically 0 deg.F.- 160 deg.F.

2.2 PRESSURE GAUGES

- A. Pressure gauges, including compound gauges and vacuum gauges, shall be Bourdon tube type with 4-1/2” dial and cast aluminum case, equal to Terrice 600C Series. Accuracy shall be 1% at mid-range.
- B. Pressure gauges for low pressure application, calibrated in inches of water gauge, ounces per sq. in. or 0-5 psi, as appropriate, shall be equal to Terrice 860.
- C. Pressure gauges at pumps shall be liquid filled Bourdon tube type with 4” dial and stainless-steel case and internals, equal to Terrice 700 Series.

- D. A brass cock or bronze ball valve and a pressure snubber shall be furnished with each pressure gauge.
- E. Ranges of pressure gauges shall be selected to be consistent with anticipated pressures. Range shall be approximately twice the normal system working pressure at the gauge location.

2.3 TEST PLUGS

- A. Pressure-temperature test plugs for insertion of pressure gauge or thermometer shall be a brass fitting with neoprene or Nordel self-sealing insert and knurled brass cap with plastic capture tab. Fittings shall be equal to Peterson “PT”. Furnish two thermometers and two pressure gauges with integral insertion stem appropriate for use with the test plugs.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Thermometers shall be installed where shown on the drawings and also at:
- B. Pressure gauges shall be installed where shown on the drawings, where required by applicable codes and also at:
- C. Thermometers and gauges shall be positioned to be read with unobstructed view from the floor. Pressure-temperature test plugs shall be installed where shown, located in a position to be most readable.
- D. Install thermometer wells in piping tees in the vertical position. Fill the well with oil or graphite and secure the thermometer in position

END OF SECTION 22 0519

SECTION 22 0520 – COMMON PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Dielectric fittings.
2. Mechanical sleeve seals.
3. Sleeves.
4. Escutcheons.
5. Grout.
6. Piping Systems - Common Requirements.
7. Equipment installation requirements common to equipment sections.

1.2 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- B. Welders shall be qualified and fully certified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
- C. Welding procedures and testing shall comply with ANSI Standard B31.1.0 Standard Code for Pressure Piping, Power piping and The American Welding Society Welding Handbook.
- D. All pressure piping systems regulated by the Ohio Pressure Piping Systems Code, Chapter 4101:8 shall conform to applicable requirements of the Code. Welders shall carry a current State of Ohio, Pressure Piping Board Certification. Each welder shall submit a copy of their signed performance qualification record to the Engineer for approval prior to beginning work on any pressure piping system.
- E. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2 - PRODUCTS

2.1 DIELECTRIC CONNECTORS

- A. A dielectric connector shall be incorporated at each connection between ferrous and copper piping. Connectors shall be:
 - 1. Dielectric coupling with non-conductive polymer liner, Lochinvar Corp. “V-line” Dielectric fitting on services 180 degrees and less.
 - 2. Dielectric flange with non-metallic bolt hole grommets and gasket.
 - 3. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F .

2.2 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- C. Pressure Plates: Plastic. Include two for each sealing element.
- D. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 SLEEVES

- A. Schedule 40 black steel pipe or 18-gauge galvanized steel poured concrete floors, walls and roof decks.
- B. 26-gauge galvanized sheet or Schedule 40 black steel pipe in the other than poured concrete.
- C. Combination pre-set floor sleeve and firestopping assembly equal to Hilti CP 680.
- D. Concrete curbs may be formed and poured around multiple pipe risers in rooms with waterproofing floor membrane, in lieu of the Smith 1720 riser sleeve and clamping ring. Curbs shall be 4” wide x 4” high with chamfered corners. Membrane and curbing shall be arranged to maintain the integrity of the membrane. Pipe sleeves shall be as described for normal areas or extended to the top level of the curb where the concrete is full depth throughout the curbed area.
- E. Piping and conduits extending thru the roof may be fitted with a manufactured pipe curb weatherproofing assembly equal to Pate pca, as an alternative to riser sleeves with clamping rings specified above.

2.4 ESCUTCHEONS

- A. Escutcheon plates shall be split-ring chromium plated pressed steel. Plates shall be sized to cover the surface penetration and sleeve. Plates shall be installed on exposed piping in finished rooms and areas where pipes penetrate walls, floors, ceilings or overhead structure.

2.5 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and non-metallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Pipe and tubing shall be cut and fabricated to field measurements and run parallel to normal building lines. Pipe ends shall be cut square and ends reamed to remove burs. The pipe interior shall be cleaned of foreign matter before erection of the pipe.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Piping shall not be run above electrical switchgear or panelboards, nor above the access space in the immediate vicinity of the equipment, in accordance with N.E.C. Article 384.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Install piping to permit valve servicing.
- H. Install piping adjacent to equipment and specialties to permit servicing and maintenance.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Install piping to allow application of insulation.

- L. Select system components with pressure rating equal to or greater than system operating pressure.
- M. Install escutcheons for penetrations of walls, ceilings, and floors.
- N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- O. Verify final equipment locations for roughing-in.

3.2 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping 2” and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping 2-1/2” and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.3 PIPE SLEEVES

- A. Pipe sleeves, floor and wall openings, water protective curbing and escutcheon plates shall be provided as described below. Pipe sleeves shall be placed in all floor slabs, poured concrete roof decks, walls and partitions, except as noted below, to allow new piping to pass thru and allow for expansion, contraction and normal movement of the pipe. Sleeves are also required for all existing piping related to the various trades in new walls, partitions, floors and roof slabs, same as for new piping.
- B. Sleeves are not required in the following:
 - 1. In floor slabs on grade.
 - 2. In stud and gypsum board or plaster walls and partitions which are not fire rated.
 - 3. For uninsulated pipe passing thru masonry walls and partitions and stud and gypsum board or plaster walls and partitions.
 - 4. In core drilled openings in solid concrete not requiring water protection. Sleeves are required, however, at core drilling thru hollow pre-cast slabs and concrete block walls, to facilitate containment of required firestopping material.
 - 5. In large floor openings for multiple pipe and duct risers which are within a fire rated shaft, unless the opening is to be closed off with concrete or other material after pipe are set.
- C. Length of wall sleeves shall be such that the sleeve ends are substantially flush with both sides of the wall or partition. Floor sleeves shall be flush with the bottom and top of the floor slab except, in mechanical rooms and other areas which might have water on the floor, sleeves shall project a minimum of 1” above finished floor. Pipe sleeves shall be sized to allow insulation to pass thru the sleeve, for insulation requiring continuous vapor barrier (domestic cold water, chilled water refrigerant, etc.). Where vapor barrier continuity is not needed, the sleeve may be

sized to pass the pipe only or the insulation as well. Refer to the following paragraph for qualification and exceptions relating to firestopping.

- D. Pipe sleeves which are part of firestopping assemblies shall conform to the requirements of the assembly with particular emphasis regarding size, annular space, length, passage or non-passage of insulation and the installation of the sleeves.
- E. Where firestopping is not required, the annular space between the sleeve, core drilling or opening and the pipe or pipe insulation shall be closed with caulking to retard the passage of smoke.
- F. Where uninsulated pipes requiring no pipe sleeves pass thru non-fire rated floor, wall or partition, the annular space shall be closed with material and methods compatible with the wall or partition material (Type M masonry grout, drywall joint compound, plaster, etc.).

3.4 Mechanical Seals

- A. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required 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.
- B. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required 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.

3.5 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.

- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 22 0520

SECTION 22 0523 – GENERAL DUTY VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ball valves.
2. Check valves.
3. Gate valves.
4. Balancing-Shutoff valves.

B. Related Sections:

1. Division 22 Plumbing piping Sections for specialty valves applicable to those Sections only. Section 22 0553 "Identification for Plumbing Systems" for valve tags and schedules.
2. Valves for natural gas, compressed air vacuum systems are specified in the system specification. See appropriate Division 22 specification.

1.2 SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.3 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
- C. Sweat end valves of equal construction and features are acceptable in lieu of those specified with screwed ends. Valves of equal construction and features with ends compatible with mechanical joint couplings are acceptable on such systems, and may be manufactured by the coupling system manufacturer. Grooved end valves shall conform to ANSI/AWWA Standard C-606.
- D. Ball valves in piping which is to be insulated shall have extended shaft necks to accommodate the insulation.
- E. All valve for Domestic potable water systems (cold, hot hot return, etc.) shall be “lead free” in accordance with the Federal Safe Water Act (S3874) definition and NSF/ANSI-61 approved

PART 2 - PRODUCTS

2.1 Refer to valve schedule on the Drawings for piping material and applications.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

- A. Drain valves shall be the same as for the shut-off service. Provide a ¾” hose thread adapter on the outlet of each drain valve that is not piped to a drainage point. Hose thread adapters on drain valves of potable water piping shall be fitted with a non-removable vacuum breaker.
- B. Internals shall be removed and the remaining elements of sweat end valves shall be protected against heat damage during soldering or brazing
- C. Valves shall be installed with the stem at or above the centerline of the pipe. Valves shall be located to be accessible for operation, servicing and/or removal.
- D. Packing glands shall be tightened before placing the valves in service.

END OF SECTION 22 0523

SECTION 22 0529 – PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Hanger Rods and Attachments.
 - 5. Pipe Riser Supports
 - 6. Roof Supports

1.2 DEFINITIONS

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design seismic-restraint hangers and supports for piping and obtain approval from authorities having jurisdiction.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Thermal-hanger shield inserts.
 - 3. Powder-actuated fastener systems.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS

- A. Hangers and supports for piping shall be equal to the Anvil catalog numbers as follows:
1. General service - clevis type - Fig. 260.
 2. Uninsulated copper tubing - copper plated clevis type - Fig. CT-65 (or plastic-coated clevis, or fiberglass construction).
 3. Where the length of the hanger rod between the top of the hanger and the attachment is 3" or less, clevis type hangers with rollers, Fig. 181, shall be used to allow for expansion travel
- B. Hangers on insulated horizontal piping shall be oversized to surround the pipe insulation. To protect the insulation from damage or inordinate compression due to concentrated weight, the following shall be provided at each hanger:
1. Pipe 2" and smaller – Anvil Fig. 168 18 ga. sheet metal rib-lock shield with belled ends, 12" long.
 2. Pipe 2-1/2" and larger – wood blocking to prevent crushing insulation, with Anvil Fig. 168 18 ga. Sheet metal rib-lock shield with belled ends, 12" long.
 3. Pipe 2-1/2" and larger – Factory fabricated assembly equal to Pipe Shields, Inc. A1000.
- C. The first two hangers on piping connecting to motor driven equipment shall be fitted with a steel spring and neoprene vibration isolation section similar to Mason Industries, No. 30N.

2.2 TRAPEZE HANGERS

- A. Trapeze hangers for numerous pipes run in parallel may be utilized. Horizontal support members shall be unistrut type section with pipe rollers (to allow for expansion travel) and spring and nut connectors, suspended with hanger rods and attachments similar to individual pipe hanger suspension.

2.3 HANGER RODS AND ATTACHMENTS

- A. Hanger rods shall be solid steel, threaded-end or all-thread rod, of diameter listed below or matching manufacturer's provisions. A hanger attachment device (for attachment to the structure) and locking nuts at the hanger attachment shall be provided on each hanger. Locking nuts shall be provided at each clevis hanger.

<u>Pipe Size</u>	<u>Min. Rod Dia.</u>
1" and smaller	1/4"
1-1/4" to 3"	3/8"
4" to 6"	1/2"
8"	5/8"
10"	3/4"
12" and larger	7/8"

B. Hanger rod attachment devices for attachment to the structure shall be:

1. Pre-set concrete inserts.
2. After-set steel expansion type concrete inserts.
3. Beam clamps for steel construction equal to Anvil Fig. 92, 93, or 94. Utilize swivel type in sloped steel construction to provide vertical support of pipe without bending hanger rods.
4. Channel support system equal to Unistrut or Hilti.

2.4 PIPE RISER SUPPORTS

A. Riser clamps on cold service insulated piping shall be:

1. Insulated Pipe size 1-1/2" and smaller shall be factory (Pipe Shields E1000) or shop fabricated assembly Fig. 261 with high density calcium silicate insulation and galvanized steel jacket.
2. Insulated Pipe size 2" and greater shall be factory fabricated assembly Pipe Shields, Inc. E1000.
3. Un-insulated copper tubing – Anvil Fig CT-121 or CT-121C
4. Un-insulated steel piping – Anvil Fig. 261.

2.5 ROOF SUPPORTS

- A. Pipe supports for pipe running across the roof shall be manufactured by Advanced Support Products, requiring no penetration of the roofing membrane. The support system shall consist of round injection molded polypropylene bases, 12 gauge hot dipped galvanized Unistrut framing and adjustable hot dipped galvanized or cadmium plated hangers and cadmium plated hanger rods as detailed. Furnish protective slip sheets of roofing membrane for installation under the bases.
- B. Pipe supports for pipe running across the roof shall be equal to Pate Model "PRS" roof support curb and "RAC" roller support assembly. Supports shall be heavy gauge galvanized steel roof curb with base plate, continuous welded corner seams, integral raised cant to match roof insulation, wood nailer, counterflashing and roller pipe supports. Units shall be field insulated on the inside with batt insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Spacing of hangers shall be as follows:

1. Steel pipe - Vertical:
 - a. At the base and 15 ft. maximum spacing unless otherwise shown.
2. Steel pipe - Horizontal:
 - a. 2" size and smaller – 8 ft. intervals
 - b. 2-1/2" thru 6" – 10 ft. intervals
 - c. 8" and larger – 12 ft.. intervals.
3. Cast iron pipe - Vertical
 - a. At the base and 15 ft. maximum spacing unless otherwise shown.
4. Cast iron pipe – Horizontal
 - a. At 10 ft. intervals.
 - b. Support each length of pipe not more than 18" from the joint.
 - c. Support terminal ends of horizontal runs and branches and each change in direction.
 - d. 5" and larger provide bracing to prevent horizontal movement in accordance with CISPI "Soil Pipe and Fittings Handbook"
5. Copper Tubing - Vertical
 - a. At the base and 10 ft. maximum spacing unless otherwise shown.
6. Copper Tubing – Horizontal
 - a. 1-1/4" size and smaller – 6 ft. intervals
 - b. 1-1/2" thru 2" – 8 ft.. intervals
 - c. 2-1/2" and larger – 10 ft. intervals
7. Plastic pipe
 - a. Per manufacturer's recommendations.

B. In piping systems with mechanical joint couplings, pipe hangers shall be provided on horizontal piping at normal specified intervals and, in addition, so that no pipe shall be left unsupported between any two couplings nor left unsupported whenever a change in direction takes place. Vertical piping shall be supported at normal specified intervals or every other pipe length, which ever is more frequent. The base of the riser or base fitting shall be supported.

C. Attachment of pipe hangers to the structure shall be with:

1. Pre-set concrete inserts in concrete construction of 4" minimum depth.
2. After-set concrete inserts, in 4" minimum depth concrete, set in drilled holes. Powder actuated driven fasteners are not permitted.
3. Provide anchoring where steel beam clamps are attached to sloping surfaces of beam flanges and where otherwise required to insure permanent attachment.
4. Side beam bracket in wood construction, secured to the wood joist with lag screws set in drilled pilot holes.

5. Unistrut channels with spring and nut rod connection may be utilized where a number of pipes are run parallel. Channel shall be attached to the structure with inserts or clamps.
 6. Attachment to steel deck is prohibited. Span from steel structural members with supplementary steel shapes where direct attachment to structural members is not practical.
- D. Attachment to manufactured trusses and other engineered structural members and supports shall be done in strict accordance with the structural manufacturer's recommendations. Refer to the architectural and structural drawings for type of engineered structural systems being used. Connections to these structural members shall be made with connection devices and methods approved by the structural manufacturer. Provide additional support with supplemental steel shapes when spacing between structural members exceeds specified distances.
- E. Pipe hangers shall be adjusted to proper elevation and all hanger rods set in a vertical position before pipe insulation is installed.
- F. Extended legs of pipe riser clamps shall be shortened as needed to maintain concealment of the clamp within the pipe chase. Ensure that adequate support is still maintained.
- G. Hanger assemblies which will remain exposed on completion of the project shall be painted before installation.
- H. Pipe supports manufactured by Advanced Support Products for pipe running across the roof shall be installed in accordance with the manufacturer's instructions and as detailed. Install protective slip sheets of roofing membrane under the bases to satisfy the requirements of both the roofing manufacturer and the support system manufacturer.

END OF SECTION 22 0529

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SECTION 22 0530- EQUIPMENT BASES AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Equipment Supports
- B. See Division 22 Section "Vibration Control" for vibration isolation devices.
- C. See Division 22 Section "Seismic Control for Plumbing Systems".

1.2 DEFINITIONS

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- B. Design seismic-restraint equipment support and obtain approval from authorities having jurisdiction.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Equipment hangers and supports.
 - 2. Equipment bases.
 - 3. Support Curbs.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 CONCRETE BASES

- A. Concrete bases and pads with anchor bolts cast-in-place. Bases shall be formed on all sides and hand troweled to a smooth, dense finish with neatly chamfered corners. Large concrete pads on grade shall be constructed with reinforcing steel or reinforcing roadway mesh.

2.2 STEEL SUPPORTS

- A. Structural steel angles, beams or channels, unistrut type channels or pipe. Supports shall be fabricated into a rigid framework with welded or bolted connections and cross-bracing or sway bracing. Supports shall be set on slab with base plates, or attached to the building structure as required. Brackets for relatively lightweight equipment may be attached to the wall. Equipment shall be set on and attached to the framework.
- B. Solid steel hanger rods supported from the structure above similar to pipe hangers. Provide sway bracing for equipment supported in this manner.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- B. Field Welding: Comply with AWS D1.1.
- C. Concrete bases for plumbing equipment are included in the Plumbing Contract. The Plumbing Contractor shall provide exact dimensions, locations and other detail for the specific equipment provided. The Plumbing Contractor shall set anchor bolts as required for the equipment.

END OF SECTION 22 0530

SECTION 22 0553 - IDENTIFICATION FOR PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Warning markers.
4. Valve tags.

1.2 SUBMITTAL

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

1.3 QUALITY ASSURANCE

- A. Labels, tags and markers shall comply with ANSI A13.1 for lettering size, colors and length of color field.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Each item or major equipment shall be labeled. This shall include water heaters, pumps, and other similar equipment consistent with tags on drawings.
- B. Labeling shall be:
1. Permanently attached engraved brass or plastic laminated signs with 1" high lettering. Signs on exterior equipment shall be brass.
 2. Stencil painted identification, 2" high letters, with standard fiberboard stencils and standard black (or other appropriate color) exterior stencil enamel.

2.2 PIPE LABELS

- A. Pipe markings shall be applied to all piping.
- B. Labeling shall be:

1. Snap-On Type – Plastic, semi-rigid snap-on type, manufacturer’s standard pre-printed pipe markers or pressure-sensitive vinyl pipe markers.
2. Adhesive Type – Strip-type markers fastened to the bare pipe or insulation with laminated or bonded application or plastic tape not less than 1-1/2” wide. On piping and insulation 6” and greater diameter provide full band.
3. Lettering heights shall be as specified by manufacturer for indicated pipe/pipe plus insulation size.
4. Markers shall extend fully around pipe and insulation or full circle at both ends of the marker.
5. Markers shall be color coded for service.
6. Flow direction arrows provided integral with the pipe marker or separate at each marker.
7. Service pressure for compressed air and natural gas piping systems.
8. In areas where exposure to water or high humidity is anticipated, provide washdown, fade-resistant style labels.

2.3 WARNING MARKERS

- A. Underground line marker tape shall be permanent, bright-colored, plastic with continuous identification lettering. Tape over service lines that cannot be detected by a metal detector shall be multi-ply with an aluminum foil core.

2.4 VALVE TAGS

- A. Each shutoff valve, other than at equipment, shall be identified with a stamped tag. Valves and tagging shall be scheduled, typewritten on 8-1/2” x 11” paper, tabulating valve number, piping system, abbreviation, location of valve (room or area) and service (e.g. – south wing reheat boxes).
- B. Valve tags shall be polished brass or plastic laminate with solid brass S hook. Tags shall be engraved with “P” for Plumbing and the designated number.

2.5 ACCEPTABLE MANUFACTURERS

- A. Labels, markings and tags shall be manufactured by:
 1. W.H. Brady
 2. Seton
 3. Allen
 4. Industrial Safety Supply
 5. McMaster-Carr

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Identification marking and tagging shall be applied after insulation and painting has been completed.
- B. Coordinate names, abbreviations and other designations used in plumbing identification work, with corresponding designations shown, specified, or scheduled on drawings.
- C. The Plumbing, Fire Suppression and HVAC Contractors shall coordinate labeling, marking and tagging to attain coordinated and consistent systems of identification.
- D. Equipment labeling shall consist of unit designation as shown on the drawings.
- E. Pipe markers shall be placed at 25 ft. centers in mechanical rooms and concealed spaces and at 50 ft. centers in other exposed locations.
- F. Refer to appropriate sections of this specification for installation of underground line marker tape.
- G. Service pressure markings to be placed upstream and downstream of regulators at each pipe service label.
- H. Valve tags shall be placed on each valve except those intended for isolation of individual items of equipment. Valve tag schedules shall be prepared as specified above.

END OF SECTION 22 0553

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SECTION 22 0719 - PIPE INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
 - a. Fiberglass.
 - b. Flexible Elastomeric.
2. Protective Jacketing

1.2 SUBMITTALS

A. Product Data:

1. For each type of product indicated.
2. Thickness and covering table.

1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

B. Thicknesses shall be in compliance with ASHRAE 90.1.

PART 2 - PRODUCTS

2.1 INSULATION GENERAL

- A. Refer to insulation schedule on the Drawings for piping material and applications.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be done by tradesmen specializing in insulation work in strict accordance with the manufacturer's recommendations.
- B. Overlap and seal all longitudinal joints. Staples and adhesive may be used as stated above. Tape and seal cross joints. Vapor barrier shall be continuous on insulation of all cold services. Vapor barrier type mastic shall be used where needed to maintain a vapor seal.
- C. Where insulation is terminated, insulation shall be beveled at 45 degrees and the beveled surface sealed with vapor barrier mastic. PVC caps over straight cut ends which have been vapor sealed may be used in lieu of beveling.
- D. Mechanical joint fittings and couplings shall be considered as a part of the pipe line and shall be insulated. Bidders on the insulation work are cautioned to verify during the bidding period the extent of this work.
- E. Insulation on cold service piping shall be run through floor and wall sleeves to maintain vapor barrier continuity. Insulation on other services may likewise be run continuous when sleeve size permits. Refer to Section 22 0529 for non-compressible insulation or blocking material and sheet metal saddles required at pipe hangers. Coordinate with the contractor on the furnishing, installation and detailed requirements of these. Provide insulation and vapor barrier on and around supports for pipe risers of services which require vapor seal so as to prevent sweating.
- F. Verify that piping has been tested before applying insulation materials and that piping surfaces are clean and dry, with foreign material removed.
- G. Fittings, valves, flanges and other devices, both exposed and concealed, requiring insulation shall be covered same thickness as pipe insulation with:
 - 1. Factory molded fitting insulation cover with PVC one-piece fitting cover.
 - 2. Miter-cut segments of pipe insulation, held in place with adhesive and/or wire, filled with insulating cement smoothed to shape and covered with PVC one-piece fitting cover.
 - 3. Fiberglass blanket insulation, held in place and covered with PVC one-piece fitting cover.
 - 4. Oversized pipe insulation, where applicable, finished same as straight run pipe insulation.

END OF SECTION 22 0719

SECTION 22 1116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Unions and Flanges.
3. Dielectric Connectors.
4. Pipe Sleeves
5. Escutcheons.

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping.
- C. Comply with NSF 61 for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIAL

- A. Refer to piping and valve schedules on the Drawings for piping materials, valves, and applications.

2.2 UNIONS AND FLANGES

- A. Unions on copper tubing, all bronze construction 150 lb., solder ends.
- B. Unions on steel pipe 2" and smaller, malleable iron with ground seat, bronze to steel, 300 lbs., screwed ends.

- C. Flanges on steel pipe with welded or screwed joints, 2-1/2” and larger. Gaskets shall be 1/16” thickness full face compressed sheet suitable for temperature and pressure ranges of the application.
- D. Mechanical joints associated with grooved end pipe are acceptable in lieu of unions and flanges.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Refer to Division 22 Section "Common Piping Materials and Methods" for basic piping installation requirements.
- B. Mechanically formed tee fittings and couplings of the T-Drill type on copper tubing shall be formed in a continuous operation using equipment specifically designed for the application in strict adherence to the manufacturer’s instructions. Cutting debris shall be removed from the piping completion. Joints shall be brazed.
- C. Piping shall be pitched for drainage. The low points shall be fitted with a 3/4” drain valve (with hose thread adapter if not piped to a floor drain) except that on piping 1-1/4” and smaller where a drain valve is not shown, a drain plug is acceptable. Hose thread adapters on drain valves of potable water piping shall be fitted with a non-removable vacuum breaker.
- D. Piping shall be installed consistent with good piping practice and run concealed wherever possible. Coordinate with other trades to attain a workmanlike installation.
- E. Piping shall be supported as specified in Section 22 0529 Pipe Hangers. Piping with mechanical joints for grooved end pipe shall be supported in accordance with the manufacturer’s recommendations. Pipe alignment in both the horizontal and vertical must be tightly maintained. Misalignment must be corrected to the satisfaction of the Engineer before insulation is applied and the system accepted.
- F. Inform the Insulation sub-contractor during the bid period as to the extent of use of mechanical joints so that sub-contractor can price the work accurately.
- G. Internals of sweat end valves shall be removed when damage or warping could occur due to applied heat of soldering. Where silver brazing is specified, solder connection of valves shall be used to reduce the danger of damage. Close open ends of piping during installation to keep interior of the pipe clean.
- H. Install strainers as indicated on the drawings. Provide a nipple and ball valve in the blow down connection of each strainer 2” and larger.
- I. Unions and flanges shall be installed at pipe connections to fixtures and equipment and as required for erection purposed.
- J. Refer to Division 22 Section "Common Piping Materials and Methods" for dielectric fitting requirements.

- K. Refer to Division 22 Section "Common Piping Materials and Methods" for sleeve requirements.
- L. Refer to Division 22 Section "Pipe Hangers and Supports" for basic hanger and support requirements
- M. Refer to Division 22 Section "Common Piping Materials and Methods" for escutcheon requirements.
- N. Refer to Division 22 Section "Identification for Plumbing Piping and Equipment" for equipment and piping labeling requirements.

3.2 FIELD QUALITY CONTROL

A. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Domestic water piping – hydrostatic at 125 psig for 6 hours at the low point of the system. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

C. Domestic water piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.3 PIPE CLEANING

- A. Before placing each water piping system in operation, the piping system shall be thoroughly flushed out with clean water.

3.4 DISINFECTION OF PIPING

- A. All new domestic water piping shall be disinfected by a company or personnel regularly engaged in the performance of this service.
- B. Disinfection shall be performed in accordance with AWWA C651- 86 Standards. Disinfection shall be means of a chlorine solution injected into the water system near the source. Outlets throughout the system shall be tested to prove presence of minimum chlorine concentration. Flush out the system with clean water until the residual chlorine content is not greater than .2 parts per million or until approved by the Health Department.
- C. Disinfection procedures shall be witnessed by the Architect, Engineer or other qualified representative.

3.5 DOMESTIC HOT WATER RETURN SYSTEM BALANCING

- A. The domestic hot water return shall be balanced and or adjusted to provide proper operation or function in accordance with the drawings, specifications and manufacturer's recommendations.
- B. Submit balance report. Report to include:
 - 1. Project name and location.
 - 2. Contractor's name and address.
 - 3. Report date.
 - 4. Location and information data for each recirculation pump.
 - 5. Location and information data for each balancing valve.
 - 6. Pump design and final pump performance settings.
 - 7. Balance valve design and final valve settings.
 - 8. Notes to explain why final data varies from indicated values.

END OF SECTION 22 1116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following domestic water piping specialties:

1. Backflow preventers.
2. Water pressure-reducing valves.
3. Temperature-actuated water mixing valves.
4. Strainers.
5. Wall hydrants.
6. Drain valves.
7. Water hammer arresters.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. Cash Acme.
 - c. Conbraco Industries, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1001.
3. Size: 1/4" to 3", as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Rough bronze.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. Cash Acme.
 - c. Conbraco Industries, Inc.
 - d. FEBCO; SPX Valves & Controls.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1001.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

2.2 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. Cash Acme.
 - c. Conbraco Industries, Inc.
 - d. FEBCO; SPX Valves & Controls.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1012.
3. Operation: Continuous-pressure applications.
4. Size: 1/2"
5. Body: Bronze.

6. End Connections: Union, solder joint.
7. Finish: Rough bronze.

B. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. Cash Acme.
 - c. Conbraco Industries, Inc.
 - d. FEBCO; SPX Valves & Controls.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Size: 3/4" to 3", as required to match connected piping or as noted on drawings.
6. Body: Bronze for 2" and smaller; steel with interior lining complying with AWWA C550 or that is FDA approved/stainless steel for 2-1/2" and larger.
7. End Connections: Threaded for 2" and smaller; flanged for 2-1/2" and larger.
8. Configuration: Designed for horizontal, straight through flow.
9. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of 2" and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of 2-1/2" and larger.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

C. Backflow-Preventer Test Kits

1. Manufacturers Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. Cash Acme.
 - c. Conbraco Industries, Inc.
 - d. FEBCO; SPX Valves & Controls.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. Zurn Plumbing Products Group; Wilkins Div.
2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cash Acme.
 - b. Conbraco Industries, Inc.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
2. Pressure Rating: Initial working pressure of 150 psig.
3. Size: 1/2” to 3”, as required to match connected piping or as noted on drawings.
4. Body: Bronze with chrome-plated finish.
5. End Connections: Threaded.

2.4 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Digital Hot Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International Inc.
 - b. Leonard Valve Company.
 - c. Powers; a Watts Industries Co.
 - d. Caleffi Hydronic Solutions “Legiomix.
2. Valves shall be digital of lead free stainless steel/polymer construction.
3. Valve shall have all of the following operational capabilities:
 - a. +/- 2F water temperature control
 - b. 2F minimum inlet to outlet water temperature differential
 - c. Automatic shutoff of hot water flow upon cold water inlet supply failure.
 - d. Automatic shutoff of hot water flow in the event of a power failure
 - e. Programmable set point range of 81-158°F (27-70°C)
 - f. Programmable thermal disinfection mode
 - g. Programmable 1st level hi/lo temp alarm display
 - h. Programmable temperature error level for safety shutdown
4. Valve shall have all of the following connectivity capabilities:
 - a. SPCO relay outputs which are energized during operation.
 - b. LCD display which indicates: set point, delivered temperature, error codes and alarm conditions.
 - c. MODBUS 485 port for remote set point adjustment and remote operating temperature visibility.
 - d. RS485 Serial Port for connection to a performance matched hot water monitoring system.
 - e. BACnet protocol card.
5. Valve shall be compliant with ASSE Standard 1017 and CSA B125 and so certified and identified.

6. Valve shall be UL listed and identified.

B. Point of Use Thermostatic Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bradley Corporation
 - b. Lawler Manufacturing Company, Inc.
 - c. Leonard Valve Company.
 - d. Powers; a Watts Industries Co.
 - e. Symmons Industries, Inc.
2. Standard: ASSE 1070.
3. Pressure Rating: 125 psig.
4. Type: Exposed mounting thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, thermometer on outlet, temperature-control handle.
8. Tempered-Water Setting: 105 deg F .
9. Tempered-Water Design Flow Rate: 0.5 gpm minimum.
10. Valve Finish: Rough bronze.
11. Piping Finish: Copper.

2.5 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers.

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for 2" and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for 2-1/2" and larger.
3. End Connections: Threaded for 1/2" and smaller; flanged for 2-1/2" and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
 - a. Strainers 2" and Smaller: 0.020 inch.
 - b. Strainers 2-1/2" to 4": 0.045 inch.
 - c. Strainers 5" and Larger: 0.10 inch.
6. Drain: Pipe plug/Factory-installed, hose-end drain valve.

2.6 WALL HYDRANTS

A. Nonfreeze Wall Hydrants

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Josam Company.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Woodford Manufacturing Company.
 - g. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.21.3M for concealed -outlet, self-draining wall hydrants.
 3. Pressure Rating: 125 psig.
 4. Operation: Loose key.
 5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
 6. Inlet: 3/4”.
 7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
 8. Box: Deep, flush mounting with cover.
 9. Box and Cover Finish: Stainless Steel
 10. Nozzle and Wall-Plate Finish: Polished nickel bronze.
 11. Include operating key with each key operated hose bibb

2.7 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves.

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: 3/4”.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.8 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. PPP Inc.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

- g. Tyler Pipe; Wade Div.
 - h. Watts Drainage Products Inc.
 - i. Zurn Plumbing Products Group; Specification Drainage Operation.
- 2. Standard: ASSE 1010 or PDI-WH 201.
 - 3. Type: Copper tube with piston.
 - 4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - 1. Locate backflow preventers in same room as connected equipment or system.
 - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 - 3. Do not install bypass piping around backflow preventers.
- C. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- D. Install balancing valves in locations where they can easily be adjusted.
- E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet. Install thermometers and water regulators if specified.
- F. Install Y-pattern strainers for water where shown on the drawings.
- G. Install water hammer arresters on each quick closing valve in water piping according to PDI-WH 201.
- H. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
- I. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Reduced-pressure-principle backflow preventers.
 - 2. Water pressure-reducing valves.
 - 3. Primary, thermostatic, water mixing valves.

- J. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 - 1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.3 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 22 1119

SECTION 221123 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following all-bronze and bronze-fitted centrifugal pumps for domestic hot-water recirculation:
 - 1. Close-coupled, in-line, seal less centrifugal pumps.
- B. See Division 22 Section "Domestic-Water Packaged Booster Pumps" for booster systems.

1.2 SUBMITTALS

- A. Product Data: For each type and size of domestic water pump specified. Include certified performance curves with operating points plotted on curves, and rated capacities of selected models, furnished specialties, and accessories.
- B. Operation and maintenance data.

1.3 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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, IN-LINE, SEALLESS CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, single-stage, close-coupled, in-line, sealless centrifugal pumps as defined in HI 5.1-5.6.
 - 1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge-type unit with motor and impeller on common shaft and designed for installation with pump and motor shaft mounted horizontally.
 - 2. Casing: Bronze, with threaded companion-flange connections.
 - 3. Impeller: Corrosion-resistant material.
 - 4. Motor: Single 3-speed. Comply with requirements in Division 22 Section "Electrical Requirements for Plumbing Equipment."
- B. Capacities and Characteristics:

1. Capacity: Refer to Drawings.r
2. Total Dynamic Head: Refer to Drawing for
3. Maximum Operating Pressure: 125 psig.
4. Maximum Continuous Operating Temperature: 220 deg F .
5. Inlet and Outlet Size: Refer to Drawings
6. Motor Horsepower: Refer to Drawings
7. Electrical Characteristics: Refer to Drawings

C. Acceptable Manufacturers:

1. Armstrong Pumps Inc.
2. Bell & Gossett Domestic Pump; ITT Industries.
3. Grundfos Pumps Corp.
4. Taco, Inc.

2.2 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.

1. Type: Water-immersion sensor, for installation in hot-water circulation piping.
2. Range: 50 to 125 deg F.
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: 120 V, ac.
6. Settings: Start pump at 115 deg F and stop pump at 120 deg F.
7. Acceptable Manufacturers:
 - a. Honeywell International, Inc.
 - b. Square D.
 - c. White-Rodgers Div.; Emerson Electric Co.

B. Timers: Electric time clock for control of hot-water circulation pump shall be thru the building control system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with HI 1.4.
- B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Install in-line, seal less centrifugal pumps with motor and pump shafts horizontal.

- E. Install continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Fabricate brackets or supports as required. Hanger and support materials are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- F. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- G. Install piping adjacent to pumps to allow service and maintenance.
- H. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles. Refer to Division 22 Section "Domestic Water Piping."
 - 1. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping. Refer to Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty valves for domestic water piping and Division 22 Section "Domestic Water Piping Specialties" for strainers.
 - 2. Install test plugs for pressure gage at suction and discharge of pumps. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and test plugs.
 - 3. Install thermometer at suction of pumps. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometer.
- I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 221123

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SECTION 22 1316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following soil and waste, sanitary drainage and vent piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.

1.2 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Cast iron pipe, fittings, and standard duty no-hub couplings shall be listed by NSF International and marked with “NSF” demonstrating certification.
- C. Plastic piping and components shall comply with NSF 14, "Plastics Piping Systems Components and Related Materials,". Include marking with "NSF-DWV" for plastic drain, waste, and vent piping; and "NSF-drain" for plastic drain piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to piping schedule on the Drawings for piping material and applications.

PART 3 - EXECUTION

3.1 PIPING INSTALLATIONS

- A. Basic piping installation requirements are specified in Division 22 Section "Common Piping Materials and Methods. "
- B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- C. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- D. Piping suspended 18" or more shall be provided with sway bracing as required by CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- E. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back-to-back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use the proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- F. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- G. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow for piping smaller than 3" and; 1 percent downward in direction of flow for piping 3" and larger.
 - 2. Vent Piping: slope down toward vertical fixture vent or toward vent stack.
- H. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- I. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
- J. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
- K. Refer to Division 22 Section "Common Piping Materials and Methods" for sleeve requirements.
- L. Refer to Division 22 Section "Pipe Hangers and Supports" for basic hanger and support requirements
- M. Refer to Division 22 Section "Common Piping Materials and Methods" for escutcheon requirements.

- N. Refer to Division 22 Section "Identification for Plumbing Piping and Equipment" for equipment and piping labeling requirements.

3.2 JOINT CONSTRUCTION

- A. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
 - 2. Hubless Joints: Make with rubber gasket and sleeve or clamp.
- B. PVC Non pressure Piping Joints: Join piping according to ASTM D 2665.

3.3 CONNECTIONS

- A. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- B. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code or indicated on the drawings.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections 2-1/2" and larger.

3.4 FIELD QUALITY CONTROL

- A. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- B. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- C. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- D. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

- E. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction.
 - 1. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 2. Prepare reports for tests and required corrective action.

3.5 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during the remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Plug the ends of uncompleted piping at end of day and when work stops.

3.6 PROTECTION

- A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION 22 1316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:
 - 1. Cleanouts.
 - 2. Floor drains.
 - 3. Roof flashing assemblies.
 - 4. Miscellaneous sanitary drainage piping specialties.
 - 5. Flashing materials.
 - 6. Oil interceptors.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for grease interceptors.

1.3 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 FLOOR DRAINS

- A. Floor drains shall be as indicated on the drawings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
 - g. Wade Manufacturing Company Division of Tyler Pipe
 - h. Sioux Chief Manufacturing Company

2.2 CLEANOUTS

- A. Cast-Iron Floor Cleanouts:

1. Manufacturer shall be same as floor drains.
2. Standard: ASME A112.36.2M for adjustable housing cast-iron soil pipe with cast-iron ferrule threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Heavy-duty, threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Not required.
7. Outlet Connection: Inside calk.
8. Closure: Plastic plug.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Heavy Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Cast-Iron Wall Cleanouts

1. Manufacturer shall be same as floor drains.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head drilled-and-threaded brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Thaler Metal Industries Ltd.
 - b. Oatey Co.
2. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch, lead flashing collar and skirt extending at least 8 inches] from pipe, with galvanized-steel boot reinforcement and counterflashing fitting. Open-Top Vent Cap: Without cap.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Floor-Drain, Trap-Seal Maintenance Device:

1. Description: Device inserted into the drain body or adjustable strainer that opens to allow water to pass thru and closes to prevent sewer gases from entering the room from the drainage system.
2. Must conform to ASSE 1072.
3. Size: Same as floor drain outlet.

B. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

2.5 OIL INTERCEPTORS

A. Oil Interceptors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. Zurn Plumbing Products Group.
 - c. Streim Co.
2. Standard: IAPMO IGC 325 High Efficiency Oil/Water Separators.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 1. Size same as drainage piping up to 4". Use 4" for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 100 feet.
 4. Locate at base of each vertical soil and waste stack.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

- F. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain the integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- G. Install roof flashing assemblies on vent stacks that extend through roof.
- H. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- I. Install floor-drain, trap-seal maintenance device on inlet to floor drains where noted.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.
- J. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- K. Install oil interceptors, including trapping, and venting according to authorities having jurisdiction and with clear space for servicing.
- L. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- M. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Oil Interceptors: Connect inlet and outlet to unit, and vent to unit inlet piping.

3.3 PROTECTION

- A. Protect drains during the remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 1319

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SECTION 221416 - INTERIOR STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following storm drainage piping inside the building.
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.

1.2 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water.

1.3 SUBMITTALS

- A. Product Data: For each type of product used.
- B. Field quality-control inspection and test reports.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to piping schedule on the Drawings for piping material and applications.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 22 Section "Common Piping Materials and Methods."

- B. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Storm Drainage Piping Specialties."
- C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Piping Materials and Methods."
- D. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- E. Piping suspended 18" or more shall be provided with sway bracing as required by CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- F. Make changes in direction for storm piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- G. Lay buried building drain piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- H. Install storm drainage piping at the following minimum slopes, 1/8" per linear foot downward in direction of flow.
- I. Sleeves are not required for cast-iron storm piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- J. Install PVC storm drainage piping according to ASTM D 2665.
- K. Install underground PVC storm drainage piping according to ASTM D 2321.
- L. Refer to Division 22 Section "Common Piping Materials and Methods" for sleeve requirements.
- M. Refer to Division 22 Section "Pipe Hangers and Supports" for basic hanger and support requirements
- N. Refer to Division 22 Section "Common Piping Materials and Methods" for escutcheon requirements.
- O. Refer to Division 22 Section "Identification for Plumbing Piping and Equipment" for equipment and piping labeling requirements.
- P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.2 JOINT CONSTRUCTION

- A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
- C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.3 CONNECTIONS

- A. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- B. Connect storm drainage piping to roof drains and storm drainage specialties.

3.4 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
 - 1. Test storm drainage piping according to procedures of authorities having jurisdiction. Maintain record of tests.

3.5 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Plug the ends of uncompleted piping at end of day and when work stops.

3.6 PROTECTION

- A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION 22 1416

SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following storm drainage piping specialties:

1. Cleanouts.
2. Roof drains.
3. Miscellaneous storm drainage piping specialties.

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 ROOF DRAINS

A. Cast-Iron Roof Drains:

1. Standard: ASME A112.21.2M.
2. Pattern: Roof drain.
3. Body Material: Cast iron.
4. Combination Flashing Ring and Gravel Stop: Required.
5. Outlet: Bottom.
6. Dome Material: Cast iron.
7. Underdeck Clamp: Required.
8. Sump Receiver: Required.
9. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.

2.2 CLEANOUTS

A. Exposed Cast-Iron Cleanouts:

1. Manufacturer shall be same as roof drains.
2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Raised-head, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Floor Cleanouts:

1. Manufacturer shall be same as floor drains.
2. Standard: ASME A112.36.2M for adjustable housing cast-iron soil pipe with cast-iron ferrule threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Heavy-duty, adjustable housing.
5. Body or Ferrule: PVC.
6. Clamping Device: Not required.
7. Outlet Connection: Threaded.
8. Closure: Plastic plug.
9. Adjustable Housing Material: PVC with threads.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Extra Heavy Duty.
13. Riser: Same as DWV piping.

C. Cast-Iron Wall Cleanouts

1. Manufacturer shall be same as floor drains.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Same as DWV piping.
5. Closure: Countersunk, drilled-and-threaded brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to 4". Use 4" for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 100 feet.
 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roof materials are specified in Division 07.
1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain the integrity of waterproof membranes where penetrated.
 2. Position roof drains for easy access and maintenance.
- F. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 PROTECTION

- A. Protect drains during the remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 1423

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SECTION 22 3333 - ELECTRIC DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Commercial, storage electric water heaters.
 - 2. Water heater accessories.

1.2 SUBMITTALS

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and maintenance data.
- D. Warranty.

1.3 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. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- C. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with potable water.

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period(s): From date of Substantial Completion:
 - a. Tanks: 10 years.
 - b. Components: 1 year.

PART 2 - PRODUCTS

2.1 COMMERCIAL ELECTRIC WATER HEATERS

- A. Description: Comply with UL 174 for household, storage electric water heaters.
 1. Storage-Tank Construction: 316 Stainless steel, vertical arrangement.
 - a. Tappings: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 2. Factory-Installed Storage-Tank Appurtenances:
 - a. Dip Tube: Provide unless cold-water inlet is near bottom of tank.
 - b. Drain Valve: ASSE 1005.
 - c. Insulation: Comply with ASHRAE/IESNA 90.1-2004.
 - d. Jacket: Steel with enameled finish.
 - e. Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
 - f. Heating Elements: Three; electric, screw-in immersion type; wired for simultaneous operation, unless otherwise indicated.
 - g. Temperature Control: Adjustable thermostat for each element.
 - h. Safety Control: High-temperature-limit cutoff device or system.
 - i. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
 3. Special Requirements: NSF 5 construction with legs for off-floor installation.
 4. Refer to the drawings for capacity and characteristics.
 5. 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.
 - a. HTP, Ariston Group.
 - b. Lochinvar Corporation.
 - c. Rheem Water Heater Div.; Rheem Manufacturing Company.
 - d. Smith, A. O. Water Products Company.
 - e. State Industries, Inc.

2.2 WATER HEATER ACCESSORIES

- A. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.
- B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than 3/4".
- C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1-2004.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

- A. Install commercial water heaters on concrete bases. Concrete base construction requirements are specified in Division 22 Section "Equipment Bases and Supports."
- B. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial, water-heater, relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- D. Install water heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.
- E. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
- F. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.
- G. Fill water heaters with water.

3.2 CONNECTIONS

- A. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections:
 - 1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial electric water heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 22 3300

SECTION 22 4200 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
1. Faucets for lavatories showers and sinks.
 2. Flushometers.
 3. Drinking Fountains
 4. Toilet seats.
 5. Protective shielding guards.
 6. Fixture supports.
 7. Disposers.
 8. Water closets.
 9. Urinals.
 10. Lavatories.
 11. Individual showers.
 12. Kitchen sinks.
 13. Service sinks.
 14. Laundry trays.

1.2 DEFINITIONS

- A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. FRP: Fiberglass-reinforced plastic.
- C. PMMA: Polymethyl methacrylate (acrylic) plastic.
- D. PVC: Polyvinyl chloride plastic.
- E. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act" for plumbing fixtures for people with disabilities and Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- B. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- C. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- D. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
 - 2. Plastic Laundry Trays: ANSI Z124.6.
 - 3. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
 - 4. Stainless-Steel Residential Sinks: ASME A112.19.3.
 - 5. Vitreous-China Fixtures: ASME A112.19.2M.
 - 6. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
 - 7. Water-Closet, Flushometer Tank Trim: ASSE 1037.
- E. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
 - 1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
 - 2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
 - 3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
 - 4. Faucets: ASME A112.18.1.
 - 5. Hose-Connection Vacuum Breakers: ASSE 1011.
 - 6. Hose-Coupling Threads: ASME B1.20.7.
 - 7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 - 8. NSF Potable-Water Materials: NSF 61.
 - 9. Pipe Threads: ASME B1.20.1.
 - 10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 - 11. Supply Fittings: ASME A112.18.1.
 - 12. Brass Waste Fittings: ASME A112.18.2.
- F. Comply with the following applicable standards and other requirements specified for shower valves:
 - 1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
 - 2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
 - 3. Faucets: ASME A112.18.1.
 - 4. Hand-Held Showers: ASSE 1014.
 - 5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
 - 6. Hose-Coupling Threads: ASME B1.20.7.

7. Manual-Control Antiscald Faucets: ASTM F 444.
 8. Pipe Threads: ASME B1.20.1.
 9. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
 10. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
- G. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
1. Atmospheric Vacuum Breakers: ASSE 1001.
 2. Brass and Copper Supplies: ASME A112.18.1.
 3. Dishwasher Air-Gap Fittings: ASSE 1021.
 4. Manual-Operation Flushometers: ASSE 1037.
 5. Plastic Tubular Fittings: ASTM F 409.
 6. Brass Waste Fittings: ASME A112.18.2.
 7. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
- H. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Disposers: ASSE 1008 and UL 430.
 2. Dishwasher Air-Gap Fittings: ASSE 1021.
 3. Flexible Water Connectors: ASME A112.18.6.
 4. Grab Bars: ASTM F 446.
 5. Hose-Coupling Threads: ASME B1.20.7.
 6. Hot-Water Dispensers: ASSE 1023 and UL 499.
 7. Off-Floor Fixture Supports: ASME A112.6.1M.
 8. Pipe Threads: ASME B1.20.1.
 9. Plastic Toilet Seats: ANSI Z124.5.
 10. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 - PRODUCTS

2.1 Fixtures and Trim

- A. Refer to the notes/schedule on the drawings for fixture and associate trim specifications.
- B. All waste and supply trim exposed to view shall be chrome plated brass.
- C. Toilet Seats:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bemis Manufacturing Company.
 - b. Centoco Manufacturing Corp.
 - c. Church Seats.
 - d. Olsonite Corp.
 - e. Beneke Div, Sanderson Plumbing Products, Inc.
 - f. Sperzel.

2. Description: Toilet seat for water-closet-type fixture.
 - a. Material: Molded, solid plastic.
 - b. Configuration: Open front without cover.
 - c. Size: Elongated.
 - d. Hinge Type: check/ self-sustaining.
 - e. Class: Heavy-duty commercial.
 - f. Color: White.

2.2 FIXTURE CARRIERS

- A. 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. Josam Company.
 2. MIFAB Manufacturing Inc.
 3. Smith, Jay R. Mfg. Co.
 4. Tyler Pipe; Wade Div.
 5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
 6. Zurn Plumbing Products Group; Specification Drainage Operation.
 7. Sioux Chief Manufacturing
- B. Urinal Carriers:
 1. Description: Urinal carrier with hanger and bearing plates for wall-mounting, urinal-type fixture. Include rectangular steel uprights with feet.
- C. Lavatory Carriers:
 1. Description: Lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include rectangular steel uprights with feet.
- D. Sink Carriers:
 1. Description: Sink carrier with exposed arms and tie rods/, Sink carrier with hanger plate, bearing studs, and tie rod/, Sink carrier with hanger plate and exposed arms for sink-type fixture. Include steel uprights with feet.
- E. Drinking Fountain Carriers:
 1. Description: Carrier with hanger and bearing plates for wall-mounted fixture. Include rectangular steel uprights with feet.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install feet and anchor lugs of carriers securely affixed to floor using all bolt holes provided.
- C. Install fixtures level and plumb according to roughing-in drawings.
- D. Attach supplies to supports or substrate within pipe spaces behind fixtures to prevent loose piping fitting piping thru walls. Install -supply stop on each water supply to each fixture connected to water distribution piping. Install stops in locations where they can be easily reached for operation.
- E. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- F. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
- G. Install toilet seats on water closets.
- H. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
- I. Install escutcheons at piping wall and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- J. Set showers in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."
- K. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- E. Adjust flow regulators for proper flow and stream height and adjust water cooler temperature settings for drinking fountains.
- F. Install fresh batteries in sensor-operated mechanisms.

3.4 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224 200

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

23 0000 General Requirements for HVAC Systems

- 23 0001 Basic HVAC Requirements
- 23 0004 Firestopping for HVAC Systems

23 0500 Common Work Results for HVAC

- 23 0513 Electrical Requirements for HVAC Equipment
- 23 0520 Pipe Materials and Methods
- 23 0529 Pipe Hangers and Supports
- 23 0548 Vibration Control
- 23 0553 Identification for HVAC Systems
- 23 0593 Testing, Adjusting and Balancing

23 0700 HVAC Insulation

- 23 0713 Duct Insulation
- 23 0719 Pipe Insulation

23 0900 Instrumentation and Control for HVAC

- 23 0913 Instruments and Control Devices
- 23 0914 Control Wiring and Cabling
- 23 0923 Direct Digital Control System

23 2000 HVAC Piping and Pumps

- 23 2300 Refrigerant Piping

23 3000 HVAC Air Distribution

- 23 3113 Ductwork
- 23 3300 Air Duct Accessories
- 23 3400 Fans
- 23 3713 Diffusers, Registers and Grilles

23 7000 Central HVAC Equipment

- 23 7433 Packaged Dedicated Outdoor Air System

23 8000 Decentralized HVAC Equipment

- 23 8126 Variable Refrigerant Volume Heat Recovery Systems
- 23 8239 Unit Heaters

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SECTION 23 0001 – BASIC HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes the following:
1. General Requirements
 2. Definitions
 3. Scope of Work
 4. Drawings and Specifications
 5. Reference Standards
 6. Allowances, Unit Prices and Alternates
 7. Site Visit
 8. Permits, Regulations and Inspections
 9. Project Management and Coordination
 10. Temporary Utilities
 11. Workmanship
 12. Protection
 13. Painting
 14. Cleaning
 15. Miscellaneous Equipment Connections
 16. Equipment Selection
 17. Shop Drawings
 18. Final Inspection and Punch List
 19. Operation and Maintenance Manuals
 20. Record Drawings
 21. Warranties
 22. Project Closeout
 23. Operation and Adjustment of Equipment
 24. Operating Demonstration and Instruction

1.2 GENERAL REQUIREMENTS

- A. All provisions of Division 00 Front End Documents and Division 01 General Requirements apply to work specified in this Division.
- B. Specification provisions of other relevant Divisions shall apply where applicable work is required to be performed under this HVAC work.
- C. A complete and functional HVAC system installation shall be provided under this Division. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect. In such event, none of the trades or their suppliers shall assume that he is relieved of the work which is specified under his branch until instructions in writing are received from the Architect.

- D. The Mechanical and Electrical drawings and specifications assign work (labor and/or materials to be provided by the General, Plumbing, Fire Suppression, HVAC or Electrical Contractor or their sub-contractors. Understanding that the contractors for mechanical and electrical work are sub-contractors to the (General) Contractor, such assignments are not intended to restrict the Contractor in assignment of work among the sub-contractor to accommodate trade agreements and practices or the normal conduct of the construction work.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SCOPE OF WORK

- A. The scope of the HVAC work includes furnishing, installing, testing and warranty of all HVAC work shown on the HVAC drawings and specified herein, including Division 00, Division 01, Division 23 and applicable provisions of other relevant Divisions.

1.5 DRAWINGS AND SPECIFICATIONS

- A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word “proved,” as used, shall mean “furnish and install.” If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect for approval before proceeding with the work.
- B. Make all necessary field measurements to insure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.
- C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having ductwork, pipe and fittings fabricated and delivered in advance of making actual measurements shall be sufficiently in advance as

to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.

- D. The Architect/Engineer shall reserve the right to make minor adjustment in locations of system runs and components where he considers such adjustments desirable in the interest of concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties.
- E. Equipment, ductwork or piping shall not be installed or run above electrical switchgear or panelboards, nor in or above the access space in the immediate vicinity of the electrical switchgear/panelboards, in accordance with NEC Article 384.
- F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the contractor causing such conflict. The Architect's decision shall be final in regard to the arrangement of ductwork, piping, etc., where conflict arises.
- G. Provides offsets in system runs, additional fittings, necessary drains and minor valves, traps, dampers and devices required to complete the installation, or for the proper operation of the system. Each Contractor shall exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.
- H. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect. In such event, none of the trades or their suppliers shall assume that he is relieved of the work which is specified under his branch until instructions in writing are received from the Architect.

1.6 REFERENCE STANDARDS

- A. Where standards (NFPA, NEC, ADTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the authority having jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

1.7 ALLOWANCES, UNIT PRICES AND ALTERNATES

- A. Refer to Sections 012100 Allowances, 012200 Unit Prices and 012300 Alternates.

1.8 SITE VISIT

- A. Refer to Section 017300 Execution.
- B. Each bidder shall visit the project site to understand the existing conditions and compare the conditions with information shown on the drawings. Report immediately to the Architect any issues or discrepancies which are discovered that affect the bid. Changes to contract price will not be considered for site condition issues that are readily apparent from a thorough site review.

1.9 PERMITS, REGULATIONS AND INSPECTION

- A. Work must conform to applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawing and specifications shall govern. Install no work contrary to minimum legal standards.
- B. Except where the permit application is made by the Architect or the Engineer, the HVAC contractor shall be responsible to file for and obtain all required permits from the governing inspection agencies for the HVAC work. Where the Architect or Engineer is the Architect or Engineer of record, they will furnish sealed and signed drawings and specifications required by the permit authorities.
- C. Include payment of all permit and inspection fees applicable to the work in this Division.
- D. All work shall be subject to inspection and approval of Federal, State and local agencies as may be appropriate as well as the Architect and Engineer.
- E. Furnish for the Owner certificates of approval from the governing inspection agencies as a condition for final payment.

1.10 PROJECT MANAGEMENT AND COORDINATION

- A. The HVAC Contractor shall initially prepare and be responsible for ¼” scale coordination drawings. These drawings shall be reproduced and distributed to the Plumbing, Fire Suppression and Electrical Contractors for their input and revisions. Assure that all contractors work together to obtain finish coordinated drawings and no work being installed until all contractors have approved and signed-off with their approval and drawings have been submitted and reviewed by the Engineer.

1.11 TEMPORARY UTILITIES

- A. Refer to Section 015000 – Temporary Facilities and Controls for division of responsibilities for temporary utilities.
- B. The use of the permanent HVAC system for temporary heating and ventilation during the latter stages of construction shall be allowed. Expedite completion of system as practicable to this end. Maintain the system during this period. Provide and maintain temporary air filters to protect coils and ducts. Replace temporary filters with the specified filters (clean) when the systems are placed on permanent duty. Air filters specified for the systems and units, including specified spare filters, are not to be used for temporary service.
- C. Cover all return duct openings with temporary filter media when recirculating air. Stop fans during heavy dust generating operations. Before turning the system over to the Owner, the Contractor shall clean duct interiors and interior surfaces and components with the air handling equipment if dirt, dust and debris have accumulated on these surfaces.
- D. Warranty periods on equipment, materials and system shall commence upon Owner acceptance of the building or system. Temporary heat use shall not jeopardize or alter the warranty requirements.

1.12 WORKMANSHIP

- A. Refer to Section 014000 Quality Requirements.
- B. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all respects, and the Architect shall have the right to stop the work if highest quality workmanship is not maintained.
- C. HVAC work shall be performed by licensed HVAC Contractors in accordance with requirements of the jurisdiction.

1.13 PROTECTION

- A. Each Contractor shall be entirely responsible for all material and equipment furnished in connection with his work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect.
- B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide plastic sheeting, drop cloths or similar barriers where dust and debris is generated, to protect adjacent areas.
- C. Contractor shall protect all equipment and materials from detrimental effects of weather or construction activity. All items shall be stored and secured in a protected location away from the daily work area. Equipment or materials shall be placed on raised skids to protect from surface moisture. Where appropriate, provide plastic sheeting or similar vapor barrier underneath the stored products to reduce the effects of ground moisture or curing concrete on the local humidity levels. Where unfinished ferrous products or finished ferrous products with raw edges are stored, provide local, dry heat to maintain ambient relative humidity levels below 65% RH to prevent rust.
- D. All equipment shall retain the original packaging until required to be removed for installation or operation. Open ends of ducts, piping, conduit, etc. shall be capped or sealed and ventilation openings into equipment shall be wrapped and sealed in plastic sheeting to prevent dust or dirt entry both when stored and after installation but still open to the effects of construction activity. Stored items as well as installed equipment shall be covered with plastic sheeting at all times until placed in service or until dust generating activity in the area has ceased.

1.14 PAINTING

- A. In addition to any painting specified for various individual items of equipment, the following painting shall be included in Division 23:
 - 1. Ferrous metal which is not factory or shop painted or galvanized and which remains exposed to view in the finished areas of the building / building including finished areas, mechanical rooms, storage rooms, and other unfinished areas shall be given a prime coat of paint.

2. Ferrous metal installed outside the building which is not factory or shop painted or galvanized shall be given a prime coat of paint.
 3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch-up.
 4. Inside of ducts, behind grilles and registers, shall be painted flat black to eliminate the viewing of shiny surfaces.
- B. Paint, surface preparation and application shall conform to applicable portions of the Painting section of Division 09 Finishes. All rust must be removed before application of paint.
- C. Finish painting is included in the General Contract except where otherwise required under remodeling work. Refer to the “Cutting and Patching” paragraph in this Section for finishing requirements.

1.15 CLEANING

- A. Debris, dust, dirt, etc shall be removed daily, particular attention shall be paid to areas that the Owner is continuing to occupy or use; any mess created in corridors, stairwells and egress paths that are maintained during construction shall be cleaned immediately.
- B. The Owners dumpsters and trash receptacles shall not be used. If a dumpster is required, it shall be provided by the contractor and located where approved by the Owner. Coordinate dumpster requirements with other contractors.
- C. Before turning an area back over to the Owner, thoroughly clean the space to leave the area in a similar condition before the start of the project where finishes are to remain. The contractor shall also clean duct interiors and interior components of new or existing air handling system equipment if dirt, dust or debris have generated in the course of work have accumulated on these surfaces.
- D. Before placing each system in operation, the equipment shall be thoroughly cleaned; cleaning shall be in accordance with equipment manufacturer's recommendations.
- E. Refer to appropriate Sections for cleaning of other equipment and systems for normal operation.

1.16 MISCELLANEOUS EQUIPMENT CONNECTIONS

- A. Certain categories of fixtures and equipment, including kitchen equipment, sterilizers, washers, laundry and laboratory equipment, require piping connections and duct connections as shown on the drawings. Equipment will be furnished and set in places by the equipment supplier.
- B. Make all final connections to these fixture and equipment, as indicated and in accordance with the manufacturer’s recommendations. All piping connections shall be valved and final connections made with unions.

- C. All steam supplies shall be dripped immediately ahead of the valves. Automatic valves, where required, will generally be furnished with the equipment but installed by the HVAC Contractor. Return traps shall be furnished by this Contractor in accordance with details shown on the drawings. Steam pressure reducers and relief valves, where required, shall be furnished by this HVAC Contractor.
- D. Supply piping and devices connecting to equipment, where exposed to view in the finished space, shall be chrome plated and insulation shall be omitted.
- E. Roughing-in drawings shall be obtained for the various fixtures and items of equipment as the time approaches when such information is required; allow a reasonable period, from the time of notice to obtain this information.
- F. Connections to equipment shall be in accordance with the manufacturer's installation guidelines. Any additional accessories recommended by the manufacturer such as gauges, shut-off valves, unions at connection points, etc., shall be provided by this Contractor.

1.17 EQUIPMENT SELECTION

- A. Materials and equipment furnished under this contract shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.
- B. The selection of materials and equipment to be furnished under this contract shall be governed by the following:
 - 1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specifications, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturer's listed.
 - 2. Where the words "or approved equal: appear after a manufacturer's name, specific approval must be obtained from the Architect during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.
 - 3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish a model or series designation, such designation is intended to establish quality level and standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval.
- C. Substitute equipment of equal quality and capacity will be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.
- D. Before bidding equipment, and again in the preparation of shop drawings the Contractor and his supplier shall verify that adequate space is available for entry and installation of the item of equipment, including associated piping and accessories. Also verify that adequate space is available for servicing of the equipment.

- E. If extensive changes in pipe, duct or equipment layout or electrical wiring and equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in the contract.

1.18 SHOP DRAWINGS

- A. Refer to Section 016000 Product Requirements.
- B. One set of shop drawings, in electronic format (.pdf), with descriptive information shall be assembled by each Contractor of equipment and materials furnished in his contract, and submitted to the Architect and/or Engineer for review as stated in Division 01. These shall be submitted as soon as practicable and before special equipment is manufactured and before installation.
- C. Shop drawings for equipment fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. Failure to do so may be cause for rejection of shop drawings.
- D. The review of shop drawings by the Architect or Engineer shall not relieve the Contactor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer's attention in a separate clearly stated notification at the time of submittal for the Engineer's review.
- E. Shop drawings for the following HVAC equipment and materials shall be submitted:
 - 1. Pipe, fittings and joining methods for the various systems.
 - 2. Firestopping systems for pipe penetrations.
 - 3. Pipe Hangers and Supports.
 - 4. Underground Piping Systems.
 - 5. Valves.
 - 6. Expansion Fittings, Joints and Guides.
 - 7. Flexible Connectors.
 - 8. Meters and Gauges.
 - 9. Vibration Isolators.
 - 10. Pipe Insulation.
 - 11. Equipment and Breeching Insulation.
 - 12. Ductwork Insulation.
 - 13. Ductwork and Sealing Systems.
 - 14. Air Duct Accessories.
 - 15. Furnaces and Cooling Coils.
 - 16. Condensing Units.
 - 17. Variable Refrigerant Flow, Heat Recovery Systems
 - 18. Refrigerant piping schematic and components.
 - 19. Dedicated Outdoor Air System Units.
 - 20. Unit Heaters.
 - 21. Air Rotation Units.
 - 22. Fans.
 - 23. Fire Dampers.
 - 24. Sound Attenuators.
 - 25. Air Control Terminal Units.

26. Diffusers, Registers and Grilles.
27. Louvers.
28. Temperature Controls System.
29. Pressure piping system welder performance qualification record per the Ohio Pressure Piping Systems Code, Chapter 4101:8.
30. Seismic Restraint Package.

1.19 FINAL INSPECTION AND PUNCH LIST

- A. Refer to Section 017700 Closeout Procedures.
- B. As the time of work completion approaches, the Contractor shall survey and inspect his work and develop his own punch list to confirm that it is complete and finished. He shall then notify the Architect and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.
- C. Requests to the Architect, Engineer or Owner for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.
- D. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completing or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.20 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Section 017823 Operation and Maintenance Data.
- B. Two copies each of operating and maintenance manuals shall be assembled for the HVAC work by the Contractors.
- C. All shop drawing and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams, parts list and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. Air and water balance reports shall also be included. In addition, the Contractor shall prepare a chart listing all items of equipment which are furnished under his contract and indicating the nature of maintenance required, the recommended frequency of checking these points and the type of lubricating media or replacement material required.
- D. These shall be assembled into three-ring loose lead binders or other appropriate binding and also combined into a single electronic file in .PDF format. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Architect or Engineer for review. Upon approval, manuals shall be turned over to the Owner.

1.21 RECORD DRAWINGS

- A. Refer to Section 017839 Project Record Drawings.
- B. Each Contractor shall maintain a separate set of prints of the contract documents and shall show all changes or variations, in a manner to be clearly discernible, which are made during construction. Upon completion of the work, these drawing shall be turned over to the Architect.

1.22 WARRANTIES

- A. Refer to Section 017700 Closeout Procedures.
- B. This Contractor shall warrant all workmanship, equipment and material entering into this contact for a period of **one** year of date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect. Any materials or equipment proving to be defective during this warranty period shall be made good by this Contractor without expense to the Owner.
- C. This provision is intended specifically to cover deficiencies in contract completion or performance which are discovered after systems are placed in operation. Also included shall be supplementary assistance in balancing, adjusting or providing operating instructions as the need develops, and replacing overload heater elements in starters where necessary to keep systems in operation. Heater element sizes shall not exceed the motor manufacturer's recommendations.
- D. This provision shall not be construed to include maintenance items such as replacing filters, re-tightening or repacking glands, greasing, oiling belt tightening and cleaning strainers after these have been done for final close-out.
- E. Provisions of this warranty shall be considered supplementary to warranty provisions under General Conditions.
- F. Extended warranties shall be provided where indicated in the equipment specification sections.

1.23 PROJECT CLOSEOUT

- A. Refer to Section 017700 Closeout Procedures.
- B. The following schedule summarizes actions to be taken or submittals to be completed by Contractor prior to issuance of the Contract Completion Certificates. Refer to applicable paragraphs of the Division 23 Sections and other applicable trade Divisions for additional requirements. This information should be submitted at least thirty days in advance of request for final inspection. Where possible, the information shall be bound in 8 – ½' x 11" hard back binders.
 - 1. Material / Suppliers List
 - 2. Record Drawings
 - 3. Certificate of Inspection
 - 4. Tests and Adjustments
 - 5. Operating Instructions and Maintenance Manuals

6. Equipment and Piping Identification
7. Receipt of spare pump seals
8. Receipt of spare filters
9. Completed Punchlist
10. Waiver of Liens
11. Affidavit of Wage Compliance
12. Change Orders and Allowance Adjustments

1.24 OPERATION AND ADJUSTMENT OF EQUIPMENT

- A. As each piping system and air distribution system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing air and water systems, adjusting fan speeds, belts, pulleys, tightening packing glands, and adjusting all operating equipment.
- B. Caution: Verify that all bearings are lubricated, all motors are operating in the right direction, and correct overload heater elements are provided on all motors. Do not depend wholly on the electrician's judgment in these matters. Follow specific instructions in regard to lubrication. Do not oil or grease presealed ball bearings unless upon manufacturer's specific instructions.
- C. Test relief valves, air vents and regulating valves to insure proper operation.

1.25 OPERATING DEMONSTRATION AND INSTRUCTIONS

- A. Refer to Section 017900 Demonstration and Training as well as individual Division 23 Sections for requirements.
- B. The Contractor shall set the various systems into operation and demonstrate to the Owner and Architect that the systems function properly and that the requirements of the Contract are fulfilled.
- C. The Contractor shall provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.
- D. A minimum of 16 hours shall be allowed for instructions to personnel selected by the Owner. Instructions shall include not less than the following:
 1. Show locations of items of equipment and their purpose.
 2. Review binder containing instructions and equipment and systems data.
 3. Coordinate written and verbal instructions so that personnel understand each.
 4. Separate instructions shall be given by manufacturer's representatives for the temperature control systems.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION – NOT APPLICABLE

END OF SECTION 23 0001

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SECTION 23 0004 – FIRESTOPPING FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

1.2 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
- B. Rated Systems: Firestopping assemblies shall be tested and rated in accordance with ASTM E814 (ANSI/UL 1479) Fire Tests of Through-Penetration Fire Stops (minimum positive pressure of .01 inches of water column) and E119 (ANSI/UL 263) Fire Tests of Building Construction and Materials Time-Temperature Curve. Firestopping shall provide an “F” fire rating equal to that of the construction being penetrated. Firestop systems shall meet all requirements of the Ohio Building Code.
- C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
 - 1. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.
 - 2. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
- D. For through-penetration firestop systems exposed to view or above ceilings in air return plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each through-penetration firestop system, submit documentation, including illustrations, from a qualified testing and inspecting agency, showing each type of

construction condition penetrated, relationships to adjoining construction, and type of penetrating item.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Firestopping materials shall be manufactured and/or supplied by:

1. Hilti, Inc.
2. Specified Technologies Inc.
3. 3M; Fire Protection Products Division.

2.2 FIRESTOPPING

A. Materials shall be in the form of caulk, putty, sealant, intumescent material, wrap strip, fire blocking, ceramic wool and other materials required for the UL listed assemblies. Where required, these shall be installed in conjunction with sleeves and materials for fill and damming.

PART 3 - EXECUTION

3.1 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

- A. General: Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer's instructions.
- B. Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.
- C. Provide firestop system for every pipe or duct at penetration of all fire resistance rated walls and horizontal assemblies.
- D. Provide rigid supports for ducts or pipes on both sides of the fire resistance rated wall or assembly where required as part of the fire stop assembly.
- E. Coordinate opening size and additional framing requirement with the General Contractor for each opening to meet the firestop installation requirements.
- F. Annular space of penetrations of nonfire-resistant-rated floor, floor/ceiling assemblies, or the ceiling membrane of a nonfire-resistant rated roof/ceiling assembly shall be sealed with a firestopping system to resist the free passage of flame and products of combustion.
- G. Where ducts penetrate fire rated assemblies and fire dampers are not indicated, the penetration shall be protected by an approved penetration firestop system installed as tested in accordance with ASTM E814 or UL 1479.
- H. Smoke Barriers:

1. Penetrations shall be sealed with a firestopping system to prevent the passage of smoke.
- I. Smoke Partitions:
 1. Penetrations shall be sealed with a caulking material to prevent the passage of smoke.
Non-rated smoke partitions do not require a fire stopping system.

END OF SECTION 23 0004

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SECTION 23 0513 - ELECTRICAL REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements for electrical work for HVAC equipment including single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation and other electrical equipment, devices, fuses, wire, conduit and installation methods.

1.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.
- B. Refer to the Mechanical drawings and also the Electrical drawings for requirements related to each trade. Coordinate all aspects of electrical components and wiring to complete the systems.

1.3 QUALITY ASSURANCE

- A. Equipment, devices shall be designed, constructed and installed in accordance with applicable standards of NEMA and the National Electric Code. Equipment shall be tested and listed by UL or other approved agency and installed in accordance with all instructions included as part of such listing.
- B. Electrical equipment, devices, fuses, wire, conduit and methods shall comply with applicable provisions of Division 26 - Electrical.

PART 2 - PRODUCTS

2.1 MOTORS

- A. General duty motors shall be induction type 1750 rpm NEMA Design "B" with copper windings, Class B or F insulation, and motor enclosure to suit the application. Service factor shall be 1.15 minimum.
- B. Two-speed motors shall be two-winding type with six leads unless otherwise specified.

- C. Motors for other than general duty application shall be furnished to suit the application and operating environment.
- D. Premium efficiency motors shall be equal to Century “E + 3”, General Electric “Energy Saver Premium Efficiency”, Baldor “Super E Premium Efficient” or Reliance “Premium Energy Efficient” series. Motor efficiencies shall be tested and conform to NEMA Standard Publication MG-1 and IEEE 112 Test Method B.
- E. Motors used with variable frequency controllers shall be rated for inverter service in accordance with NEMA Standard Publication MG-1, Part 31, designed to handle 1600V at a 0.1 micro-second rise time and include Class F or H insulation, but with a Class B temperature rise. Motors shall be equipped with a maintenance free, conductive micro fiber, shaft grounding ring with a minimum of two rows of circumferential micro fibers to discharge electrical shaft currents within the motor and/or its bearings.
- F. Electronically Commutated Motors – Fans
 1. Motor enclosures: Open Drip Proof, Totally Enclosed Fan Cooled, Totally Enclosed Air Over, Totally Enclosed Non-Vented.
 2. Electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors.
 3. Motors are permanently lubricated, heavy duty ball bearing type to match with the equipment load and pre-wired to the specific voltage and phase.
 4. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor or integrated variable frequency drive.
 5. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
 6. Motors can achieve up to 95% efficiency, model and horsepower dependent.
- G. Motor sizes shown on the drawings are to be considered minimum. Motors furnished shall be sized so as to not operate in the service factor range. Motors for direct driven pumps and fans shall be selected so as to not operate in the service factor range at any point on the curve.
- H. The HVAC Contractor and equipment suppliers shall compare the electrical power requirements of the intended equipment with power feeders to the equipment shown on the Electrical drawings. Verify adequacy and compatibility of voltage, phase, wiring, capacity, number and size of conductors (versus equipment connection points), fusing and other information on the electrical and mechanical drawings to that required for the equipment. If the selected equipment requires revision of the electrical, added cost must be borne by the HVAC Contractor.

2.2 STARTERS

- A. Magnetic starters shall comply with provisions of Division 26 - Electrical Specifications and shall be NEMA construction (IEC rated not acceptable) with thermal overload element on each phase, 115 volt control voltage and hand-off-automatic switch, where appropriate. An integral control transformer shall be incorporated in the starter for each motor of 200 volt and greater. A single control transformer is acceptable for multiple motor packaged equipment, however, when

such is the manufacturer's standard. Duplex type units (pumps, compressors, etc.) are not included in this exception. A control transformer shall be provided in each starter to insure standby operating capability.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Motor connections of factory assembled equipment shall be made with flexible conduit except for plug-in electric cord connections.
- B. All power wiring shall be run in conduit. Control wiring shall be run in conduit except where open wiring is permitted in other applicable specification sections.
- C. Fuses shall be furnished and installed in fuse clips of equipment and switches provided by the Mechanical Contractors.
- D. If a non-basis of design manufacturer is provided by the HVAC contractor and the specific unit has a powered component with a MCA and/or MOCP greater than the basis of design, the HVAC contractor shall be responsible to provide all required electrical changes required to power the non-basis of design unit. The HVAC contractor shall coordinate with the Electrical Contractor any variances in the MCA and/or MOCP of the units provided.

END OF SECTION 23 0513

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SECTION 230520 – PIPE MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes materials and methods for piping common to several Sections of Division 23. Included in this Section are the following:
 - 1. Pipe, Fittings and Joining Methods.
 - a. Steel Pipe, Fittings and Joints
 - b. Copper Tubing, Fittings and Joints
 - 2. Unions and flanges
 - 3. Dielectric Connectors
 - 4. Pipe Sleeves, Openings, Penetrations, Curbing and Escutcheons
 - 5. Piping Installation Methods
 - 6. Pipe Testing

- B. Refer to other Sections in Division 23 for selection of piping materials for the various services. Piping materials and installation methods peculiar to certain individual systems are specified in Sections related to those systems.

1.2 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Pipe and fittings.

1.3 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

- B. Welders shall be qualified and fully certified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

- C. Welding procedures and testing shall comply with ANSI Standard B31.1.0 Standard Code for Pressure Piping, Power piping and The American Welding Society Welding Handbook.

- D. All pressure piping systems regulated by the Ohio Pressure Piping Systems Code, Chapter 4101:8 shall conform to applicable requirements of the Code. Welders shall carry a current State of Ohio, Pressure Piping Board Certification. Each welder shall submit a copy of their signed performance qualification record to the Engineer for approval prior to beginning work on any pressure piping system.

- E. Piping between the power boiler (steam boiler above 15 psig) and the valve to valves required in ASME Code, Section 1, shall be in conformance with ANSI B31.1 – Power Piping. Welding shall be performed under PP certification and so stamped.

PART 2 - PRODUCTS

2.1 Refer to Piping Systems Schedule on Drawings for piping products.

2.2 UNIONS AND FLANGES

- A. Unions on Copper Tubing – All bronze construction 150 lb., solder ends.
- B. Unions on Steel Pipe (2” and Smaller) – Malleable iron with ground seat, bronze to steel, 300 lbs., screwed ends.
- C. Flanges on Steel Pipe (2-1/2” and larger) – Welded or screwed joints. Gaskets shall be 1/16” thickness full face compressed sheet suitable for temperature and pressure ranges of the application. Bolts for flanges in all steam and high temperature hot water piping shall be No. 7 hardened bolts.

2.3 DIELECTRIC CONNECTORS

- A. A dielectric connector shall be incorporated at each connection between ferrous and copper piping. Connectors shall be:
 - 1. Dielectric coupling with non-conductive polymer liner, Lochinvar Corp. “V-line” Dielectric fitting on services 180 degrees and less.
 - 2. Dielectric flange with non-metallic bolt hole grommets and gasket.
 - 3. Brass adaptor, for HVAC application only.

2.4 PIPE SLEEVES, OPENINGS, PENETRATIONS, CURBING & ESCUTCHEONS

- A. Piping Wall Sleeves & Penetration Sealing Assemblies
 - 1. New Piping – Pipe sleeve construction for existing piping passing through:
 - a. New, poured concrete floors, walls and roof decks – Schedule 40 black steel pipe or 18-gauge galvanized steel.
 - b. Other than poured concrete – Schedule 40 black steel pipe or 26-gauge galvanized steel.
 - 2. Existing Piping – Pipe sleeve construction for existing piping passing through:
 - a. New poured concrete floors – 18-Gauge Galvanized sheet metal
 - b. Thru new walls and partitions – 26-gauge Galvanized sheet metal
- B. Piping Riser Sleeves
 - 1. Cast-In-Place Concrete Floors – Cast-in-place combination plastic pre-set floor sleeve and firestopping assembly
 - a. Equal to Hilti CP 680.

- C. Curbing – As an alternative to waterproof riser sleeves and clamping rings, the following curbs may be utilized:
 - 1. Concrete Curbs for Piping Risers – Curbs may be formed and poured around multiple pipe risers in rooms with waterproofing floor membrane. Curbs shall be 4” wide x 4” high with chamfered corners. Membrane and curbing shall be arranged to maintain the integrity of the membrane. Pipe sleeves shall be as described for normal areas or extended to the top level of the curb where the concrete is full depth throughout the curbed area.
 - 2. Roof Curb Housing Assembly – Piping and conduits extending through the roof may be fitted with a manufactured pipe curb weatherproofing assembly:
 - a. Equal to Sigrist #Pipe Chase Housing
- D. Escutcheon Plates – Escutcheon plates shall be split-ring chromium plated pressed steel. Plates shall be sized to cover the surface penetration and sleeve. Plates shall be installed on exposed piping in finished spaces and areas where pipes penetrate walls, floors, ceilings, or overhead structure.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION METHODS

- A. Cutting, Cleaning & Erection – Pipe and tubing shall be cut and fabricated to field measurements and run parallel to normal building lines. Pipe ends shall be cut square and ends reamed to remove burrs. The pipe interior shall be cleaned of foreign matter before erection of the pipe.
- B. Workmanship – Piping shall be installed consistent with good piping practice and run concealed wherever possible. Coordinate with other trades to attain a workmanlike installation.
- C. Drainage – Piping shall be pitched for drainage. The low points shall be fitted with a ¾” drain valve (with hose thread adapter if not piped to a floor drain) except that on piping 1-1/4” and smaller where a drain valve is not shown, a drain plug is acceptable. Hose thread adapters on drain valves of potable water piping shall be fitted with a non-removable vacuum breaker.
- D. Piping Supports – Pipe alignment in both the horizontal and vertical must be tightly maintained. Misalignment must be corrected to the satisfaction of the Engineer before insulation is applied and the system accepted. Piping supports as follows:
 - 1. General Piping – Shall be supported as specified in Section 23 0529 Pipe Hangers.
- E. Valve Protection – Internals of sweat end valves shall be removed when damage or warping could occur due to applied heat of soldering or brazing. Where silver brazing is specified, solder connection of valves shall be used to reduce the danger of damage.
- F. Soft Copper Connections – Piping within 2 ft. of the coil connections to small heating and/or cooling units, reheat box coils and duct coils may be Type “L” soft copper to facilitate connection in a confined space. Joints shall be brazed or soldered consistent with the piping system or flared-tubing fittings may be used where appropriate.

- G. Piping Protection – Close open ends of piping during construction and installation to keep interior of the pipe clean.
- H. Electrical Protection – Piping shall not be run above electrical switchgear or panelboards, nor above the access space in the immediate vicinity of the equipment, in accordance with N.E.C. Article 384.
- I. Temperature Controls Devices –
 - 1. Control Devices and Fittings – Bulb wells for temperature sensing specified in the Controls and Instrumentation Section shall be furnished by the Control sub-contractor and installed by the Piping Contractor. Other types of control devices (differential pressure switches, flow meters, etc.) shall also be installed by the Piping Contractor. Devices, fittings (tees, weldolets, thredolets), locations and installation details shall be closely coordinated with the Controls sub-contractor and device manufacturer's instructions.
 - 2. Automatic Control Valves – Automatic control valves shall be furnished by the Temperature Controls sub-contractor for installation by the HVAC piping contractor. Flare fittings for flare end valves shall be provided by the HVAC piping contractor.

3.2 UNIONS AND FLANGES

- A. Erection and Maintenance Purposes – Unions and flanges shall be installed at pipe connections to fixtures and equipment and as required for erection and/or maintenance purposes.

3.3 PIPE SLEEVES

- A. Pipe sleeves shall be placed in the initial stages of construction before concrete, masonry, and other general construction activity. Means shall be taken to assure that the sleeve will not move during or after construction. Beams, columns, and other structural members shall not be sleeved except upon approval of the Architect.
- B. Length of wall sleeves shall be such that the sleeve ends are substantially flush with both sides of the wall or partition. Floor sleeves shall be flush with the bottom and top of the floor slab except, in mechanical rooms and other areas which might have water on the floor, sleeves shall project a minimum of 1" above finished floor. Pipe sleeves shall be sized to allow insulation to pass thru the sleeve, for insulation requiring continuous vapor barrier (domestic cold water, chilled water refrigerant, etc.). Where vapor barrier continuity is not needed, the sleeve may be sized to pass the pipe only or the insulation as well.
- C. Firestopping – Pipe sleeves which are part of firestopping assemblies shall conform to the requirements of the assembly with particular emphasis regarding size, annular space, length, passage or non-passage of insulation and the installation of the sleeves.
- D. Where firestopping is not required, the annular space between the sleeve, core drilling or opening and the pipe or pipe insulation shall be closed with caulking to retard the passage of smoke.

- E. Where uninsulated pipes requiring no pipe sleeves pass thru non-fire rated floor, wall or partition, the annular space shall be closed with material and methods compatible with the wall or partition material (Type M masonry grout, drywall joint compound, plaster, etc.).
- F. Pipe sleeves, floor and wall openings, water protective curbing and escutcheon plates shall be provided as described below. Except as noted below, sleeves shall be placed to allow new piping to pass through and allow for expansion, contraction, and normal movement of the pipe. Sleeves are also required for all existing piping related to the various trades in new walls, partitions, floors, and roof slabs, same as for new piping. Pipe sleeves shall be placed in all:
 - 1. Floor slabs,
 - 2. poured concrete roof decks,
 - 3. walls and partitions,
 - 4. except as noted below, to allow new piping to pass through and allow for expansion, contraction, and normal movement of the pipe. Sleeves are also required for all existing piping related to the various trades in new walls, partitions, floors, and roof slabs, same as for new piping.
- G. Sleeves are not required in the following:
 - 1. In floor slabs on grade.
 - 2. In stud and gypsum board or plaster walls and partitions which are not fire rated.
 - 3. For uninsulated pipe passing through masonry walls and partitions and stud and gypsum board or plaster walls and partitions.
 - 4. In core drilled openings in solid concrete not requiring water protection. Sleeves are required, however, at core drilling through hollow pre-cast slabs and concrete block walls, to facilitate containment of required firestopping material.
 - 5. In large floor openings for multiple pipe and duct risers which are within a fire rated shaft, unless the opening is to be closed off with concrete or other material after pipe are set.
- H. Where pipes penetrate walls and floors other than those required to be fire rated, the annular space between the sleeve, core drilling or opening and the pipe insulation shall be closed to retard the passage of smoke.

3.4 PIPE TESTING

- A. All piping provided in this work shall be pressure tested as specified below.
- B. Pipe testing for HVAC piping shall be:
 - 1. Refrigerant piping – refer to appropriate Refrigeration Sections.
- C. Testing shall be performed prior to application of insulation. Ensure that air is vented from piping when piping is hydrostatically tested.
- D. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be monitored by a recorder. Furnish a written record of each piping system test indicating date,

system, pressure, duration, and results of tests. Copies of test reports shall be included in the O&M manuals.

- E. Leaks discovered during testing shall not be patched. Threaded connections shall be either tightened or replaced. Small leaks in welded pipe may be chipped and rewelded.
- F. Where a new pipe connects to an existing pipe, provide the following to facilitate testing, cleaning, draining and eventual shutoff service:
 - 1. A shutoff valve in the new pipe near the point of connection.
 - 2. A ¾" valved stub with capped ¾" hose connector beyond the valve for testing of the new pipe extension. Close valve, remove handle after testing is complete. Wire handle to valve body.

END OF SECTION 232113

SECTION 23 0529 – PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Hanger Rods and Attachments.
- B. See Division 23 Section “Metal Ducts” for duct hangers and supports.

1.2 DEFINITIONS

- A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design seismic-restraint hangers and supports for piping and obtain approval from authorities having jurisdiction.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS

- A. Hangers and supports for piping shall be equal to the Anvil catalog numbers as follows:

1. General Service – clevis type – Anvil Fig. 260.
 2. Uninsulated Copper Tubing - copper plated clevis type – Anvil Fig. CT-65 (or plastic coated clevis).
 3. Where the length of the hanger rod between the top of the hanger and the attachment is 3" or less, clevis type hangers with rollers, Anvil Fig. 181, shall be used to allow for expansion travel
- B. Hangers on insulated horizontal piping shall be oversized to surround the pipe insulation. To protect the insulation from damage or inordinate compression due to concentrated weight, the following shall be provided at each hanger:
1. Pipe 2" and smaller – Anvil Fig. 168 18 ga. sheet metal rib-lock shield with belled ends, 12" long.
 2. Pipe 2-1/2" and larger – Factory fabricated assembly equal to Pipe Shields, Inc. A1000.

2.2 TRAPEZE HANGERS

- A. Trapeze hangers for numerous pipes run in parallel may be utilized. Horizontal support members shall be unistrut type section with pipe rollers (to allow for expansion travel) and spring and nut connectors, suspended with hanger rods and attachments similar to individual pipe hanger suspension.

2.3 HANGER RODS AND ATTACHMENTS

- A. Hanger rods shall be solid steel, threaded-end or all-thread rod, of diameter listed below. A hanger attachment device (for attachment to the structure) and locking nuts at the hanger attachment shall be provided on each hanger. Locking nuts shall be provided at each clevis hanger.

- B. Pipe Hanger Rod Size Schedule

<u>Pipe Size</u>	<u>Min. Rod Dia.</u>
1" and smaller	1/4"
1-1/4" to 3"	3/8"
4" to 6"	1/2"
8"	5/8"
10"	3/4"
12"	7/8"
14" to 16"	1"
18" to 20"	1-1/4"

- C. Hanger rod attachment devices for attachment to the structure shall be:
1. After-set steel expansion type concrete inserts.

2. Beam clamps for steel construction equal to Anvil Fig. 92, 93, or 94. Utilize swivel type in sloped steel construction to provide vertical support of pipe without bending hanger rods.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Spacing of hangers shall be as follows:

1. Steel pipe - Horizontal:
 - a. 2" and smaller – 8 ft. intervals
 - b. 2-1/2" thru 6" – 10 ft. intervals
 - c. 8" and larger – 12 ft. intervals.
2. Copper Tubing – Horizontal
 - a. 1-1/4" and smaller – 6 ft. intervals
 - b. 1-1/2" – 2" – 8 ft. intervals
 - c. 2-1/2" and larger – 10 ft. intervals

B. Attachment of pipe hangers to the structure shall be with:

1. After-set concrete inserts, in 4" minimum depth concrete, set in drilled holes. Powder actuated driven fasteners are not permitted.
2. Provide anchoring where steel beam clamps are attached to sloping surfaces of beam flanges and where otherwise required to insure permanent attachment.
3. Attachment to steel deck is prohibited. Span from steel structural members with supplementary steel shapes where direct attachment to structural members is not practical. This does not apply to steel deck with concrete slab poured deck. Refer to notes 1 and 2 above.

C. Pipe hangers shall be adjusted to proper elevation and all hanger rods set in a vertical position before pipe insulation is installed.

D. Hanger assemblies which will remain exposed on completion of the project shall be painted before installation.

END OF SECTION 23 0529

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SECTION 23 0548 - VIBRATION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Vibration Isolators

1.2 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Indicate inertia bases and locate vibration isolators.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Open Spring Isolator

1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
2. Spring Mounts: Provide with leveling devices, 0.25 inch neoprene sound pads and zinc chromate plated hardware.
3. Mason Industries Series “SLFH”

B. Neoprene Mounts

1. Mount: Double deflection neoprene with a minimum static deflection of 0.35”. All metal surfaces shall be neoprene covered to prevent corrosion and have friction pads both top and bottom.
2. Mason Industries Series “ND”

C. Neoprene Pad Isolators

1. Pad shall be 1” thick sandwich type consisting of a 0.5” cork center with 0.25” neoprene waffle pad top and bottom.
2. Mason Industries Series “NK”.

D. Spring Hanger

1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
2. Housings: Neoprene in shear or double deflection LDS rubber upper and lower elements.
3. Mason Industries Series “30N”

2.2 MANUFACTURERS

- A. Mason Industries.
- B. Kinetics Noise Control
- C. Amber Booth

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Isolators installed outside shall be furnished weather protected with springs PVC coated and other ferrous parts hot dip galvanized or cadmium plated.
- B. Isolators for chillers, cooling towers, boilers and other equipment with significant water capacity shall be equipped with vertical limit stops.

3.2 INSTALLATION

- A. Follow manufacturer’s instructions in setting and adjusting isolators. Insure that no direct hard surface to surface contact occurs. Fasten device to floor as recommended by the isolation supplier.
- B. Where electrical connections are to be made to equipment mounted on isolators, inform the Electrical Contractor to connect to the equipment with flexible conduits.
- C. See Specification Section 23 0529 Pipe Hangers and Supports for spring hanger locations and hanger installation requirements.
- D. Adjust isolators after piping system is at operating weight.
- E. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- F. Adjust active height of spring isolators.
- G. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 23 0548

SECTION 23 0553 - IDENTIFICATION FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment Labels.
2. Pipe Labels.
3. Warning Markers.
4. Valve Tags.
5. Duct Labels.
6. Controls Equipment Labels.

1.2 SUBMITTAL

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

1.3 QUALITY ASSURANCE

- A. Labels, tags and markers shall comply with ANSI A13.1 for lettering size, colors and length of color field.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Each item or major equipment shall be labeled. This includes all VRF system components, DOAS Units, Fans, and other similar equipment.
- B. Labeling shall be:
1. Permanently attached engraved brass or plastic laminated signs with 1” high lettering. Signs on exterior equipments shall be brass.

2.2 PIPE LABELS

- A. Pipe markings shall be applied to all piping.
- B. Labeling shall be:

1. Plastic semi-rigid snap-on type, manufacturer’s standard pre-printed color coded pipe markers extending fully around the pipe and insulation or pressure-sensitive vinyl pipe markers similar to above.
 2. On piping and insulation 6” and greater diameter, full band as specified above or strip-type markers fastened to the pipe or insulation with laminated or bonded application or by color-coded plastic tape not less than 1-1/2” wide, full circle at both ends of the marker.
- C. Identification markings shall include service (e.g. hot, chilled, steam) and arrows indicating direction of fluid flow provided integral with the pipe marker or separate at each marker.

2.3 WARNING MARKERS

- A. Underground line marker tape shall be permanent bright-colored, plastic with continuous identification lettering. Tape over service lines that cannot be detected by a metal detector shall be multi-ply with an aluminum foil core.

2.4 VALVE TAGS

- A. Each shutoff valve, other than at equipment, shall be identified with a stamped tag. Valves and tagging shall be scheduled, typewritten on 8-1/2” x 11” paper, tabulating valve number, piping system, abbreviation, location of valve (room or area) and service (e.g. – south wing reheat boxes).
- B. Valve tags shall be polished brass or plastic laminate with solid brass S hook. Tags shall be engraved with “H” for HVAC and the designated number.

2.5 DUCT LABELS

- A. Duct markings shall be applied to all ductwork.
- B. Identification markings shall include service (e.g. supply, return, exhaust, outside air) and direction of air flow provided integral with duct marker or separate at each marker.
- C. Duct markings shall be laminated plastic color-coded pressure sensitive vinyl tape, 2-1/2” width, 3 mil minimum thickness.

2.6 CONTROLS EQUIPMENT LABELS

- A. Each controls device or major controls equipment shall be labeled to match controls drawings. This shall include thermostats, switches, sensors, controllers, panels and other similar equipment.
1. Equipment labels - Self-Adhesive, Engraved, Laminated Phenolic Label: Adhesive backed, with black letters on a white background. Minimum letter height shall be 3/8 inch.

2. Device labels - Marker Tape: Self-laminating, clear polyester, 3/8" high tape with black lettering.

B.

2.7 ACCEPTABLE MANUFACTURERS

- A. Labels, markings and tags shall be manufactured by:
 1. W.H. Brady
 2. Seton
 3. Allen
 4. Industrial Safety Supply

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Identification marking and tagging shall be applied after insulation and painting has been completed.
- B. Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled on drawings.
- C. The Plumbing, Fire Suppression and HVAC Contractors shall coordinate labeling, marking and tagging to attain coordinated and consistent systems of identification.
- D. Equipment labeling shall consist of unit designation as shown on the drawings. Exhaust labeling shall also indicate service of room or area of service.
- E. Pipe and duct markers shall be placed at 25 ft. centers in mechanical rooms and concealed spaces and at 50 ft. centers in other exposed locations.
- F. Refer to appropriate sections of this specification for installation of underground line marker tape.
- G. Valve tags shall be placed on each valve except those intended for isolation of individual items of equipment. Valve tag schedules shall be prepared as specified above.

END OF SECTION 23 0553

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SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes TAB to produce design objectives for the following:
 - 1. Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
 - 2. HVAC equipment quantitative-performance settings.
 - 3. Verifying that automatic control devices are functioning properly.
 - 4. Reporting results of activities and procedures specified in this Section.

1.2 SUBMITTALS

- A. LEED Submittals:
 - 1. Air Balance Report for Prerequisite EQ 1: Documentation of work performed for ASHRAE 62.1.
 - 2. TAB Report for Prerequisite EQ 1: Documentation of work performed for ASHRAE/IESNA 90.1.
- B. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

1.3 QUALITY ASSURANCE

- A. TAB Firm Qualifications: Engage a TAB firm certified by AABC or NEBB.
- B. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
- C. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems." NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems." SMACNA's TABB "HVAC Systems - Testing, Adjusting, and Balancing."
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1.

- E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.4 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.5 COORDINATION

- A. 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.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
 - 1. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- D. Examine system and equipment test reports.
- E. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are

accessible and appropriate for effective balancing and for efficient system and equipment operation.

- F. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- G. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- H. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.
- I. Examine strainers for clean screens and proper perforations.
- J. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- L. Examine system pumps to ensure absence of entrained air in the suction piping.
- M. Examine equipment for installation and for properly operating safety interlocks and controls.
- N. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
 - 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
 - 5. Sequence of operation for control modes is according to the Contract Documents.
 - 6. Controller set points are set at indicated values.
 - 7. Interlocked systems are operating.
 - 8. Changeover from heating to cooling mode occurs according to indicated values.
- O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
 - 1. Permanent electrical power wiring is complete.
 - 2. Hydronic systems are filled, clean, and free of air.
 - 3. Automatic temperature-control systems are operational.

4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" SMACNA's TABB "HVAC Systems - Testing, Adjusting, and Balancing" and this Section.
 1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2 - "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.

- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling unit components.
- L. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure fan static pressures to determine actual static pressure as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
 - 3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
 - 4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
 - 5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
 - 6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 - 1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

- a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure terminal outlets and inlets without making adjustments.
 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 3. Measure total system airflow. Adjust to within indicated airflow.
 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
 7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
 8. Record the final fan performance data.
- C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Balance systems similar to constant-volume air systems.
 2. Set terminal units and supply fan at full-airflow condition.
 3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
 4. Readjust fan airflow for final maximum readings.
 5. Measure operating static pressure at the sensor that controls the supply fan, if one is installed, and verify operation of the static-pressure controller.
 6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
 7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
 8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
- D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
 2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
 3. Set terminal units at full-airflow condition.
 4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
 5. Adjust terminal units for minimum airflow.
 6. Measure static pressure at the sensor.
 7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.7 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer, model, and serial numbers.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.8 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.9 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Refrigerant Coils: Measure the following data for each coil:
 - 1. Dry-bulb temperature of entering and leaving air.
 - 2. Wet-bulb temperature of entering and leaving air.
 - 3. Airflow.
 - 4. Air pressure drop.
 - 5. Refrigerant suction pressure and temperature.

3.10 PROCEDURES FOR TEMPERATURE MEASUREMENTS

- A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
- C. Measure outside-air, wet- and dry-bulb temperatures.

3.11 TEMPERATURE-CONTROL VERIFICATION

- A. Verify that controllers are calibrated and commissioned.
- B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- C. Record controller settings and note variances between set points and actual measurements.
- D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
- E. Check free travel and proper operation of control devices such as damper and valve operators.
- F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.
- G. Check the interaction of electrically operated switch transducers.
- H. Check the interaction of interlock and lockout systems.
- I. Check main control supply-air pressure and observe compressor and dryer operations.
- J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
- K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.12 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
 - 2. Air Outlets and Inlets: 0 to minus 10 percent.
 - 3. Heating-Water Flow Rate: 0 to minus 10 percent.
 - 4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.13 FINAL REPORT

- A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to certified field report data, include the following:
 - 1. Pump curves.

2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outside-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.

END OF SECTION 23 0593

SECTION 23 0713 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Fiberglass.
 - 2. Protective Jacketing

1.2 SUBMITTALS

- A. Product Data:
 - 1. For each type of product indicated.
 - 2. Thickness and covering table.

1.3 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Manufacturers:

1. Johns Manville Corporation
2. Owens Corning Corp.
3. Knauf Fiber Glass
4. Manson
5. CertainTeed

2.2 PRODUCTS

- A. Refer to schedule on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be done by tradesmen specializing in insulation work in strict accordance with manufacturer's recommendations.
- B. Blanket insulation shall be wrapped tight to the duct. Insulation shall be secured to ducts 20” wide and greater with weld pins and fasteners, 18” on center maximum. Adhesive shall be applied to the duct as an aid to installation and adhesion. Vapor barrier jacket shall be lapped, stapled and sealed with adhesive and 3” wide FSK pressure sensitive tape.
- C. Board insulation with factory applied jacket shall be secured to the duct with weld pins and fasteners, 12” on center maximum. Vapor barrier jacket shall be lapped, stapled and sealed with adhesive and 3” wide ASJ pressure sensitive tape.
- D. Ductwork which is internally lined with acoustical insulation, flexible ductwork with factory applied insulation and fiberglass ductwork need not be further insulated. Required internal lining is shown on the drawings. Refer to Section 23 3113 Ductwork and coordinate with the various trades.
- E. Return air ductwork in the attic above the building insulation shall be insulated.
- F. Equipment and devices in supply ductwork which could potentially condense moisture shall be insulated.
- G. Exterior ductwork type ‘T1’ shall be installed per manufacturers recommendation. Paint ductwork to match exterior wall color. Painting by G.C.

END OF SECTION 23 0719

SECTION 23 0719 - PIPE INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
 - a. Fiberglass.
 - b. Flexible Elastomeric.
2. Protective Jacketing

1.2 SUBMITTALS

A. Product Data:

1. For each type of product indicated.
2. Thickness and covering table.

1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

B. Thicknesses shall be in compliance with most current version of ASHRAE 90.1.

PART 2 - PRODUCTS

2.1 INSULATION GENERAL

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- D. Stainless Steel Pipe Insulation Products
 - 1. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
 - 2. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

2.2 FIBERGLASS INSULATION

- A. Factory molded tubular fiberglass with “all service” jacket having an integral vapor barrier. Longitudinal joints of the jacket shall be overlapping with factory applied adhesive. In lieu of the factory adhesive, staples on 6” centers may be used with vapor barrier mastic applied to seal both the joint and staple holes. Butt joints shall be sealed with 3” wide ASJ pressure sensitive tape.
- B. Vapor barrier jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- C. Manufacturers:
 - 1. Johns Manville Corp.
 - 2. Owens Corning Corp.
 - 3. Knauf Fiber Glass
 - 4. Manson Insulation Inc.

2.3 FLEXIBLE ELASTOMERIC INSULATION

- A. Factory molded tubular preformed flexible elastomeric cellular rubber insulation applied with an air dried, contact adhesive compatible with insulation.
 - 1. Minimum Service Temperature: -40°F.
 - 2. Maximum Service Temperature: 220°F.
 - 3. Connection: Waterproof vapor barrier adhesive.
- B. Manufacturers:
 - 1. Aeroflex
 - 2. Armacell International
 - 3. Rubatex

2.4 PROTECTIVE JACKETING

- A. PVC Plastic

1. One piece molded type fitting covers and sheet material, 10 mill thickness, off white color. Connection with special Z-joint closure and factory supplied snap-straps.
- B. Aluminum Jacket
 1. Formed aluminum sheet, 0.016” thickness, smooth finish with longitudinal slip joints and 2” laps. Fitting covers shall be same thickness die shaped fitting covers with factory attached protective liner.
 2. Metal jacket bands shall be 3/8” wide, 0.015” thick aluminum.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be done by tradesmen specializing in insulation work in strict accordance with manufacturer's recommendations.
- B. Overlap and seal all longitudinal joints. Staples and adhesive may be used as stated above. Tape and seal cross joints. Vapor barrier shall be continuous on insulation of all cold services. Vapor barrier type mastic shall be used where needed to maintain a vapor seal.
- C. Where insulation is terminated, insulation shall be beveled at 45° and the beveled surface sealed with vapor barrier mastic. PVC caps over straight cut ends which have been vapor sealed may be used in lieu of beveling.
- D. Mechanical joint fittings and couplings shall be considered as a part of the pipe line and shall be insulated. Bidders on the insulation work are cautioned to verify during the bidding period the extent of this work.
- E. Insulation on cold service piping shall be run through floor and wall sleeves to maintain vapor barrier continuity. Insulation on other services may likewise be run continuous when sleeve size permits. Refer to the Piping Material and Methods Section for special considerations which must be given at fire-rated wall and floor penetrations. Refer to Section 230529 - Pipe Hangers and Supports for non-compressible insulation or blocking material and sheet metal saddles required at pipe hangers. Coordinate with the piping contractor on the furnishing, installation and detailed requirements of these. Provide insulation and vapor barrier on and around supports for pipe risers of services which require vapor seal so as to prevent sweating.
- F. Re-insulate piping where existing insulation has been damaged or removed in the performance of work in this project.
- G. Verify that piping has been tested before applying insulation materials and that piping surfaces are clean and dry, with foreign material removed.
- H. Fittings, valves, flanges and other devices, both exposed and concealed, requiring insulation shall be covered same thickness as pipe insulation with:

1. Factory molded fitting insulation cover with PVC one-piece fitting cover.
 2. Miter-cut segments of pipe insulation, held in place with adhesive and/or wire, filled with insulating cement smoothed to shape and covered with PVC one-piece fitting cover.
 3. Fiberglass blanket insulation, held in place and covered with PVC one-piece fitting cover.
 4. Oversized pipe insulation, where applicable, finished same as straight run pipe insulation.
- I. Refrigerant piping shall be insulated with 3/4" insulation. Exterior refrigerant piping shall have an aluminum jacket to protect against water damage.

END OF SECTION 23 0719

SECTION 23 0913 - INSTRUMENTS AND CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes instruments and control devices for HVAC Direct Digital Control (DDC) systems and components.
 - 1. Electronic Sensors
 - a. Thermistor Temperature Sensors & Transmitters
 - b. Humidity Sensors
 - c. Pressure Transmitters & Transducers
 - 2. Status Sensors
 - 3. Detection Equipment
 - 4. Thermostats
 - 5. Humidistats
 - 6. Actuators
 - 7. Control Valves
 - 8. Dampers

- B. Related Sections:
 - 1. Section 23 0914 – Control Wiring and Cabling
 - 2. Section 23 0923 – Direct Digital Control System
 - 3. Section 23 0950 – Variable Frequency Motor Controllers

1.2 SUBMITTALS

- A. Product Data: For each control component indicated.

- B. Shop Drawings:
 - 1. Each component shall be labeled for proposed usage and its corresponding item tag per the control drawing, diagram and sequence of operation submittal.
 - 2. Damper schedule.
 - 3. Valve schedule.

- C. Operation and maintenance data.

1.3 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Where a list of manufacturers is not provided, products offered by the controls system contractor or their preferred vendor may be incorporated, subject to compliance with the specification.
- B. Where a list of manufacturers is provided under components below, the product shall be selected only from the list of manufacturers provided.

2.2 CONTROL SYSTEM COMPONENTS

- A. Refer to Section 23 0923 “Direct Digital Control System” for manufacturers and specifications for the DDC system, including operator workstation, distributed controllers, network requirements, accessories, control software and graphic requirements.
- B. Refer to Section 23 0914 “Control Wiring and Cabling” for power wiring, control cabling, transformers, fusing power distribution cabinets and power line filtering for the DDC system.
- C. Control system components specified in this Section include sensors, detection equipment, indicators, thermostats, humidistats, air flow measuring stations, meters, actuators, control valves and dampers.

2.3 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, pipe immersion, or duct mounting as required.
- B. Thermistor Temperature Sensors & Transmitters:
 - 1. Accuracy: $\pm 0.36^{\circ}\text{F}$ at calibration point.
 - 2. Wire: Twisted, shielded-pair cable.
 - 3. Single Point Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 10 sq. ft.
 - 4. Averaging Elements in Ducts: 36 inches long, flexible for ducts 10-20 sq. ft. and 72 inches long, flexible for ducts over 20 sq. ft.
 - 5. Insertion Elements for Liquids: Brass or stainless-steel socket with insertion length of:
 - a. 2-1/2” for pipes 8” and smaller
 - b. 6” for pipes 10” and larger
 - 6. Wall Mounted Temperature Sensor:
 - a. Manufacturer's standard cover, approximately 3”W.x 5”H.x 1”D., white color, conforming to NEMA-1 requirements. UL listed. Surge immunity compliance with IEEE C62.41.
 - b. Digital LCD display for system values such as setpoints, operating mode (occupied/unoccupied/override), VAV discharge air temperature, etc.
 - c. LED override status light.

- d. Three button keypad for temperature setpoint adjustment up/down and timed override (typical for VAV box application).
 - e. Four button keypad for temperature setpoint adjustment up and down, timed override, heat/cool/off/auto selection and fan on/off/speed/auto selection (typical for fan coil, rooftop unit or AH unit control)
 - f. Separate wiring subbase and electronics.
 - g. Unshielded twisted pair, non polarity sensitive connection to controller
 - h. RJ-45 jack for network access via PC.
7. Wall-Mounted Combination Temperature/CO2 Sensor:
- a. Sensor shall be as described for Wall Mounted Sensor with:
 - 1) Supply power voltage 18 – 30 VAC
 - 2) CO2 Measurement Range 0 to 2000 ppm
 - 3) CO2 Output Signal
8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
9. Strap-On Pipe-Mounted Temperature Sensor:
- a. Accuracy:
 - 1) Platinum RTD: $\pm 0.6\%$ @ 32°F (0°C);
 - 2) Nickel RTD: $\pm 0.5^\circ\text{F}$ @ 32°F (0°C);
 - 3) Balco RTD: $\pm 0.1\%$ @ 32°F (0°C);
 - 4) Thermistors: $\pm 0.36^\circ\text{F}$ from 32 to 158°F (0 to 70°C).
 - b. Operating Temperature: -32 to 240°F (-35.5 to 115.5°C).
 - c. Probe Material: Copper conductor.
 - d. Mounting: Strap-on to pipe (fits 2 to 5 pipe sizes).
- C. Humidity Sensors: Thermoset polymer capacitive sensor.
1. Accuracy: 2 % over full range with linear output.
 2. Room Sensor Range: 5 to 95% relative humidity, non-condensing.
 3. Wall Mounted Sensor:
 - a. Manufacturer's standard cover, approximately 3"W x 5"H x 1"D, white color, conforming to NEMA-1 requirements. UL listed. Surge immunity compliance with IEEE C62.41.
 - b. No LCD display or keypad, sensor only.
 - c. Separate wiring subbase and electronics.
 - d. Unshielded twisted pair, non polarity sensitive connection to controller
 - e. RJ-45 jack for network access via PC.
 4. Duct Sensor: 20 to 80% relative humidity range with element guard and mounting plate.
 5. Outside-Air Sensor: 20 to 80% relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of -22 to +185°F.
- D. Pressure Transmitters & Transducers:
1. Static-Pressure Transmitter: Non-directional sensor with suitable range for expected input, and temperature compensated.
 - a. Accuracy: 2% of full scale with repeatability of 0.5%.
 - b. Output: 4-20 mA.
 - c. Building Static-Pressure Range: 0-0.25 inches w.g.
 - d. Duct Static-Pressure Range: 0-5 inches w.g.

2. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
3. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
4. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
5. Pressure Transmitters: Direct acting for gas or liquid service; range suitable for system; linear output 4 to 20 mA.

2.4 STATUS SENSORS

- A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- 5-inches w.g.
- B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig piped across pump.
- C. Current Switches and Relays: For status inputs for electric motors shall comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter (20A single phase) or separate relay (contacts rated for 120/240V and appropriate amperage) for higher amperage single phase and three phase motors all within a common junction box, current sensor status, adjustable status trip point, LED status indication lights and suitable for 175 percent of rated motor current.
- D. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
- E. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- F. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.
- G. Momentary Contact Switches:
 1. Momentary contact switches shall be white, wall mounted push-button type to provide digital input to the DDC system to initiate a control function.

2.5 DETECTION EQUIPMENT

- A. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104°F; with 2 factory-calibrated alarm levels at 50 and 100 ppm.
- B. Carbon Dioxide Sensor and Transmitter: solid-state non-dispersive infrared (NDIR) sensors

1. Temperature range: 32 to 122°F.
 2. Measuring range: 0-2000 ppm
 3. Accuracy: 5% + or – or 75 ppm max.
 4. Calibration: required for span only (automatic zero adjustment)
 5. Digital display: 4 digit LED
 6. Output: 0-10 VDC, 4-20 mA, selectable
 7. Alarm relay: 1000 ppm, field adjustable from 700-1300 ppm
 8. Enclosure: High impact plastic enclosure, white approx. 5”W x 2.5”H x 2”D
 9. Duct mounted models: Sampling inlet/outlet ports, filter, tubing, mounting hardware
 10. Calibration kit: Canister of gas, regulator and digital calibration readout
- C. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.
- D. NO₂ & CO Gas Detection System:
1. System shall be complete with digital transmitters and a multi-channel controller.
 2. Transmitters:
 - a. Rugged PVC enclosure with hinged door
 - b. 24V DC power
 - c. Auto reset thermal fuse
 - d. LED indicator for power, alarm and fault
 - e. RS 485 communication bus to the central controller
 - f. Electrochemical sensors
 - g. CETCI model DST-ECO Carbon Monoxide transmitter, 0-200 ppm (fan start at 25 ppm, alarm at 100 ppm, adj.)
 - h. DST-END transmitter for Nitrogen Dioxide, 0-10 ppm (fan start at .7 ppm, alarm at 1.5 ppm, adj.)
 - i. Equal to Critical Environmental Technologies DST-W Digital Transmitter
 3. Multichannel Controller:
 - a. Field programmable, 8 analog transmitter capacity via RS485 communication to remote digital transmitters
 - b. BacNet output module
 - c. Eight SPDT relays
 - d. Audible alarm with silence button with remote combination 103 dB horn/4” diameter strobe light
 - e. 24 V power supply
 - f. Automatic reset thermal fuse
 - g. Two line LCD display readings
 - h. UL certified
 - i. Equal to Critical Environmental Technologies PDC Multi-Channel Controller.
 4. Provide all power and communication cabling required in conduit. Utilize eight SPDT relays to hard wire fan actuation. Monitor on DDC system via BACnet communication.
 5. Calibration kit: Canister of gas, regulator and digital calibration readout.
- E. Manufacturers:
1. Critical Environment Technologies
 2. Brasch
 3. Bacharach

2.6 THERMOSTATS

- A. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85°F set-point range, and 2°F maximum differential.
- B. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85°F set-point range, and 2°F maximum differential.
 - 1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
 - 2. Selector Switch: Integral, manual on-off-auto.
- C. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.
 - 1. Bulbs in water lines with separate wells of same material as bulb.
 - 2. Bulbs in air ducts with flanges and shields.
 - 3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
 - 4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
 - 5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
 - 6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.
- D. Room Thermostat Cover Construction: Manufacturer's standard locking covers.
 - 1. Set-Point Adjustment: Exposed
 - 2. Set-Point Indication: Exposed
 - 3. Thermometer: Exposed
 - 4. Color: White
- E. Room thermostat accessories include the following:
 - 1. Insulating Bases: For thermostats located on exterior walls.
 - 2. Thermostat Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.
 - 3. Adjusting Key: As required for calibration and cover screws.
 - 4. Set-Point Adjustment: 1/2-inch diameter, adjustment knob.
- F. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.
- G. Air stream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.

- H. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
 - 1. Bulb Length: Minimum 20 feet.
 - 2. Quantity: One thermostat for every 20 sq. ft. of coil surface.
- I. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.
 - 1. Bulb Length: Minimum 20 feet.
 - 2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

2.7 ACTUATORS

- A. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 - 1. Manufacturers: Belimo Aircontrols (USA), Inc.
 - 2. Listing: Actuators shall have ISO 9001 quality certification and be UL listed under standard 873.
 - 3. Characteristics: Actuators shall be fully modulating/proportional, pulse width, floating/tri-state or two-position as required and be factory or field selectable. Each actuator shall have visual position indicators. Proportional actuators shall accept a 0-10VDC or 0-20mA input signal with 2-10VDC and 4-20mA operating range, respectively. Actuators shall be capable of operating on 24, 120 or 230VAC or 24VDC and Class 2 wiring as required by the application. Power consumption shall not exceed 10VA for 120V actuators and 8 watts for DC actuators. Actuators shall be capable of being mechanically and electrically parallel to increase torque if required
 - 4. Fail-Safe Operation: Mechanical, spring-return mechanism shall be provided on all dampers and valves except where noted otherwise. Provide external, manual gear release on non-spring return actuators.
 - 5. Valves: Size for torque required for valve close off at maximum pump differential pressure plus 25% safety factor.
 - 6. Dampers: Size for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
 - e. Dampers with 2- to 3-Inch w.g. (of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
 - f. Dampers with 3- to 4-Inch w.g. of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

- g. Coupling: V-bolt and V-shaped, toothed cradle.
- 7. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
- 8. Run Time: 12 seconds open, 5 seconds closed.

2.8 CONTROL VALVES

- A. Control Valves: Factory fabricated, of type, body material, and pressure class based on fluid system, maximum pressure and temperature rating of piping system, unless otherwise indicated.
- B. Valves shall be equipped with a manual positioner to allow positioning of the valve in the absence of power.
- C. Sizing – Hydronic system control valves shall be sized as follows:
 - 1. Two-Position: Line Size
 - 2. Two or Three Way Modulating: 10 ft.hd. water pressure drop or as otherwise noted on the plans.
- D. Ball Valves 2” and smaller
 - 1. Body:
 - a. Cast Bronze or Brass
 - b. ANSI B16.5 Class 150
 - c. Threaded or soldered pipe connection
 - 2. Trim:
 - a. Stem: Stainless Steel
 - b. Ball: Stainless with an equal percentage flow characteristic or modified equal percentage flow characteristic for 2-way, linear for 3-way.
 - 3. Bonnet
 - a. Brass
 - b. Packing: Reinforced Teflon or carbon filled Teflon and EPDM O-Ring.
 - c. Seat: Reinforced Teflon or carbon filled Teflon.
- E. Butterfly Valves 2.5” – 12”
 - 1. Body:
 - a. Cast Iron with extended neck or flange and insulation clearance.
 - b. Flanged with full lugged connections.
 - 2. Trim:
 - a. Stem: Stainless Steel
 - b. Disc: Stainless Steel, Nickel Plated Ductile Iron, or Ductile Iron coated with Nylon 11, equal percentage flow characteristics or modified equal percentage flow characteristics, bubble tight shut off.
 - c. Seat: EPDM
- F. Globe Valve 2” and Smaller

1. Body
 - a. ANSI B16.5 Class 125 and 250
 - b. Cast Bronze or Brass
 - c. Threaded (FNPT), union sweat, or flared connections
 2. Bonnet
 - a. Brass
 - b. Packing: Self-adjusting Ethylene Propylene Rubber (EPR) ring pack u-cups, spring loaded PTFE and Elastomer v-rings, or spring loaded Teflon cone.
 3. Brass Trim
 - a. Stem: Stainless Steel
 - b. Plug: Brass, equal percentage flow characteristic or modified equal percentage flow characteristic.
 - c. Replaceable Seat: Brass against molded Elastometric disc, or bronze.
 4. Stainless Steel Trim (Steam Applications)
 - a. Stem: Stainless Steel
 - b. Plug: Brass, equal percentage flow characteristic or modified equal percentage flow characteristic.
 - c. Replaceable Seat: Stainless Steel.
- G. Globe Valves 2.5” and Larger
1. Body
 - a. ANSI B16.5 Class 125 and 250
 - b. Cast Iron with black lacquer finish
 - c. Flanged Connections
 2. Bonnet
 - a. Brass
 - b. Packing: Ethylene Propylene Terpolymer (EPT) ring packs, EDPM O-ring, or spring loaded Teflon cone.
 3. Trim
 - a. Stem: 316 Stainless Steel
 - b. Plug: Brass, equal percentage flow characteristic or modified equal percentage flow characteristic.
 - c. Replaceable Seat: bronze.
- H. Pressure-Independent Valves
1. Body
 - a. Brass rated at no less than 360 psi at 250 deg F.
 2. Bonnet
 - a. Brass
 - b. Packing: Reinforced Teflon or carbon filled Teflon and EPDM O-ring.
 3. Trim

- a. Stem: Brass or Stainless Steel
 - b. Ball: Plated brass or Stainless Steel, equal percentage flow characteristic or modified equal percentage flow characteristic for 2-way, linear for 3-way.
 - c. Disc: Thrust-bearing Teflon disc with double O-ring design.
 - d. Seat: Reinforced Teflon or carbon filled Teflon with EPDM O-rings
 - e. Packing: EPDM O-ring.
- I. Close-off Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings.
1. Water Valves:
 - a. Two-Way: 150% of total system pump head.
 - b. Three -Way: 300% of pressure differential between ports A and B at design flow rate or 100% of total system pump head.

2.9 DAMPERS

- A. Dampers: AMCA-rated, parallel and opposed blade design as required by the application.
- B. Outside air and relief air dampers (exposed to outside air) shall be severe cold option design with the following features:
1. Frame: Extruded aluminum, 4" x 0.08" thickness with polystyrafoam insulation.
 2. Blades: Extruded aluminum, double wall profile with expanded polyurethane foam insulation filled cores and thermally broken. Insulation factor of R-2.29
 3. Seals: Blade and frame edge seals are extruded silicon, secured in an integral slot.
 4. Bearings: Celcon inner bearing fixed to a 7/16" aluminum hexagonal blade pin, rotating within a polycarbonate outer bearing without metal-to-metal or metal-to-plastic bearing contact.
 5. Linkage: Hardware mounted within the frame, aluminum and zinc plated steel construction.
 6. Operating temperature: -40 to 155°F.
 7. Leakage: 4.9 cfm/sq. ft. at 4" w.g., maximum
- C. Return and other control dampers not exposed to outside air shall be constructed with the following features:
1. Frame: Extruded aluminum, 5" x 0.125" thickness.
 2. Blades: Extruded aluminum, airfoil profile.
 3. Seals: Blade seals shall be extruded EPDM. Frame seals shall be extruded TPE thermoplastic, secured in an integral slot.
 4. Bearings: Molded synthetic
 5. Linkage: Hardware mounted within the frame, aluminum and zinc plated steel construction.
 6. Operating temperature: -72 to 275°F.
 7. Leakage: 3 cfm/sq. ft. at 1.0" w.g. max.

2.10 AIR FLOW MEASURING STATIONS

- A. The probe assembly shall consist of one or more electronic air flow measuring units capable of continuously monitoring airflow. Each probe shall contain multiple electronic flow sensors and be thermal dispersion type. They shall be mounted in an array format to produce a true velocity profile. The sensors shall operate over a 350 to 7500 fpm velocity range and the velocity measured by each sensor shall output a signal directly proportional to flow to the supporting electronics. The output signal shall be fully isolated. The signal transmitter shall be an electronic device capable of receiving airflow probe signals over the probe interconnecting cables, linearizing each signal and then summing and averaging them. Finally the signals shall be converted to a 4 to 20 MA output signal for automatic transmission to any suitable remote input and/or recording device. A 24 volt AC power supply is required for each transmitter. The control panel shall be provided with integral diagnostics including on-line zero and on-line sensor verification. It shall have an integral reference standard for field calibration of transmitter output. The output span shall be adjustable from a minimum 0 to 1000 to a maximum 7500 fpm. The transmitter assembly shall be housed in a metal enclosure having a hinged door and lock. This unit shall not require recalibration. System accuracy shall be +/- 2% of rate plus +/- 0.55 of full scale.
1. Each supply and return fan shall have an independent air flow measurement station. Multiple fan arrays shall sum flow of each fan to report a total fan array air flow.
 2. The outdoor air intake damper shall have an independent air flow measuring station.
- B. Air flow measuring station shall be manufactured by:
1. Ebtron
 2. Paragon Controls

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify location of wall mounted sensors with drawings and room details before installation. Install devices to match rough in height of light switches provided by the Electrical Contractor, Coordinate location and placement with other wall mounted devices, cabinets, etc.
- B. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- C. Install guards on thermostats in the following locations:
1. Entrances.
 2. Public areas, such as lobbies.
 3. Gymnasiums.
 4. Corridors.
 5. Where indicated on drawings.
- D. Automatic dampers shall be furnished by the controls subcontractor to the HVAC Contractor for installation in accordance with Section 23 3300 "Air Duct Accessories."

- E. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- F. Damper linkages shall be through frame hardware; linkage attachments to blades are not acceptable.
- G. Damper jack shafting is not permitted, provide an actuator for each damper section.
- H. Install labels and nameplates to identify control components according to Section 23 0553 "Identification for HVAC Piping and Equipment."
- I. Install hydronic instrument wells, valves, and other accessories according to Section 23 2113 "Hydronic Piping."
- J. Install refrigerant instrument wells, valves, and other accessories according to Section 23 2300 "Refrigerant Piping."
- K. Install duct volume-control dampers according to Section 23 3300 "Air Duct Accessories" specifying air ducts.

END OF SECTION 23 0913

SECTION 23 0914 – CONTROL WIRING AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes control wiring, both line and low voltage, transformers, power distribution, fusing and panels, power filtering and communication cabling which is required to perform the automatic control functions described.
- B. Related Sections:
 - 1. 23 0913 Instruments and Control Devices
 - 2. 23 0923 Direct Digital Control System

1.2 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. Wiring, both line and low voltage, shall comply with NEC and shall be subject to approval by the local code enforcing authorities.
- C. Wire, conduit and installation methods shall conform to applicable provisions of Division 26 - Electrical except that wiring smaller than No. 12 and conduit smaller than 3/4" are permitted as appropriate for the application.
- D. Communication cabling shall conform to applicable provisions of Division 27- Section "Communications Horizontal Cabling".
- E. All wiring and cabling insulation in air return plenums shall not exceed maximum flame spread rating of 25 and smoke development rating of 50 as established by NFPA 255 test methods.

PART 2 - PRODUCTS

- A. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
 - 1. Output ripple of 5.0 mV maximum peak to peak.
 - 2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
 - 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

- B. Power Line Filtering: Provide internal or external transient voltage and surge suppression for workstations or controllers with the following:
 - 1. Minimum dielectric strength of 1000 V.
 - 2. Maximum response time of 10 nanoseconds.
 - 3. Minimum transverse-mode noise attenuation of 65 dB.
 - 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.
- C. Power distribution, fusing and panels:
 - 1. Power distribution transformers, fuses, termination strips etc. shall be organized in NEMA 1 enclosure panels. Panels shall be 16 gauge steel construction, with removable front cover and various size removable knockouts, arranged for surface mounting and polyester powder coat finish inside and outside, UL listed. Arrange and bundle wiring inside of panels neatly with cable ties. Panel and internal devices shall be permanently marked to correspond to power wiring diagram shop drawings provided in the operating and maintenance manual.
- D. Cabling:
 - 1. Provide CAT 5E Ethernet fiber optic cabling to interconnect major controllers and work station computer or Web server to establish the primary network configuration as determined by the direct digital control system architecture. Provide excess cabling at each connection for servicing by looping cable near the panel.
 - 2. Secondary LON or BacNet MS/TP bus wiring to secondary controllers such as unitary controllers serving VAV boxes shall be as required by the communication protocol.
 - 3. All cabling insulation shall be approved and labeled for use in air plenums where installed in these locations.

PART 3 - EXECUTION

3.1 ELECTRICAL POWER SUPPLIES

- A. The Electrical Contractor will provide a power source to motors through his starters only. Where power sources are required beyond these starters, or beyond sources explicitly shown on the electrical drawings, these shall be provided by the Controls Contractor. Where auxiliary contacts are required on starters to perform the required functions, these too shall be provided by the Controls Contractor, where not provided under the Electrical Contract. Auxiliary relays maybe provided in lieu of auxiliary contacts.
- B. Electrical circuits serving direct digital or electronic control panels, transformers, and other control equipment and devices shall be from the nearest appropriate emergency electrical panel. Coordinate with the Electrical Contractor.
- C. Circuits serving control panels and transformers for low voltage service shall be independent and used for no other purpose. These shall originate from the nearest appropriate emergency electrical panel. Circuit wiring from the electrical panel shall be included in this contract. These circuits shall be clearly identified at the panels.

3.2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install all work in accordance with the following:
1. All wiring to be ran in a neat, workmanlike manner. All wiring to be tie wrapped or in conduit as per specifications. Wiring or conduit to be ran parallel or at right angles to building structure. Install all wiring free of sags. Bundle wiring together that follows a common path.
 2. All conduit, plenum wiring, and panels shall be supported directly from the building structure with beam clamps and bridle ring. Do not support from pipe, pipe hangers, threaded rod, ductwork, ductwork strapping or other conduit.
 3. Do not lay conduit or plenum wiring on acoustic ceiling tiles, grid members or uninsulated water piping. Conduit and wiring should be installed in such a way as to not interfere with removing ceiling tiles for above ceiling access.
 4. Do not run wiring near lighting ballasts or other high voltage devices that could cause interference.
 5. All line voltage wiring must be kept separate from low voltage wiring. Line and low voltage wiring may not be run in the same conduit. Line and low voltage wiring must be kept separate in control panels.
 6. Label all wire jackets at control panel/controller and at device with tag as shown on wiring details and flow diagrams.
 7. Observe proper polarity as shown on wiring diagrams when connecting 24VAC power and ground controllers and other devices. Note that all transformer secondary grounds must be tied to chassis ground as shown in wiring diagrams unless otherwise noted.
 8. Coordinate with General Contractor and all trades to perform rough-ins for temperature control sensors and devices.
 9. Coordinate with General Contractor and all trades to confirm mounting locations for temperature control panels.
 10. Completely seal all duct, unit and wall penetrations. Avoid ceiling penetrations if at all possible. Completely seal any ceiling penetrations that are absolutely necessary.
 11. All network communication wires shall be labeled at each controller with the designation or the controller that the communication wire originates from and terminates to
 12. Verify network communications and correct any issues.
 13. Clean all construction debris from inside temperature control panels before operation.
- B. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
- C. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." All line voltage wiring and low voltage wiring (except as stated below) shall be run in conduit. Low voltage wiring concealed above accessible ceilings may be run without conduit. Open wiring dropping into walls shall be run in conduit. Thermostats shall be installed on a single gang box and conduit shall be installed to extend into the plenum. Open wiring shall be bundled and supported at 3 ft. maximum intervals with a system of J-hooks or equivalent means. Open wiring in air plenums shall be rated for such use and so labeled.
- D. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."
1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 2. Install exposed cable in raceway.

3. Cabling concealed above accessible ceilings may be run without conduit. Cabling dropping into walls shall be run in conduit. Wall mounted sensors shall be installed on a single gang box and conduit shall be installed to extend to above an accessible ceiling location.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

END OF SECTION 23 0914

SECTION 23 0923 – DIRECT DIGITAL CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. A complete system of computer based, direct digital automatic temperature controls shall be installed under this contract as required to accomplish the sequence of control for various items of equipment and systems indicated on the drawings and as specified in Division 23.
- B. Direct Digital Controls (DDC) upgrade for the existing building controls is part of the scope of work. Refer drawings for systems sequence of operations. Controllers, system architecture, communication cabling and network, software, graphics, etc. shall be seamlessly integrated as part of the new system.
- C. This Section includes Direct Digital Control (DDC) components, including operator work station, controller/server, equipment specific and generic controllers, I/O interface, software and graphics.
- D. See Sections 23 0913 “Instruments and Control Devices”, Section 23 0914 “Control Wiring and Cabling” and Section 23 0993 “Sequence of Operations for Controls” for requirements that relate to this Section.

1.2 SUBMITTALS

- A. Product Data: For all hardware and software.
- B. Shop Drawings:
 - 1. Schematic air and fluid flow control diagrams.
 - 2. Sequence of operations descriptions and points list.
 - 3. Power, wiring diagrams.
 - 4. DDC System Hardware components, including controllers, actuators, sensors, valves, dampers, cabinet enclosures, wiring, misc. controls devices, etc.
 - 5. Control System Software
 - 6. Graphics – Screen examples specific to the project for:
 - a. DOAS Unit
 - b. VRF System
 - c. Fans
 - d. Hot Water Heater Pump
 - e.
- C. Software and firmware operational documentation.
- D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Each control subcontractor must be an authorized temperature control contractor in the business of installing and servicing direct digital temperature control systems for over five (5) years. The bidder must have installed and successfully completed at least ten (10) DDC systems of similar size using the same hardware that is proposed.
- B. Subcontractor installation and service office must be located within 75 miles (90 minute travel time maximum) of the building site.
- C. Design and installation of the digital control system shall be performed by employees trained and certified by the equipment supplier. Electrical power work other than low voltage shall be performed by licensed electricians.
- D. The temperature controls subcontractor shall provide all necessary engineering support for a complete and functional system, including but not limited to engineering, programming, installation, supervision, commissioning and troubleshooting.
- E. Refer to 23 0801 Mechanical Systems Commissioning.
- F. 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.

PART 2 - PRODUCTS

2.1 CONTROL SYSTEM

- A. Contractors:
 - 1. Honeywell International Inc Authorized Controls Integrator (ACI) (local authorized contractors only, branch office is not acceptable)
 - 2. Schneider Electric (TAC, Invensys) – I/A Series
 - 3. BuildingLogiX
- B. Complete DDC system shall consist of operator workstation, sensors, indicators, actuators, final control elements, interface equipment, wiring, cabling, power supplies and power distribution, other apparatus, accessories, software and graphics connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems as specified here and in related Division 23 Sections.

2.2 LICENSING AGREEMENT AND OPEN PROTOCOL

- A. A true Open Licensing Agreement shall be provided and executed with the Owner to permit total and open access to the system for servicing and software revisions by other qualified servicing contractors.

- B. The supplied system must incorporate open protocol with the ability to access all data using Java base Web enabled browsers without requiring proprietary operator interface and configuration programs.
- C. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a server. Proprietary database and user interface programs are not acceptable (except for unitary controllers as noted below).
- D. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135-1995, BACnet and LonMark to assure interoperability between all present and future system components is required.
- E. Proprietary programming shall not be utilized. In addition, all required programming software and graphics shall be embedded in the server or controllers without the need for external software to execute queries or revisions. All graphics shall reside in the server. Remote access via LAN or Web shall not require external software to provide complete access to all data, graphics, alarms, programming, etc.

2.3 DDC ARCHITECTURE

- A. DDC system shall be complete with an Operators Workstation/Server, Configurable Controllers, Unitary Controllers, required I/O modules for controller expansion, communication cards in controlled devices such as chillers, variable frequency drives (furnished with the equipment, coordinate card requirements), arranged for a completely integrated building automation system network.
- B. Physical connection of BACnet network controllers shall be via Ethernet/Ethernet IP using the Owner's Local Area Network (LAN).
- C. Where data drops are not shown for the Configurable Controllers or Operator Station/Server, the temperature control subcontractor shall be responsible to provide the IP data drop to each network controller location for controller connectivity. Installation shall be subcontracted to the division 27 technology contractor; coordinate connection requirements. In addition, provide an additional IP data drop to each controller, or group of controllers to provide local access to data acquisition for the HVAC service technician.
- D. All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.
- E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

- F. DDC system accessibility over the LAN or the Internet shall be user name and password protected. Provide separate user name/password for multiple level hierarchy to restrict access to appropriate personnel at the different levels (view, programming, etc.). The system must be set up to have at least 3 access levels: guest, user and administrator. Guest privileges shall be limited to view only. Users shall be able to make setpoint and schedule changes. Administrators shall have all privileges as users in addition to being able to assign passwords.

2.4 OPERATOR WORKSTATION/SERVER

- A. An operator workstation/server shall be provided to effectively program, manage and access DDC information from all of the controllers. Interface shall utilize dynamic color graphics of each mechanical system, building floor plan, and control device depicted by point-and-click graphics.
- B. All DDC information shall be accessible through the server over the LAN as well as over the Internet via Ethernet IP.
- C. Operator Workstation/Server Computer: Equal to Dell Studio XPS 630.
- D. Minimum Requirements (or equivalent):
 1. Processor: Intel Core 2 Duo.
 2. Ports/Jacks: (6) USB 2.0, (2) IEEE 1394a, headphone, microphone, 19-1 media reader, (1) RJ-45, 2.1 audio, S video in/out, S/PDIF optical
 3. Random-Access Memory: 2GB Dual Channel DDR2 SDRAM.
 4. Monitor: 20" wide screen, WSXGA resolution, 5ms pixel display rate, 720p high definition display flat panel.
 5. Graphics: Intel GMA 3100
 6. Hard-Disk Drive: 160 GB.
 7. 48X combo optical drive.
 8. Communications: Integrated Gigabit Ethernet (10/100/1000Base-T), internal WiFi 802.11 a/b/g/n Draft 2.0
 9. 10W Stereo Speakers
 10. Operating System: Microsoft Windows
 11. Keyboard.
 12. Mouse: Three button, optical.
 13. Six outlet surge protector.
 14. Printer: Laser jet type, B&W, 8Mb RAM equal to HP LaserJet 1022
 15. Workstation desk and chair will be provided with loose furnishings by others.
- E. The server shall provide integrated control, supervision, data logging, alarming, scheduling and network management functions. The controller/server provides the Internet connectivity and Web serving capabilities, presenting real time information in Web based, rich graphical displays for the system. Application control programs to provide: Calendar functions, Scheduling, Trending, Alarm monitoring and routing, and Time synchronization.
- F. Proprietary programming shall not be utilized. In addition, all required programming software shall be embedded in the server or controllers without the need for external software to execute queries or revisions. All graphics shall reside in the server. Remote access via LAN or Web shall not require external software to provide complete access to all data, graphics, alarms, programming, etc.

- G. The server shall support standard Web browser access via the Intranet/Internet.
- H. Provide and maintain an Audit Log that tracks defined activities on the system. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached a user-defined buffer size. Archive the log locally. For each log entry, provide the following data: Time and date, User ID, Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.
- I. The controller/server shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval. Copies of the current database and the most recently saved database shall be stored in the server. The age of the most recently saved database is dependent on the user-defined database save interval. The controller/server database shall be formatted to allow for user viewing and editing, if desired.

2.5 CONFIGURABLE CONTROLLERS/SERVERS

- A. Individual configurable controllers shall be provided for each central HVAC equipment or system (AH unit, boiler, chiller, etc.). Distributed HVAC equipment, such as air control box terminals, fan coils, unit heaters, etc may utilize local, unit specific controllers.
- B. Controllers shall be capable of functioning in either a standalone capacity or integrated into the building network.
- C. Controllers shall be fully configurable type with both control and server capabilities including integrated control and management of external devices, supervision, data logging, alarming, scheduling, network management functions, Internet connectivity, web serving. The controller shall include software technology capable of integrating a variety of devices, interoperable networks and protocols such as LonWorks, BACnet, ModBus, etc into a seamless operating platform.
- D. The controllers shall be expandable by the use of input/output I/O modules to provide additional points beyond resident points provided on the controller module.
- E. Each configurable controller shall include the following minimum hardware features. Where required for functionality provide additional communication cards, memory cards or I/O modules: Two (2) Ethernet Port -10/100 Mbps, One (1) RS-232 port, One (1) RS-485 ports (BACnet MS/TP), LON Tunnel service, BACnet driver (Ethernet and Ethernet IP), One LONWorks Interface Port with driver – 78KB FTT-10A, Power Supply 24V power supply module, Battery Backup, 64 Mb flash memory for long term data backup and 64 Mb RAM.
- F. I/O modules shall connect to the controller with a single multi pin plug, powered through the controller with a minimum of eight (8) universal inputs, four (4) analog outputs and four (4) relay outputs, Form A contacts. Do not exceed maximum I/O modules recommended by the manufacturer.
- G. The controller/server must be capable of operation over a temperature range of 0 to 50°C and storage temperatures of between 0 and 70°C. The controller/server must be capable of operation over a humidity range of 5 to 95% RH, non-condensing.

- H. The controller/server shall support standard Web browser access via the Intranet/Internet.
- I. Where acting as a server, provide and maintain an Audit Log that tracks all activities performed on the controller/server. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached it's user-defined buffer size. Provide the ability to archive the log locally (to the controller/server), to another controller/server on the network, or to a server. For each log entry, provide the following data: Time and date, User ID, Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.
- J. The controller/server shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval. Copies of the current database and, at the most recently saved database shall be stored in the controller/server. The age of the most recently saved database is dependent on the user-defined database save interval. The controller/server database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.
- K. Controllers shall be fully programmable with “drag and drop” graphic representations of control algorithms and easy to use “wizards” that automate controller configurations.
- L. Controllers shall be “Native” BACnet devices with interoperable native BACnet, IP, LON and MS/TP communication support.
- M. Each controller with I/O modules shall include input/output capabilities with, as a minimum, sufficient universal inputs, digital inputs, universal outputs and digital outputs to perform the required function and include an additional spare two (2) universal inputs, (2) analog outputs and two (2) relay outputs for future upgrade capability (spare points are not required for unitary controllers).

2.6 UNITARY CONTROLLERS

- A. Controller designed specifically for VAV reheat air terminal units, fan coil, unit heater, etc., shall be used for each distributed HVAC equipment item. Local controllers shall be capable of functioning in a standalone capacity but shall be integrated into the building network.
- B. Use of a dedicated network with a proprietary communication protocol that is compatible for integration into the configurable controllers is acceptable provided the unitary controllers use true peer to peer communication for all devices, the communication network uses simple non polarity sensitive twisted pair wiring and the network provides for interoperability between devices and controllers such as Echelon LonWorks is acceptable.
- C. For VAV reheat air terminal units:
 - 1. The controller shall include, where required, a digital communication to:
 - 2. The remote, space temperature and/or humidity wall sensor,
 - a. The remote wall sensor shall include a communication jack for connecting a laptop to the terminal unit controller for air/water balance purposes.
 - 3. Velocity pressure pneumatic input via polyethylene tubing for supply air flow reading,
 - 4. Supply air flow sensor,

5. Flow balancing software (damper adjustment, set point monitoring and adjustment, flow validation and calibration, sequence/calibration/control set point logs)
 - a. Terminal unit supply air temperature sensor
 6. Damper actuator shall be separate from the VAV reheat box controller; integrated controller/actuator devices are not acceptable.
 7. Integral controller/damper actuator is acceptable.
- D. Controllers used for remote temperature and humidity sensing, adjustment and override such as VAV air terminal unit controllers and fan coil units shall include S-link communication via two wire, unshielded cable (non polarity sensitive) to provide power and communication interface for remote sensors.

2.7 CONTROLLER ENCLOSURE AND LISTING

- A. Controllers shall be placed within enclosures that conform to NEMA-1 construction and shall further meet UL 94-5V flammability ratings for plenum application use.
- B. Each controller shall be UL-916 listed and meet FCC Part 15 Class A.

2.8 GUI DISPLAY FRAMES

- A. System Access – The system must be set up to have at least 3 access levels: guest, user and administrator. Guest privileges shall be limited to view only. Users shall be able to make setpoint and schedule changes. Administrators shall have all privileges as users in addition to being able to assign passwords.
- B. Each Air Handling Unit heating water system and cooling system shall have a minimum of 5 graphic screens available from the tree view.
 1. Diagrammatic – One diagrammatic screen shall display the airflow pattern with all dampers, coils and fans shown in their correct schematic location and dynamic data for all input values shown. This main graphic screen shall show the control devices in mechanical flow diagram format with directional arrows to indicate normal flow arrangement. These screens shall be available to anyone with access to the system, and therefore shall be view only.
 2. Text Screen – Text screen shall display text information with the following primary categories:
 - a. Occupied status
 - b. Unit status
 - c. Temperatures,
 - d. Heating, cooling mode
 - e. Economizer,
 - f. Static pressure & setpoints
 - g. Supply, return and exhaust fan status including setpoints.
 3. A loop tuning screen shall also be furnished for each control loop, so that people with the appropriate access can change loop tuning parameters from PCs without needing individual programming tools.
 4. Override screens shall be furnished for each controller to permit overriding control points without the need for vendor specific software.

5. An alarm screen shall also be furnished for each AHU, heating plant or cooling plant. The heating and cooling systems shall have similar screens as the AHUs.
- C. Each VAV air terminal unit shall have a graphics screen and a text screen.
- D. Systems that won't permit creating these customized screens as described herein will not be acceptable. Systems that use controllers that won't permit overrides of inputs and outputs from a browser based graphic screen will not be acceptable.
- E. Animations
1. All shapes shall be 3-D with a common perspective.
 2. All dampers shall have a minimum of 4 animation levels to show partially open, half open, mostly open, fully open, and closed position of dampers.
 3. All analog inputs shall show the actual value and engineering units on the graphic screen.
 4. Binary inputs shall be linked to flashing animated displays.
 5. Safety alarms will flash when in alarm.
 6. Filter status shall be indicated when value indicates that they are dirty.
 7. To prevent clutter on the graphic displays, symbols will only be shown for equipment that is controlled or monitored by the DDC system.
 8. Normal status for safeties will not be indicated, and normal status for safeties will be indicated by an image of a clean filter.
 9. Pumps and fans shall rotate when flow is proven by a monitoring device. Coils shall change color when valves are open to permit water flow through the coils.
- F. Color Schema – Graphics shall use common color schemes to make the overall system easy to understand. All overall backgrounds shall be white or other neutral color. All text shall be black. Any value that is in alarm shall be red or have a red background. Any value that is overridden shall have a blue background. All like sensors shall be the same color. For example, all temperature devices shall be yellow, all pressure devices shall be purple, all humidity devices shall be teal, all fire alarm devices shall be red, and all CO2 devices shall be green.
- G. Current setpoints and occupancy status shall be shown at the bottom of each graphic screen.
- H. Floor Plans – Overall floor plan drawings shall be provided, and permit access to each zone's individual floor plan sections.
1. On the individual floor plan sections, room numbers and room temperature and setpoint shall be displayed. Values that are out of the acceptable range shall appear in a different background color and/or flash.
 2. Each VAV air terminal unit shall have its own graphic screen that contains the points from within its controller including the box flow setpoint, room temperature setpoint, maximum cooling flow setpoint, minimum cooling flow setpoint, and minimum heating flow setpoint, plus the discharge air temperature from the AHU supplying the unit. The VAV text screen shall have the same information as the graphic screen plus high and low flow calibration values, damper rotation adjustment (CW or CCW), and air balance set-up features.
 3. GUI shall permit operator the ability to enable, set or disable high and low occupied and unoccupied limits for each room temperature reading.
- I. Text Screens shall be available for all levels of access. Setpoint and output values are changeable from the text screen for users with appropriate access privileges and administrators, but not guests. When a value can be overridden or edited, a red box shall appear around it when

the cursor is position on it. A single click of the mouse shall bring up pop up menu that provide options to make a permanent override, change setpoint, or release a previous override of an output point. Analog inputs shall have pop up menus that allow setting high and low alarm limits and the ability to enable and disable alarm limits as appropriate for the sensing device. Pop up menus must be customized to include a description of the point that is being modified. Generic override menus are not permitted because they would not describe to an operator what is about to be modified. The Control Contractor shall set up all initial alarms as indicated in the point matrix.

- J. Text screens shall include schedule information including current state and date and time of next scheduled event. Positioning the mouse over the current state shall permit single click access to the schedule. The schedule screen shall allow the operator to edit a yearly, weekly, daily, holiday or special event schedule for the system being viewed. Temperature values and setpoints shall be displayed below the schedule information, and shall have a minimum of 1 decimal place. Heating, cooling and damper outputs shall be displayed next. The OA temperature for economizer switchover shall be displayed and adjustable from the text screen. Air flow readings shall be shown with setpoint and actual readings. Fan information shall be shown next, followed by static pressure readings and setpoints, which shall have a minimum of 2 decimal places. Miscellaneous setpoints including night setback cooling and heating, average zone temperature, return air warm-up and cool-down, dehumidification, and unoccupied mixed air temperature setpoints shall all be shown and adjustable. All safeties shall be shown, followed by coil pump control information.
- K. Each system shall have its own specific alarm screen available to all operators but only editable by operators with user and administration access privileges. From the alarm screen, users and administrators shall be able to enable and disable alarms. Points that are in alarm shall have an alarm symbol highlighted in red. Points that are not in alarm shall be shown in gray. Alarms that are disabled shall have a way to indicate this on the alarm screen graphic.
- L. Loop tuning screens shall be available through the web browser interface to save the owner the cost and time associated with using vendor specific software for tuning loops. Access to these screens shall not be provided to guests. Air handling units shall have dedicated screens for discharge air temperature, static pressure, and outside air control loops. Loop tuning screen for discharge air temperature shall include the discharge air temperature, discharge air temperature setpoint, cooling loop throttling range, I-gain and ramp time, heating loop throttling range, I-gain and ramp time, economizer loop throttling range, I-gain and ramp time, unoccupied heating loop throttling range, I-gain and ramp time, cooling valve output, heating valve output, and damper control output. Screens shall also have graphs that show 5 minutes of live data for the discharge air temperature, setpoint, cooling valve, heating valve and mixed air dampers. Each loop tuning screen shall include the appropriate throttling range, I-gain and ramp time.
- M. Each non-unitary controller shall have an override screen. These screens shall be available on-site for use during point-to-point check-out and commissioning. The override screen shall show the inputs and outputs for each controller with the points in their wired location. Unused points shall be shown as spares. Points that are in alarm shall have a red background, and points that are overridden shall have a blue background just as on other screens. These screens shall show the actual values that come back from the controller, not the values that may have been typed in for override at the GUI if the controller software is not accepting the override value. The override screen shall also permit timed overrides.

- N. Each AHU shall also have a overview screen listing every VAV terminals data in a text format that includes occupancy mode, room temperature, room setpoint, box flow, flow setpoint, temperature leaving VAV terminal, % cooling and % heating. Also, each VAV AHU shall have an air balance screen that will permit balancing the system through a computer connected to the Ethernet or directly to the appropriate BC without vendor specific software. The air balancing screens shall permit at least 8 manual override commands: normal, position (%), flow value, flow percent, open, close, min flow, and max flow.
- O. Heating systems and cooling systems with multiple pieces of equipment such as pumps with lead-lag control shall display which device is lead and when the other device will become lead on the text screen.
- P. Although only one outside air temperature sensor is needed per building, the GUI shall use independent outside air temperature points, so that during check-out and commissioning, the outside air temperature for a system can be changed without changing the outside air temperature for the whole building. The GUI shall also have a global outside air temperature point that can be overridden from the screen for the controller where the point is physically connected. Overriding this outside air temperature value will change it for all systems, except when outside air temperature has been overridden for an individual system.
- Q. The system shall allow for the easy development and editing of dynamic graphics. Wizards shall be utilized to assist the operator with their manipulation of the graphic system. The operator shall be able to, through a single mouse function, select between the dynamic display mode and the graphic edit mode for the currently viewed graphic frame, assuming appropriate access level is provided to the operator. Systems requiring multiple mouse or operator keyboard commands to enter the graphic edit mode are not desirable and require thorough definition of steps involved to accomplish function.
- R. Animation of system data shall be provided via graphic elements on the display frames. Standard graphic element library shall be provided to assist the operator with their implementation. The ability to define and add new animated graphic elements shall be provided. As a minimum, the ability to move, size, draw, arrange, align, layer, space, rotate, invert, duplicate, cut, copy, paste, erase any animated element shall be provided. System parameters and setpoints shall be assignable and modifiable by the animated graphic elements, relieving the need for keyboard commands for system manipulation.
- S. The ability to simultaneously display a dynamic X/Y chart of selected points, shall be provided. The chart shall be an element of the graphic display and shall automatically update with the display data. The chart shall allow for dynamic manipulation to modify the range, rate, and timeframe of view, in both a real-time as well as historical configuration. A minimum of 4 values shall be included on any chart display element. There shall not be a limit to the quantity of chart elements displayed on a graphic frame. Trace colors and X values shall be User configurable. Systems not providing this capability are required to provide an equivalent charting package with the GUI offering.
- T. The ability to provide graphically displayed global scheduling and editing functions shall be provided. The ability to link these functions to the associated equipment or zone frames shall be a standard feature. A calendar shall be provided for display and modification of the SDC time clock functions. The User shall be able to view a daily, weekly, monthly, annual, special or holiday schedule from a defined display frame. A list of served areas shall be displayed on the same screen, this list shall be displayed at all times, pull down menus or other means of

accessing these areas shall not be acceptable. The system shall have a master override screen that will allow an operator to change the schedule for every piece of equipment in every building by changing the master schedule.

- U. All analog values shall be trended every 15 minutes. The trend samples shall be saved in the BC for at least 36 hours. Access to trended data shall be available by the single click of a mouse on the analog value. Systems that open other windows and require a selection of the desired data are not acceptable.

2.9 GUI ALARMING

- A. The GUI shall provide, as standard, alarm annunciation of system data. On every display frame, the ability to view, acknowledge, delete and manipulate real-time and historical alarms shall be provided. The ability to provide a unique and custom alarm display for every display frame shall be provided. The ability to continuously or upon request, view the alarm display, shall be provided.
- B. Alarm conditions shall be capable of invoking, as a minimum; a display frame, an email message, a text message sent to a pager or cellular phone.
- C. Alarm logging shall be provided in a user definable configuration. All alarms shall be displayed and/or routed as follows, as a minimum; GUI display frame, local printer, server printer, client printer, logged to file, and archived in standard format for information management. Alarm groupings shall be hierarchical in nature allowing up to 8 alarm groups and 16 sub-groups. The GUI shall not possess any limits on the quantity of alarms that can be logged, including historical data archiving. Systems possessing limits must define the restrictions and may not be acceptable.
- D. Provide up to 999 alarm priorities with up to 5 alarm color changes, per priority, according to alarm status.

2.10 GUI TRENDING

- A. The GUI shall automatically perform time based, user defined, periodic collection of real time point data. The data shall be presented as an X/Y chart in the display frame. The data shall be stored and archived in a file format that allows for the manipulation and utilization of the data by third party applications.
- B. A dynamic trend shall be defined as a group of at least 4 data points, with a circular buffer of 2000 data points. A historical trend shall be defined as a group of at least 8 data points, with the sampled points limited only by archival disk space. Sampling rates shall be user selectable from instantaneous (one per second) to once a week. Collection of data shall be user selectable to start and stop on a specific time and date. There shall be no limit to the number of X/Y charts within a display frame.

- C. X/Y charting and column and row reporting shall be an integral part of the system. All points shall be chartable or reportable. Analytical data shall be displayed for any of the selected points in a clearly displayed X/Y chart. This analytical data shall consist of at least the following: Average Mean, Standard Deviation, Simple Average, Current Value, Cycle Length, Cycle High and Cycle Low.
- D. X/Y charting shall provide for the following chart manipulation: display, zoom, scroll, centering, pen legend and export to Excel, Text via Dynamic Data Exchange.

PART 3 - EXECUTION

- 3.1 Furnish a complete set of shop drawings showing the kind of control equipment for each of the various systems and their functions, along with indication on the drawing of all original setpoints and calibration values and set up parameters, and sequence of operation and also that of the automation system. These drawings shall be submitted for approval to the Engineer, together with a complete brochure describing the equipment and their function and operation.
- 3.2 The control equipment supplier shall submit a detailed outline of the owner training material for review and comment by the Engineer during the shop drawing phase. The control system training program shall be customized to reflect the systems installed under this contract and shall cover, as a minimum: software navigation (via custom graphics and Windows based icons), system architecture, pass wording and system security features, input/output control functions, alarm functions/acknowledgement, trending/long term reporting, and control component operation.
- 3.3 Upon completion of the project, furnish and turn over to the Owner and Architect (3) complete sets of brochures describing the various items of equipment, their functions and directions for operation and maintenance.
- 3.4 Upon completion of the control system, the Control Contractor shall adjust all components of the system. ATC Contractor shall make all adjustments in the control system required and as directed by the air balance contractor to achieve the desired air balance quantities. All instruments shall be carefully calibrated and each control function shall be demonstrated to function properly, to the satisfaction of the Engineer and the Owner. Provide a complete instruction manual covering the function and operation of all components. At the time of demonstration, each function shall be simulated to insure that controls respond properly to all signals, and the Owner shall be instructed in the proper operation of the system.
- 3.5 In addition to the adjustments and fine tuning, the Contractor shall include as a part of this contract an additional 40 hours of service technician time for work as directed or authorized by the Engineer to make software changes or field adjustments to hardware.
- 3.6 During the first year of operation, after acceptance by the Owner, the Control Contractor shall provide complete service to adjust or assist the Owner in adjusting the equipment to obtain

optimum performance from the control equipment and from the heating and air conditioning systems in general. This shall be done without additional expense to the Owner. This work shall include revisions to DDC software programs and controller programs, and all PC front end software upgrades. All software shall be provided to the Owner in disk form, including back-ups of final field programs.

- 3.7 The control equipment manufacturer shall provide instruction and training of the Owner's personnel regarding the hardware and software of the system. Software training shall include programs, methods of programming, control loops, scheduling and reports. Training covering hardware shall include operation information, functional use, wiring diagrams and schematic diagrams necessary to troubleshoot the operating system. Training shall include "hands on" instructions to completely familiarize Owner's personnel with the equipment and system. Training of Owner's personnel shall be equal in scope and detail to that provided by the manufacturer to its service technicians.

3.8 TRAINING

The control equipment supplier shall provide 40 hours of instruction at the job site to familiarize the Owner's personnel in the application and details of the installed system. Site training classes shall not be scheduled for longer than 4 hours duration except at the discretion of the Owner.

3.9 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 2. Test and adjust controls and safeties.
 3. Test calibration of controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 4. Test each point through its full operating range to verify that safety and operating control set points are as required.
 5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 6. Test each system for compliance with sequence of operation.
 7. Test software and hardware interlocks.
- C. DDC Verification:
1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
 2. Check instruments for proper location and accessibility.

3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 4. Check instrument tubing for proper fittings, slope, material, and support.
 5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
 6. Check temperature instruments and material and length of sensing elements.
 7. Check control valves. Verify that they are in correct direction.
 8. Check dampers. Verify that proper blade alignment, either parallel or opposed, has been provided.
 9. Check DDC system as follows:
 - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
 - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
 - d. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

END OF SECTION 23 0923

SECTION 23 2300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.

1.2 SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop based on manufacturer's test data.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
 - 1. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.3 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."
- D. The equipment manufacturer shall provide piping installation instructions to the Contractor and supervision as needed to insure that the piping system is installed in accordance with the equipment manufacturer's recommendations.

1.4 PRODUCT STORAGE AND HANDLING

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:
1. Suction Lines for Air-Conditioning Applications: 300 psig.
 2. Suction Lines for Heat-Pump Applications: 535 psig.
 3. Hot-Gas and Liquid Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

- A. Copper Tube – Type C1
1. Hard Copper Tube: ASTM B280 Type “ACR” hard, seamless copper thoroughly cleaned and dehydrated for use with the refrigerant used. Tubing which has not been so prepared and sealed or which has been open to the atmosphere for any length of time shall not be used.
 2. Fittings: ASME B16.22 wrought-copper fittings.
 3. Brazing Filler Metals: AWS A5.8/A5.8M silver brazed joints.
- B. Copper Coil – Type C2
1. Soft Copper Coil Piping: ASTM B280-20/B1003-16 Type C12200 coiled, seamless copper thoroughly cleaned and dehydrated for use with the refrigerant used. Tubing which has not been so prepared and sealed or which has been open to the atmosphere for any length of time shall not be used.
 2. Fittings: ASME B16.22 wrought-copper fittings.
 3. Brazing Filler Metals: AWS A5.8/A5.8M silver brazed joints.

2.3 VALVES AND SPECIALTIES

- A. Refrigerant devices specified below shall be specifically designed for the refrigerant application and of construction pressure class consistent with the duty imposed.
- B. Manual Shutoff Valves:
1. Brass construction with sweat ends. Valves shall be ball type or may be packed type with backseating construction or packless type.
- C. Service Valves:
1. Shutoff type with charging and test ports.
- D. Solenoid Valves:
1. Brass body, sweat ends, normally closed with manual lift stem and holding coil in a NEMA 1 enclosure, voltage to match controls.
- E. Thermal Expansion Valves:

1. Thermostatically operated diaphragm type with brass body, external equalizer and external superheat adjustment.
2. Expansion valves shall be manufactured by:
 - a. Alco
 - b. Sporlan

F. Hot Gas By-pass Valves:

1. Pilot operated modulating regulators with integral solenoid pilot assembly and external equalizer tubing and connections.
2. Hot Gas By-pass valves shall be manufactured by:
 - a. Alco FA8
 - b. Sporlan

G. Flexible Pipe Connectors:

1. Corrugated copper bellows type with woven bronze wire protective jacket suitable for 400 psi refrigerant use.

H. Filter Dryers:

1. Sealed type or replaceable core type equal to Sporlan “Catch-All”.

2.4 REFRIGERANTS

A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Arkema Inc.
 - b. DuPont Fluorochemicals Div.
 - c. Genetron Refrigerants; Honeywell International Inc.
 - d. Mexichem Fluor Inc.

PART 3 - EXECUTION

3.1 SCHEDULE

- A. Piping from Outdoor AC/Heat Pump unit to indoor branch selector boxes – Type C1
- B. Piping from Indoor branch selector boxes to terminal units, fan coil units, etc. – Type C2
- C. Piping from Outdoor AC/Heat Pump unit to indoor fan coil unit – Type C2

3.2 INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. All joints shall be brazed using silver solder while flowing an inert gas such as dry nitrogen through the piping.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Piping shall be hung from the building structure with copper or plastic coated clevis hangers and steels rods as described in 230529 Pipe Hangers and Supports. Hangers for insulated pipe shall be oversized and a sheet metal saddle with belled ends incorporated to protect the insulation.
- F. When brazing remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- G. Install pipe sleeves at penetrations in exterior walls and floor assemblies.
- H. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."
- I. Service valves shall be provided on the condensing unit liquid and suction connections/compressor suction and hot gas connections/condenser hot gas and liquid connections if not furnished on the unit.
- J. A solenoid valve, a sight glass-moisture indicator and a thermostatic expansion valve shall be provided for each evaporator coil circuit. A filter dryer shall be provided in each liquid line near the condensing unit or the evaporator coil. A shut off valve shall be provided on both the inlet and outlet of a replaceable core filter-dryer.
- K. Hot gas by-pass valve assembly shall be provided on the first stage of capacity control/for each compressor where lead-lag selection is incorporated and as indicated. Hot gas piping shall be run from the compressor discharge to the refrigerant distributor of the evaporator coil and the equalized line extended to the suction header.
- L. Flexible pipe connectors shall be provided where recommended by the equipment manufacturer.
- M. Solenoid valves shall be mounted within the enclosure of outdoor equipment or otherwise protected from weather.

3.3 CLEANING

- A. Before installation of refrigerant piping, clean pipe and fittings using the following procedures:
 - 1. Shot blast the interior of piping.
 - 2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
 - 3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
 - 4. 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.
 - 5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
 - 6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

3.4 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 - 4. Charge system with a new filter-dryer core in charging line.

3.5 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 - 1. Open shutoff valves in condenser water circuit.
 - 2. Verify that compressor oil level is correct.
 - 3. Open compressor suction and discharge valves.
 - 4. Open refrigerant valves except bypass valves that are used for other purposes.
 - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 2300

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SECTION 23 3113 - DUCTWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Duct materials.
2. Duct liner.
3. Rectangular ductwork.
4. Round ductwork.
5. Flat Oval ductwork.
6. Duct connectors.
7. Sealants and gaskets.
8. Hangers and supports.
9. Seismic-restraint devices.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports / and seismic restraints shall withstand the effects of gravity / and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.
 1. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:

1. Fabrication, assembly, and installation techniques.
 2. Factory- and shop-fabricated ducts and fittings.
 3. Reinforcement and spacing.
 4. Seam and joint construction.
 5. Duct Connectors
 6. Duct Liner
 7. Duct Sealants and Gaskets
 8. Penetrations through fire-rated and other partitions.
 9. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
 10. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
- C. Coordination Drawings: Plans, drawn to scale (1/4" = 1'-0"), on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 2. Suspended ceiling components.
 3. Structural members to which duct will be attached.
 4. Size and location of initial access modules for acoustical tile.
 5. Penetrations of smoke barriers and fire-rated construction.
 6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.
- D. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 DUCT MATERIALS

- A. Refer to schedule on drawings.

2.2 RECTANGULAR DUCTWORK

- A. Construction
 - 1. Single wall factory- or shop-formed continuous helical (spiral) lock seam.
- B. Fittings/Transitions – Shall conform to SMACNA Figure 2-7.
 - 1. Transition angles shall be limited to 30 degrees on converging transitions and 20 degrees on diverging transitions.
 - 2. Elbows shall have an inside radius equal to the duct width. 90 degree elbows shall be square with double wall turning vanes. Elbows less than 90 degrees shall be radiused. Non-radiused elbows less than 90 degrees, with or without turning vanes are not permitted.
 - 3. Branch take-offs, where not detailed otherwise, shall be with a static boot (45 degree clinch collar) per SMACNA Figure 2-6 or conical spin-in fitting. Straight tap take-offs are not permitted.
 - 4. Square throat, radius heel 90-degree elbows are not permitted.

2.3 ROUND DUCTWORK

- A. Medium pressure applications, upstream of VAV boxes (2” S.P. and higher).
 - 1. Construction
 - a. Single wall factory- or shop-formed continuous helical (spiral) lockseam.
 - 1) Manufacturers: McGill AirFlow “Uni-Seal” or “Uni-Rib” or equal by Lindab or SEMCO.
 - 2. Joints/Seams
 - a. Slip connections or gasketed flanges.
 - 3. Fittings/Transitions – Shall be compatible with duct system.
 - a. 90-Degree Branch tees shall be streamlined, spin-in conical type with Y branches.
 - b. 45-Degree lateral tee wherever possible.
 - c. Die-stamped elbows, $r/D = 1.5$ (minimum).
 - d. Radiused, angled (15° max.) or mitered (15° max.) offsets.
 - e. Concentric transitions, $\theta = 45^\circ$ max.
 - f. Eccentric transitions, $\theta = 30^\circ$ max.
- B. Low pressure applications, downstream of VAV boxes (1” S.P. or less).
 - 1. Construction
 - a. Single wall factory- or shop-formed continuous helical (spiral) lockseam.
 - 1) Manufacturer: McGill AirFlow “Uni-Seal” or “Uni-Rib” or equal by Lindab or SEMCO.
 - 2. Joints/Seams
 - a. Slip connections or gasketed flanges.

- b. Longitudinal seams may be utilized for 1” and less (positive and negative) static pressure construction class at final air devices.
- 3. Fittings/Transitions – Shall be compatible with duct system.
 - a. Factory- or shop-formed and welded.
 - b. Elbows shall be long radius type.
 - c. Standard tees allowed.
 - d. Segmented elbows allowed.
 - e. Elbows for longitudinal seam round ductwork shall be factory- or shop-formed segmented standing seam or pleated. Other fittings shall be comparable to the elbows.
 - f. Manufacturers: McGill AirFlow “Uni-Seal” or “Uni-Gasket” with beaded sleeve transverse joint connectors.

2.4 FLAT OVAL DUCTWORK

- A. Double Wall Flat Oval – Shall be acoustically lined double wall spiral lock seam with perforated liner and 1” fiberglass insulation.
 - 1. Manufacturer: Lindab “SPIROoval” Double wall, McGill AirFlow “ACOUSTI-k27” or equal by SEMCO.
- B. Fittings:
 - 1. Branch fittings from oval main duct shall be lateral round taps located on the minor axis and shall be at no less than a 45° angle.
 - 2. Double wall to single wall transitions shall be provided where flat oval and single wall round ducts connect.
 - 3. Fittings shall utilize a solid inner liner.
- C. Connections shall be flanged, gasketed and “slip & drive” style connection utilizing a ¼” thick neoprene gasket between the two flanges.

2.5 DUCT CONNECTORS

- A. Rectangular Duct Connectors
 - 1. Shall be equal to Ductmate Industries “25 and “35” may be used on rectangular ductwork except where welding or brazing is specifically required. Adhere strictly to manufacturers instructions.
- B. Round duct branch connection to rectangular sheet metal duct
 - 1. Shall be equal to Flexmaster Series FL, straight side with or without manual damper, as described on the drawings. Connectors installed on interior lined rectangular duct shall have an integral insulation guard sleeve.
- C. Rectangular tap-to-round branch connection with static boot configuration
 - 1. Shall be equal to Flexmaster USA Type STO. Buckley “Air-Tite” Bellmouth BM and BM-D fittings with neoprene gasket and adhesive facing may be used for duct taps to rectangular sheet metal duct which is not internally lined.

2.6 SEALANT AND GASKETS

- A. Duct sealant materials shall be:
 - 1. Water based synthetic latex emulsion duct sealant equal to Ducmate PROSeal.
 - a. No V.O.C's
 - b. UL 181B-M Listed, UL 723 classified
 - c. For applications up to 15" w.g.
 - d. Gray Color
- B. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.7 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.8 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2. Ductmate Industries, Inc.
 - 3. Hilti Corp.
 - 4. Kinetics Noise Control.

5. Loos & Co.; Cableware Division.
 6. Mason Industries.
 7. TOLCO; a brand of NIBCO INC.
 8. Unistrut Corporation; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of the ICC Evaluation Service.
1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- D. Restraint Cables: ASTM A 603, galvanized or ASTM A 492, stainless-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.
- F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
 2. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- B. Ductwork Coordination
1. Coordinate duct layout carefully with other trades to avoid conflict with structural elements, lighting and plumbing- heating piping. Flattening of ductwork and offsets to fit ductwork in available space is generally shown. In the absence of such, the Contractor shall arrange the ductwork to maintain concealment and allow ceilings and lights to be installed as intended. Do not hang ductwork until possible interferences with electrical

and mechanical trades have been resolved. Having ductwork fabricated and delivered in advance shall not be justification for interference with other trades.

2. Provide a complete set of ¼" = 1'-0" sheet metal fabrication drawings. The drawings shall be used for overall coordination with the other trades. Meet with the other trades prior to developing and finalizing these drawings.

C. Joints & Seals

1. Transverse joints and longitudinal seams shall be assembled with sealant to conform to SMACNA Class B seal. Selection of sealant materials shall be compatible with the application. Sealants shall be applied in accordance with manufacturer's recommendations.
2. Exterior ductwork shall be sealed with mineral impregnated fiber tape. Ductwork shall be supported as noted or detailed on the drawings.

D. Hangers, Straps & Supports – Attachment of hangers, straps, and supports to the structure shall be as follows:

1. Concrete Construction
 - a. Pre-set concrete inserts in concrete construction of 4" minimum depth.
 - b. After-set concrete inserts, in 4" minimum depth concrete, set in drilled holes. Powder actuated driven fasteners are not permitted.
2. Steel Construction – Utilize beam clamps in steel construction. Provide anchoring where clamps are attached to sloping surfaces of beam flanges and where otherwise required to insure permanent attachment.
3. Wood Construction – Side beam bracket in wood construction, secured to the wood joist with lag screws set in drilled pilot holes.
4. Unistrut type channel support systems may be utilized. Channel shall be attached to the structure with inserts or clamps.
5. Attachment to steel deck is prohibited. Span from steel structural members with supplementary steel shapes where direct attachment to structural members is not practical. This does not apply to steel deck with concrete slab poured on the deck. Refer to A. and B. above.
6. Attachment to manufactured trusses and other engineered structural members and supports shall be done in strict accordance with the structural manufacturers recommendations. Refer to the architectural and structural drawings for type of engineered structural systems being used. Connections to these structural members shall be made with connection devices and methods approved by the structural manufacturer. Provide additional supports with supplemental steel shapes when spacing between structural members exceeds specified distances.

E. Duct Routing and Penetrations

1. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures. Ductwork shall not be run above electrical switchgear or panelboards,

nor above the access space in the immediate vicinity of the equipment in accordance with NEC.

2. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
3. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
4. Coordinate openings required for the passage of ductwork thru walls, partitions, floors and roofs with the General Contractor.
5. Sheet metal sleeves in conjunction with fire dampers shall be placed in walls and floors to pass ductwork. Floor sleeves shall project 4" above the finished floor in equipment rooms and areas of similar usage, and shall form a waterproof seal. Exceptions shall be at locations where the opening is protected from drainage falling thru by means of concrete curbs or shaft walls. This Contractor shall be responsible for providing 4" high x 4" wide concrete curbs with beveled edges to protect floor openings related to his work in equipment rooms or providing an equal effective waterproofing metal curb, if not specifically included in the General Contract.

F. Duct Protection & Cleaning

Protect duct interiors from moisture, construction debris and dust, and other foreign materials by covering each open end of the duct with visqueen secured with duct tape before the end of each day's work. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."- Duct Cleanliness Level –Intermediate. If deficiencies in storing practices are found by the Engineer, the Contractor will be required to thoroughly clean all interior surfaces with alcohol prior to installation.

- G. Wet exhaust ductwork shall be pitched back to the dishwasher hood / back to the grilles to drain. Provide trapped 1" drain piping from low points and extend to a floor drain or other drain point. Longitudinal seams shall not be located along the bottom of a horizontal duct.
- H. Where interior duct surfaces are visible thru grilles, registers and diffusers, the inside of the duct shall be coated with flat black paint before the device is installed, to eliminate obtrusive appearances.

END OF SECTION 23 3113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Air Control Dampers & Accessories
 - a. Manual balancing dampers.
 - b. Backdraft dampers.
2. Life Safety Dampers & Accessories
 - a. Fire dampers.
3. Pressure Differential gauges.
4. Turning vanes.
5. Duct-mounted access doors.
6. Flexible connectors.
7. Flexible ducts.
8. Air blenders.
9. Sound attenuators:
 - a. Duct Silencer
 - b. Return Air Canopy

B. Related Sections:

1. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.
2. Division 23 Section "Ductwork" for ductwork materials, requirements, and schedules.
3. Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing requirements for metal ducts.

1.2 SUBMITTALS

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

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances, and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.
 - d. Wiring Diagrams: For power, signal, and control wiring.

- C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 AIR CONTROL DAMPERS & ACCESSORIES

A. MANUAL BALANCING DAMPERS & ACCESSORIES

1. Steel Rectangular Dampers

a. Construction

- 1) General – Single cross-blade up to 12 blade widths and in larger sizes, multiple blade type 6" maximum width with opposed blade arrangement.
- 2) Frame – 16 ga., galvanized steel hat channel with reinforced corners
- 3) Blades – 14 ga., galvanized steel, one piece airfoil shape, parallel blade. Synthetic blade edge seals.
- 4) Jamb Seals – 300 Series stainless steel cambered compression type.
- 5) Linkage – Out of airstream steel assembly
- 6) Leakage Class – Class 1A

b. Manufacturers

- 1) Ruskin CD60 or approved equal by
- 2) Greenheck
- 3) Nailor
- 4) Pottorff

2. Aluminum Rectangular Dampers

a. Construction

- 1) General – Single cross-blade up to 12 blade widths and in larger sizes, multiple blade type 6" maximum width with opposed blade arrangement.
- 2) Frame – 16 ga., extruded aluminum hat channel with reinforced corners
- 3) Blades – heavy gage extruded aluminum, one piece airfoil shape, parallel blade. Synthetic blade edge seals.
- 4) Jamb Seals – Flexible metal compressible type.
- 5) Linkage – Out of airstream steel assembly.
- 6) Leakage Class – Class 1A.

b. Manufacturers

- 1) Ruskin CD50 or approved equal by
- 2) Greenheck

- 3) Nailor
- 4) Pottorff

3. Steel Round Dampers

a. Construction

- 1) General – Single blade design.
- 2) Frame – 20-ga. galvanized steel.
- 3) Blades – 20-ga. galvanized steel.
- 4) Control Shaft – Square axle shaft.
- 5) Max Velocity – 1500 fpm.

b. Manufacturers

- 1) Ruskin #MDRS25 or approved equal by
- 2) Greenheck
- 3) Nailor
- 4) Pottorff

4. Damper Adjustment Handle

a. Construction

- 1) General – Locking quadrant positioner with handle
- 2) Handle – Heavy gage steel handle to accept square rod.

b. Schedule

- 1) Uninsulated ductwork – Ventfabrics "Ventlock" #641
- 2) Externally insulated ductwork – Ventfabrics #644

c. Manufacturers

- a) Ventfabrics
- b) Duro Dyne
- c) DynAir

B. BACKDRAFT DAMPERS

1. Construction

- a. General – Adjustable, counterbalanced type.
- b. Frame – Extruded aluminum, 12-ga., galvanized steel brace at corners.
- c. Blades – Extruded aluminum with extruded vinyl blade edge seals mechanically locked into blade edge.
- d. Bearings – Corrosion resistant, synthetic type.
- e. Counterbalance – Zinc plated bar on blades.

2. Manufacturers

- a. Ruskin #CBD6 or approved equal by:
- b. Greenheck
- c. Nailor
- d. Pottorff

2.2 LIFE SAFETY DAMPERS & ACCESSORIES

A. FIRE DAMPERS

1. Compliance – Dampers shall be constructed and tested to conform with UL 555 and shall be UL listed. AMCA Leakage Classes.
2. Construction
 - a. General – Dynamic rated, folded blade curtain type with blades folded in the head of the damper housing. Equipped with a 165°F fusible link (unless otherwise noted).
 - b. Horizontal Air Streams – Gravity-drop type.
 - c. Vertical Air Streams – Spring-loaded type.
3. Damper Schedule – The following is a description of the fire damper types as indicated on the plans:
 - a. TYPE “A”
 - 1) Low velocity (below 2000 fpm) with blades stored in the air stream.
 - b. TYPE “B”
 - 1) Low velocity with blades stored out of the air stream.
 - c. TYPE “C”
 - 1) High velocity with blades stored out of the air stream and rectangular, round, or oval duct collar each side.
 - d. TYPE “D”
 - 1) Horizontal ceiling radiation classified damper, folded type equal to Ruskin CFD and CFDR, with coated fire-retardant fabric over blades, and spring-closing mechanism. Dampers are to be mounted in conjunction with diffusers, grilles, and registers in fire rated ceiling assemblies to maintain fire integrity of the UL listing of the floor-ceiling or roof-ceiling assembly. Installation shall conform to manufacturer’s instructions for mounting, connection and support or dampers and insulating board protection over diffusers and duct above.
 - e. TYPES “AA”, “BB” and “CC” – (3-hour)
 - 1) Duct fire doors similar to Ruskin IBD 23, identical in configuration to Types “A”, “B” and “C” fire dampers respectively. Fire doors shall be designed specifically for application in ducts or in fire wall openings, shall bear a UL fire door label for a 3-hour rating (Class A opening) and conform to NFPA 90A, Paragraph 3-3.1.
4. Controls – Fire dampers located at double wall locations shall be provided with a closed position proving micro-switch. Switch shall change state if the fusible link releases and closes the fire damper. The switch shall be equal to Honeywell BX-2RW863-A2.
5. Manufacturers
 - a. Ruskin
 - b. Greenheck
 - c. Pottorff
 - d. Nailor
 - e. Duro Dyne

2.3 PRESSURE DIFFERENTIAL GAUGES

- A. Pressure differential gauges for air filter application shall be dial type gauges. Range shall be appropriate for the application. Gradations shall read in inches w.c.
- B. Each gauge shall be furnished with vent valves, aluminum or plastic tubing, static pressure tips and mounting bracket or flange.
- C. Manufacturer
 - 1. Dwyer "Magnehelic" Series 2000 or approved equal.

2.4 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. METALAIRE, Inc.
 - 4. SEMCO Incorporated.
 - 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- E. Vane Construction: Single wall for ducts up to 36 inches wide and double wall for 36" wide and larger dimensions.

2.5 DUCT-MOUNTED ACCESS DOORS

- A. Duct Access Doors – Doors shall be factory fabricated with following characteristics:
 - 1. Construction Material – Constructed of the same material as the ductwork system served (except galvanized sheet metal for fiberglass duct).
 - 2. Door Thickness – Doors located in:
 - a. Insulated ductwork (internal and/or external) shall have double-wall insulated doors, thickness as required per the insulation schedule.
 - b. Uninsulated ductwork shall have single-wall construction.
 - 3. Hinge – Continuous Piano Hinge. 1.5" wide steel construction, zinc plate.
 - a. Ventfabrics #Ventlok 157 or equal.

4. Latches – Provide the following type of latch for each application:
 - a. Low pressure ductwork (1” w.c. or less) – Cam lock type latches.
 - b. High Pressure ductwork (greater than 1” w.c.) – Heavy duty handle type latches.
 5. Frame & Seal – Frame and neoprene gasket between door and frame.
 6. Size – Access doors shall be 18” x 16” minimum except smaller where duct size will not permit such size.
 7. Pressure Application – Access doors and panels shall be designed to provide tight seal commensurate with the duct system operating pressure. Apply duct sealer or rubber gasket between frame and duct and on ducts of 3” S.P. and higher construction class, mechanical fastening of the frame and rubber gasket shall be provided.
 8. Removable Sash Access Door – Where sufficient clearance is not available to allow the door to swing open 90 degrees or for round ductwork, a removable access panel with neoprene gasket, frame and cam lock latches on all four sides shall be provided in lieu of the hinged door.
- B. Large Plenum Access Doors – doors shall be factory fabricated and as described for duct access doors except that doors shall be 18” x 48” (unless otherwise noted) with overlapping frame,
1. Construction Material – Constructed of the same material as the ductwork system served (except galvanized sheet metal for fiberglass duct).
 2. Door Thickness – Doors located in:
 - a. Insulated ductwork (internal and/or external) shall have double-wall insulated doors, thickness as required per the insulation schedule.
 - b. Uninsulated ductwork shall have single-wall construction.
 3. Hinge – Continuous piano hinge. 2” wide steel construction, zinc plated. Ventfabrics #Ventlok 167 or equal.
 4. Latches – Heavy duty type. Lever both outside and inside. Ventfabrics #Ventlok No. 310 or equal.
 5. Latch Quantity – Two latches shall be provided, except on doors 50” and higher three shall be provided.
 6. Frame & Seal - Shall be mechanically fastened to the plenum wall.
 7. Pressure Application – Access doors and panels shall be designed to provide tight seal commensurate with the duct system operating pressure. Apply duct sealer or rubber gasket between frame and duct and on ducts of 3” S.P. and higher construction class, mechanical fastening of the frame and rubber gasket shall be provided.

2.6 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. Ventfabrics, Inc.
 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.

- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 30 oz./sq. yd.
 - 2. Net Fabric Width: 4” wide.
 - 3. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 4. Service Temperature: Minus 40 to plus 200°F.

- E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 oz./sq. yd.
 - 2. Net Fabric Width: 4” wide.
 - 3. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 - 4. Service Temperature: Minus 50 to plus 250°F.

2.7 FLEXIBLE DUCTS

- A. Flexible insulated duct shall be constructed of galvanized steel spiral wire mechanically locked to an airtight aluminum or polyester inner core, 1" thick 3/4 lb. density fibrous glass insulation and a polyethylene or reinforced metalized vapor barrier outer jacket equal to Flexmaster Type 5 or 5M. Duct shall be rated at a minimum of 6” positive and 4" negative static pressure and shall be listed as Class 1 Air Duct or Air Duct Connector with 25-50 flame-smoke ratings per UL 181 and comply with NFPA 90A.

- B. Non-insulated flexible duct equal to Flexmaster NI-85 may be used on duct systems not specified to be insulated, with similar restriction stated above.

- C. Flexible duct shall be used at final connections to air control terminal units and ceiling air diffusers except as limited in Part 3.

2.8 SOUND ATTENUATORS

- A. Duct Mounted Silencer
 - 1. Sound attenuators shall be constructed of sheet metal with inner perforated metal lining and baffles backed with sound absorbing fiberglass, designed for maximum attenuation with minimum air resistance.
 - 2. Dynamic insertion loss in Decibels for a 5 ft. rectangular unit shall be:

<u>Octave Band</u>	<u>dB</u>
1	6
2	10
3	18
4	30
5	42
6	33
7	22
8	11

- 3. Units shall be:

- a. Industrial Acoustics “Quiet Duct” Type MS or equal by
 - b. Semco
 - c. Vibro-Coustics.
- B. Return Air Canopy
1. Performance – ASHRAE, SMACNA pressure and velocity classifications and ASTM E477, ASTM E84 25/50 Flame/Smoke Spread
 2. Construction – 20-gauge solid steel casing, absorptive acoustic fiberglass acoustic media. Fiberglass to be shot-free inorganic glass fiber with long, resilient fibers, bonded with thermosetting resin.
 3. Manufacturer:
 - a. Price Industries
 - b. Titus
 - c. Tuttle & Bailey

PART 3 - EXECUTION

3.1 INSTALLATION

A. GENERAL

1. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
2. Materials – Install duct accessories of materials suited to duct materials use:
 - a. Galvanized-steel accessories in galvanized-steel and fibrous-glass ducts,
 - b. Stainless-steel accessories in stainless-steel ducts,
 - c. Aluminum accessories in aluminum ducts,
 - d. Or as noted above.

B. BACKDRAFT DAMPERS

1. Install at discharge of exhaust fans at least one half the fan diameter away from fan.

C. FIRE DAMPERS

1. Fire dampers shall be installed in conformance with the manufacturer’s instructions and SMACNA recommendations.
2. Dampers shall be installed in sheet metal wall or floor sleeves along with retaining angles and duct access doors or panels. Sleeve and duct connections shall be breakaway type or rigid type with corresponding gauge requirements in accordance with SMACNA recommendations.

D. VOLUME DAMPERS

1. Locations:

- a. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts.
- b. Install volume damper upstream/downstream of each supply, return or exhaust air device, register or grille.
- c. Volume dampers shall be in accessible locations for testing, balancing, and adjusting purposes. Coordinate with reflected ceiling plans.
2. Lined Ductwork – Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
3. Install steel volume dampers in steel ducts.
4. Install aluminum volume dampers in aluminum ducts.
5. Set dampers to fully open position before testing, adjusting, and balancing.

E. PRESSURE DIFFERENTIAL GAUGES

1. Install air filter pressure differential gauges in a readable location on or near the air handling unit, filter housing or as otherwise indicated on the drawings.

F. ACCESS DOORS

1. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - a. On both sides of duct coils.
 - b. Upstream / and downstream from duct filters.
 - c. At outdoor-air intakes and mixed-air plenums.
 - d. At drain pans and seals.
 - e. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - f. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors; and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - g. Control devices requiring inspection.
 - h. Elsewhere as indicated.
2. Install access doors with swing against duct static pressure to ensure closure.
3. Label access doors according to Division 23 Section "Identification for HVAC System" to indicate the purpose of access door.

G. FLEXIBLE CONNECTORS

1. Location: Install flexible connectors to connect ducts to equipment.
2. For fans developing static pressures of 5-inch w.g. and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

H. FLEXIBLE DUCTS

1. Connect flexible ducts to metal ducts with Panduit straps or stainless-steel clamps. End of the insulation and jacket shall be sealed to the metal duct with double wrapped duct tape. Maximum length of flexible duct shall be:
 - a. Terminal units to supply ducts – 3 ft.
 - b. Air devices to ducts – 7 ft.
2. Flexible duct installation locations:
 - a. Shall be installed:
 - 1) At final air devices above accessible ceilings.
 - b. Shall *not* be installed:
 - 1) Where ductwork is exposed.
 - 2) Above inaccessible ceilings – coordinate with reflected ceiling plan.
 - 3) Through any wall, ceiling, floor, or fire rated assembly.
 - 4) In the immediate vicinity of, and connecting to, air devices in fire rated ceilings where the assembly details require steel ductwork.

I. SOUND ATTENUATORS

1. Return Air Canopy – Install above return air device per manufacturer’s recommendations in lieu of shop-fabricated plenum per detail.

END OF SECTION 23 3300

SECTION 23 3400 - FANS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Inline Square Centrifugal Fan.
 - 2. Ceiling Mounted Centrifugal Fan.
 - 3. Ceiling Circulation Fan
- B. Related Sections
 - 1. 23 0513 Electrical Requirements for HVAC Equipment
 - 2. 23 0531 Equipment Drives
 - 3. 23 0548 Vibration Control

1.2 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Fans shall be constructed, rated and labeled in accordance with AMCA Standard 210-67. Fans shall be statically and dynamically balanced throughout the operating range.
- B. Where the Class (I, II, III, etc.) of fan is stated, the class shall be adequate for the duty specified plus a 25 percent increase in static pressure. No infringement will be allowed on this requirement.
- 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. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- E. UL Standard: Power ventilators shall comply with UL 705.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Fans shall be provided as specified below and shown on the drawings, complete with motors, drives and associated devices.
- B. All fans of any one listed type shall be of the same manufacturer.
- C. Fan motors shall be direct drive, ECM type. Refer to Section 23 0513 Electrical Requirements for HVAC Equipment.
- D. Motor HP shall be sufficient to handle the full load of the fan, including drive losses, at the selected condition without exceeding the motor rating. In no case shall the motor size be less than shown without prior approval from the Engineer. All motors 1 HP and larger shall be “premium efficiency” series. Motors which are fed from variable frequency drive controllers for variable speed operation shall be designed and constructed for VFD drive duty and shall be compatible with the controller specified in Section 23 0531 Equipment Drives. Refer to Section 23 0513 Electrical Requirements for HVAC Equipment.
- E. Motorized backdraft dampers, where specified, shall be furnished with a 120V actuator. Refer to HOA controller details on HVAC drawings for additional information.
- F. All fans shall be provided with a Hand/Off/Auto controller from the unit manufacturer.

2.2 MOTORS

- A. Refer to Section 23 0513 - Electrical Requirements for HVAC Equipment

2.3 INLINE SQUARE CENTRIFUGAL FAN

- A. Construction – Backward inclined fan wheel, direct drive ECM motor, as indicated, motor disconnecting means and inlet cone. Housing shall be constructed of square galvanized sheet metal with 1” acoustical lining.
- B. Mounting – Mounting brackets with neoprene vibration isolators for suspension mounting.
- C. Direct drive units shall have motor out of the air stream and be furnished with a solid state speed controller with off position, and cover plate. The speed controller shall be turned over to the Electrical Contractor for installation.
- D. Finish– The exterior of the fan shall be galvanized/factory primed and painted with a semi-gloss enamel, color selected by the Architect.
- E. Refer to the drawings for capacities, arrangement, class and other features and accessories. Fans shall be manufactured by:
 - 1. Cook
 - 2. Greenheck

3. Twin City Fan

2.4 CEILING MOUNTED CENTRIFUGAL FAN

- A. Ceiling fan shall consist of a centrifugal fan or fans with forwardly curved blades, direct connected motor with internal overload protection, motor disconnecting plug, sheet metal housing with ½” acoustical liner, discharge duct collar with gravity damper and finished metal or plastic ceiling grille.
- B. Fan shall be furnished with a solid state speed controller with off-position and cover plate. The speed controller shall be turned over to the Electrical Contractor for installation.
- C. Refer to the drawings for capacities, arrangement, class and other features and accessories. Fans shall be manufactured by:
 - 1. Greenheck
 - 2. Cook
 - 3. Twin City Fan

2.5 CEILING CIRCULATION FAN

- A. Fan shall be ETL certified and built pursuant to construction guidelines set forth by UL standard 507 and CSA standard 22.2. The fan components shall be designed specifically for high volume, low speed fans to ensure lower noise operation. Sound levels from the fan operating at maximum speed shall not exceed 55 dBA, as measured on the floor below the fan and 20 feet horizontally from the center of the fan.
- B. Airfoils:
 - 1. Fan shall be equipped with ten (10) high volume, low speed airfoils, fabricated of extruded aluminum alloy. Airfoils shall be connected by means of two (2) locking bolts per airfoil. The airfoils shall be connected to the hub and interlocked with zinc plated steel retainers.
- C. Winglets:
 - 1. Each airfoil shall be equipped with winglets designed to redirect outward airflow into downward airflow. The winglets shall be molded of high density polypropylene. Winglets shall be attached to the tip of each airfoil by means of a barrel screw.
- D. Motor:
 - 1. The fan motor shall be an AC induction type inverter rated at 1725 RPM. Motor shall be totally enclosed, fan cooled (TEFC) with an IP55 NEMA classification. Motor shall be manufactured with a double baked Class F insulation and be capable of continuous operation in -30 deg F. to 122 deg. F ambient conditions.
- E. Gearbox:
 - 1. The gear box shall include a high efficiency, hermetically sealed, nitrogen filled, offset helical gear reducer with two stage gearing, hollow output shaft, cast iron housing, double lip seals, high quality bearings with crowned cages for optimal lubrication flow,

and precision machined gearing to maintain backlash less than 11 arc-minutes over the life of the unit.

2. Gearbox shall be equipped with a passageway in which wiring, piping, etc can be routed below the fan. A non-rotating, standard junction box with aluminum cover shall be provided at the base of the fan for installing future optional features.

F. Mounting Post:

1. Fan shall be equipped with a mounting post that provides a structural connection between the fan assembly and upper mounting system. Mounting post shall be a minimum 3"x3" square tubing and powder coated for corrosion resistance.

G. Hub:

1. The fan hub shall be precision cast aluminum alloy for high strength and light weight. The hub shall be secured to the output shaft of the gearbox by means of a steel flange interface. Both hub and flange shall be machined to achieve a well balanced and solid rotating assembly. The hub shall incorporate a minimum of five (5) safety retaining clips made of 1/4" thick steel that shall restrain the hub/airfoil assembly in case of gearbox output shaft failure.

H. Mounting System:

1. The fan mounting system shall be designed for secure installation from a structural support beam(s). All components in the mounting system shall be of welded construction using low carbon steel no less than 3/16" thick and be powder coated for appearance and resistance to corrosion. All mounting bolts shall be SAE Grade 8 or equivalent.

I. Safety Cable:

1. The fan shall be equipped with a safety cable that provides an additional means of securing the fan assembly to the building structure. The safety cable shall be 3/8" diameter and fabricated of 7 x 19 stranded galvanized steel. The loops shall be secured with swaged fittings, pre-loaded and tested to 3,000 lb-f.
2. Field construction of safety cables is not permitted.

J. Controller:

1. The fan controller shall be constructed using a Variable Speed Drive that is pre-wired to the motor and factory programmed to minimize the starting and braking torques, for smooth and efficient operation. The controller shall be pre-wired to the motor using a short run of flexible conduit THHM with a dedicated ground conductor to minimize electromagnetic interference and radio frequency interference. An incoming power cord shall also be pre-wired to the controller for ease of installation.
2. The controller shall be contained within a completely sealed aluminum enclosure with an IP45 NEMA classification. The controller shall be secured to the mounting post 'onboard' the fan assembly.

K. Wall Control:

1. The fan shall be equipped with a remote wall control. The wall control shall be a digital keypad device mounted inside an aluminum bezel. The bezel shall be capable of mounting to a standard wall box. The wall control shall be equipped with a touchpad control and an LED display for controlling the fan's direction, operation, and speed.
2. Communication with the fan drive controller shall be by a standard CAT-6 Ethernet cable that is field provided by the E.C.

3. Wall control shall be equipped with a simple diagnostic program to identify faults in the system. Wall remote device shall be capable of retrieving fan operation and diagnostic data (fault messages).
- L. Special Equipment Warranty:
 1. In addition to the 1 year parts and labor warranty described in the front end construction documents, the following special warranties shall be provided by the manufacturer.
 - a. Airfoils – Lifetime Parts warranty
 - b. Hub – Lifetime Parts warranty
 - c. Motor – 10 year Parts warranty
 - d. Gearbox – 10 year Parts warranty
 - e. Controller – 10 year Parts warranty
- M. Fans shall be manufactured by:
 1. Big-Ass Fans
 2. Greenheck
 3. Cook

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fans and roof curbs level and plumb, in accordance with manufacturer's written instructions.
- B. Support units as described below using the vibration control devices specified herein and in Section 23 0548 Vibration Control.
 1. Suspended unit: Suspend unit from structural steel support frame using threaded steel rods and vibration isolation springs.
- C. Arrange installation of fans to provide access space around fans for service and maintenance.
- D. Adjust damper linkages for proper damper operation. Motorized backdraft dampers are to be wired by the Electrical Contractor to open when the fan operates.
- E. Perform the following operations and checks before start-up.
 1. Remove shipping blocking and bracing.
 2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork and electrical are complete. Verify proper thermal overload protection is installed in motors starters and disconnects.
 3. Verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Align belts and reinstall belt guards.

4. Lubricate bearings, pulleys, belts and other moving parts with factory-recommended lubricants.
5. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full open position.

END OF SECTION 23 3400

SECTION 23 3713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grilles
2. Registers
3. Diffusers
4. Louvers
5. Special Air Diffusion Devices

B. Related Sections:

1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, grilles, and return air canopies.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 GRILLES, REGISTERS AND DIFFUSERS

- A. Air outlet and inlet devices shall be equal to those specified by catalog number and description in the schedule on the drawings. Damper operators shall be concealed screw type. An auxiliary mounting frame shall be furnished with each grille and register except those mounted on exposed ducts or in lay-in application.
- B. Linear "T" bar air supply diffusers shall be slotted diffusers with fixed air pattern control complete with a galvanized sheet metal supply plenum having a round or oval duct connection and 1/2" neoprene coated fiberglass insulation on the interior. The unit shall be designed to mount on or alongside the ceiling "T" bar and shall include flanges on both sides of the diffuser to support the ceiling tiles. Additional "T" bars matching those of the ceiling system shall be provided by the HVAC Contractor if the diffuser does not have these flanges. Units shall have a center notch where required to accommodate intervening "T" bars.

C. Manufacturers:

1. Price
2. Titus
3. Tuttle & Bailey

2.2 LOUVERS

A. Louvers shall be exterior weatherproof type equal to those scheduled and shown on the drawings. Louvers shall be assembled entirely by welding. Louvers shall withstand uniform wind loading pressure of 20 psf. Performance data indicating pressure loss and water penetration, derived from AMCA 500 testing, shall be included with submittals.

1. Aluminum louvers shall be 12 ga. Extruded aluminum with R1 caustic etch and finished with Kynar 500 (or equivalent) fluoropolymer finish. Color is to be selected by the Architect from the manufacturer's standard colors.
2. Steel louvers shall be formed of 16 gauge sheet steel phosphatized with G90 zinc coating. Louvers shall be factory prime coated and finished with baked enamel of color selected by the Architect from the manufacturer's standard colors.
3. Bird screen shall be ½" mesh aluminum wire on the interior face of the louver attached at 12" centers on the perimeter.

B. Manufacturers:

1. Ruskin
2. Pottorff
3. Greenheck
4. Airolite

2.3 SPECIAL AIR DIFFUSION DEVICES

A. Self contained variable volume ceiling diffusers shall be 24" x 24" nominal "T" bar ceiling lay-in type. Diffusers shall have four integral volume control dampers to regulate air volume on varying demand for both cooling and heating. Two integral thermal elements with room air aspiration and adjustable setpoint, one for cooling and one for heating, shall be arranged thru linkage to power the volume dampers. Changeover thermal element shall be incorporated in the diffuser to index cooling and heating in accordance with supply air temperature. Diffusers shall be Acutherm "Therma-Fuser" TF-HC Series.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractor shall be responsible for comparability of ceiling mounted devices with the ceilings and suspension systems (lay-in, concealed spline, plaster, drywall, etc.). Verify with architectural drawings.
- B. Carefully align square and rectangular devices with the vertical and horizontal building lines. Diffusers shall be attached rigidly to the ductwork. Where connected by flexible ducts, special supports shall be provided as required, either from the ceiling suspension system or by independent suspension wires or rods from the building structure.
- C. Inside of ducts behind grilles, registers, and diffusers shall be painted flat black, as needed, to eliminate the sight of shiny surfaces.
- D. Each ducted air device shall be provided with a balancing damper, located either at the run out duct to the final air device for accessible locations or an integral damper at the air device for inaccessible locations. Transfer air devices are not required to have balance dampers, unless noted. Duct mounted air devices shall be provided with standoff frame and integral balance damper or scoop style damper, as noted. Refer to drawings for other specific instances.
- E. Exterior louvers shall be installed by the General / HVAC Contractor. Install louver assemblies in strict accordance with manufacturer's recommendations. Louvers to be installed plumb, square, level and true. Blank off all unused portions of the louver with 14 ga. Aluminum and insulate blank off with 1" rigid foil faced insulation. Seal blank off areas airtight.

END OF SECTION 23 3713

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SECTION 23 7413 – PACKAGED DEDICATED OUTSIDE AIR SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes packaged, dedicated outside air units with the following components and accessories:
 - 1. Direct-expansion cooling.
 - 2. Gas furnace.
 - 3. Hot Gas Reheat Coils
 - 4. Roof curbs.

1.2 SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each DOAS unit, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and maintenance data.
- D. Warranty.

1.3 QUALITY ASSURANCE

- A. ARI Compliance:
 - 1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies.
 - 2. Comply with ARI 270 for testing and rating sound performance.
 - 3. Comply with ARI 1060 for testing and rating of energy recovery module.
- B. ASHRAE Compliance:
 - 1. Comply with ASHRAE 15 for refrigerant system safety.
 - 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
 - 3. Comply with applicable requirements in ASHRAE 62.1.
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

- E. UL Compliance: Comply with UL 1995.
- F. 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.
- G. Motors 1 HP and larger shall be “premium efficiency” series motor, VFD rated with shaft grounding rings.

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five (5) years from date of Substantial Completion.
 - 2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than ten (10) years from date of Substantial Completion.
 - 3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three (3) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Daikin
 - 2. Mitsubishi
 - 3. Greenheck
 - 4. LG
 - 5. CaptiveAire

2.2 CASING

- A. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs. Panels shall be easily removable for servicing all components.
- B. Unit casing construction shall be double wall, 2” thick with minimum R-13 foam insulation.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.3 FANS

- A. Air circulating fans shall be either ECM or direct drive plenum type with backwards curved fan blades. Direct drive plenum fans shall be provided with a VFD capable of full fan modulation.
- B. Condenser fans shall be either ECM or direct driven propeller type with wire guards.

2.4 COILS

- A. Supply-Air Refrigerant Coil:
 - 1. Aluminum plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
 - 2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
 - 3. Coil Split: Interlaced.
 - 4. Condensate Drain Pan: Stainless steel formed with pitch and drain connections complying with ASHRAE 62.1.
- B. Hot Gas Refrigerant Reheat Coil
 - 1. Aluminum tube micro-channel coil.
- C. Outdoor-Air Refrigerant Coil:
 - 1. Aluminum -plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
 - 2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.

2.5 REFRIGERANT CIRCUIT COMPONENTS

- A. Compressor:
 - 1. Hermetic, scroll, inverter duty, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.
- B. Refrigeration Specialties:
 - 1. Refrigerant: R-32, R-454b.
 - 2. Expansion valve with replaceable thermostatic element.
 - 3. Refrigerant filter/dryer.
 - 4. Manual-reset high-pressure safety switch.
 - 5. Automatic-reset low-pressure safety switch.
 - 6. Minimum off-time relay.
 - 7. Automatic-reset compressor motor thermal overload.
 - 8. Brass service valves installed in compressor suction and liquid lines.
- C. Refrigerant Detection & Mitigation Control

1. Refrigerant systems with an A2L or higher flammability classification, as defined in ASHRAE Standard 15 and 34, shall be equipped with a refrigerant leak detection system. The leak detection system shall provide the following mitigation controls to ensure there is never a build up of refrigerant greater than the lower flammability limit of the respective refrigerant. The following shall occur:
 - a. Activate refrigerant system safety shut-off valves to reduce releasable refrigerant charge.
 - b. Energize the air circulation fan(s).
 - c. De-energize potential ignition sources, including open flames (direct and indirect gas furnaces) and unclassified electrical sources of ignition with apparent power rating greater than 1kVa, where the apparent power is the product of the circuit voltage and current rating.

2.6 AIR FILTRATION

1. Pre and Final filters as indicated on unit schedule.

2.7 GAS FURNACE

- A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.
 1. CSA Approval: Designed and certified by and bearing label of CSA.
- B. Burners: Stainless steel
 1. Fuel: Natural gas.
 2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
- C. Heat-Exchanger and Drain Pan: Stainless steel.
- D. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.
- E. Safety Controls:
 1. Gas Control Valve: Modulating type, minimum 10:1 turndown.
 2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.8 ELECTRICAL POWER CONNECTION

- A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.9 CONTROLS

- A. Provide a factory mounted DDC controller capable of providing the sequence of operation described on the contract drawings. Controller shall have a BACnet MS/TP communication module. Provide control components as shown in control diagram.
- B. Units shall be provided with the following external control components, for field installation:
 - 1. Supply duct static pressure sensor.
- C. Control Accessories:
 - 1. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
 - 2. Leaving Coil / Entering Fan Temperature Sensor
 - 3. Duct High Limit Switch
 - 4. Discharge Air Temperature Sensor
 - 5. Outside Air Temperature Sensor
 - 6. Supply Air Fan Proving
 - 7. Coil guards of painted, galvanized-steel wire.

2.10 ACCESSORIES

- A. Coil guards of painted, galvanized-steel wire.

2.11 UNIT MOUNTING AND AIR DISCHARGE

- A. Unit shall be mounted on grade. Secure to concrete equipment pad. Provide neoprene isolators below unit to facilitate rain water drainage from underneath unit.
- B. Unit shall be provided with a side discharge for supply air. If the unit is not capable of being provided with a side discharge, a 24" insulated curb shall be provided to facilitate installation of ductwork and an elbow with turning vanes below the unit.
 - 1. Curb shall be anchored to the concrete equipment pad.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The unit shall be set in place, shimmed level, and secured.
- B. Provide condensate drainage piping from the drain pan per the contract documents. Provide a concrete splash block at the outlet of the condensate drain.
- C. The Plumbing Contractor shall provide a natural gas connection to the unit. A gas shut-off valve and dirt leg shall be provided on the exterior of the unit upstream of the gas connection. The HVAC contractor shall coordinate gas location with the Plumbing Contractor.

- D. The Electrical Contractor will provide power wiring thru a fused disconnect switch to one set of power terminals in each unit. All other power and control wiring required for the completion of the systems shall be furnished and installed by the HVAC Contractor. All wiring shall be furnished and installed by the HVAC Contractor. All wiring shall be run in ½” and larger conduit in accordance with applicable provisions of the Electrical Specifications.

END OF SECTION 23 7415

SECTION 23 8126 – VARIABLE REFRIGERANT VOLUME HEAT RECOVERY SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes split-system variable capacity heat recovery air-conditioning units consisting of separate evaporator-fan and compressor-condenser components. System shall be variable refrigerant volumes series heat and cool model.
- B. Operation of the system shall permit either individual cooling or heating of each fan coil simultaneously or all of all the fan coil units associated with one branch cool/heat selector box. Each fan coil or group of fan coils shall be able to provide set temperature independently via a local remote controller, an Intelligent Controller, and System Graphical User Interface.

1.2 SUBMITTALS

- A. Product Data: For each unit indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Operation and maintenance data.

1.3 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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.4 WARRANTY

- A. The units shall have a manufacturer's warranty for a period of 12 months from date of startup or 18 months from date of shipment, whichever comes first. The units shall have a limited labor warranty for a period of 12 months from date of startup or 18 months from date of shipment, whichever comes first. The compressors shall have a warranty of six (6) years from date of startup or six and ½ years from date of shipment, whichever comes first. During the stated period, should any part fail due to defects in material and workmanship, it shall be repaired or replaced at the discretion of equipment manufacturer according to manufacturer's terms and conditions. All warranty service work shall be performed by a factory trained service professional.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Daikin – “VRV Emerion”
 2. Trane/Mitsubishi - “Hyper Heat”
 3. LG – “Multi V”
 4. Carrier/Toshiba - “U-Series”

2.2 EVAPORATOR-FAN UNIT

- A. Ceiling Cassette:
1. Indoor unit shall be a ceiling suspended, fan coil unit, operable with specified refrigerant, equipped with an electronic expansion valve. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature. A mildew-proof, polystyrene condensate drain pan and resin net mold resistant filter shall be included as standard equipment. The indoor unit’s sound pressure shall range from 31 dB(A) to 41 dB(A) at low speed measured at 3.3 feet below and from the unit.
 2. The unit shall be mounted from structure with the manufacturer provided bracket.
 3. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
 4. The unit shall be provided with either a built-in or factory supplied condensate pump.
- B. Multi-Position Air Handling Unit
1. Indoor unit shall be a floor mounted vertical or horizontal right air handling unit, operable with the provided refrigerant, equipped with an electronic expansion valve and direct-drive ECM type fan with auto CFM adjustment, for installation within a conditioned space. When installed in a vertical configuration it shall have top discharge air and bottom return air. It shall be connected to the outdoor heat recovery unit. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature. Included as standard equipment, a condensate drain pan and drain pump kit that pumps to 18-3/8” from the drain pipe opening. The indoor units sound pressure shall range from 29 dB(A) to 40 dB(A) at low speed measured 5 feet below the ducted unit.
 2. Unit shall be capable of 0.8” fan external static pressure.
 3. Electric Heat Kits:

- a. Electric heat kits shall be capable of mounting directly to the outlet of the Multi-Position Air Handling Unit.
- b. Heater shall come with the ability to connect power from a dedicated branch circuit.

C. Refrigerant Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 3 row cross fin copper evaporator coil with 13 fpi design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1-1/4" outside diameter PVC.
5. A condensate pan shall be located under the coil.
6. A condensate pump with a 18-3/8" lift shall be located below the coil in the condensate pan with a built in safety alarm.
7. A thermistor will be located on the liquid and gas line.

D. Evaporator Fan:

1. The fan shall be direct-drive DC (ECM) type fan, statically and dynamically balanced impeller with three fan speeds available.
2. The unit shall be equipment with an automatically adjusting external static pressure logic selectable during commissioning.
3. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range of 0.12 to 0.47 HP respectively.
4. The airflow rate shall be available in three settings.
5. The fan motor shall be thermally protected.
6. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.
7. Fan motor external static pressure range for nominal airflow:

A. Filters:

1. Wall Mounted & Ceiling Cassette's
 - a. Filters shall be reusable type, integral with the unit.
2. Multi-Position Air Handling Units
 - a. Unit shall have a 1" filter slot. Provide a MERV 8 filter with unit.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER UNIT

A. General:

1. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil

- separators, service ports and refrigerant regulator. High/low pressure gas line, liquid and suction lines must be individually insulated by the installing contractor between the outdoor and indoor units.
2. The outdoor unit can be wired and piped with outdoor unit access from the left, right, rear or bottom.
 3. For future expansion each outdoor system shall be able to support the connection of up to 41 indoor units dependant on the model of the outdoor unit.
 4. The system will automatically restart operation after a power failure and will not cause any settings to be lost.
 5. The unit shall incorporate an auto-charging feature and a refrigerant charge check function.
 6. The outdoor unit shall be modular in design and should allow for side-by-side installation with minimum spacing.
 7. The following safety devices shall be included on the condensing unit; high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
 8. To ensure the liquid refrigerant does not flash when supplying to the various fan coil units, the circuit shall be provided with a sub-cooling feature.
 9. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation.
 10. The outdoor unit shall be capable of heating operation at 0°F dry bulb ambient temperature without additional low ambient controls.
 11. The system shall continue to provide heat to the indoor units in heating operation while in the defrost mode.
- B. Casing steel, finished with baked enamel, 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.
- C. Compressor:
1. The inverter scroll compressors shall be variable speed (PAM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency or STD ON/OFF) shall be controlled to eliminate deviation from target value.
 2. The inverter driven compressor in each condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll “G-type” with a maximum speed of 7,980 rpm.
 3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
 4. The capacity control range shall be 6% to 100%.
 5. Each non-inverter compressor shall also be of the hermetically sealed scroll type.
 6. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
 7. Oil separators shall be standard with the equipment together with an intelligent oil management system.

8. The compressor shall be spring mounted to avoid the transmission of vibration.
9. Units sized 20 nominal ton shall contain a minimum of 4 compressors. In the event of compressor failure the remaining compressors shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity. The microprocessor and associated controls shall be designed to specifically address this condition.
10. In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the Duty Cycling Function, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours.

D. Refrigerant Coil:

1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.
4. The fins are to be covered with an anti- corrosion acrylic resin and hydrophilic film type E1.
5. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns

E. Fan:

1. The condensing unit shall consist of one or more propeller type, direct-drive 750 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.32 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.
3. The fan shall be a vertical discharge configuration.
4. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
5. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
6. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps.

2.4 BRANCH SELECTOR BOX

- A. General: The branch selector box shall be specifically designed for use with variable refrigerant volume heat recovery systems.
1. The selector boxes shall be factory assembled, wired, and piped.
 2. The selector boxes controllers must be run tested at the factory.
 3. The selector boxes must be mounted indoors.

4. When simultaneously heating and cooling, the units in heating mode shall energize their subcooling solenoid valve.
5. The number of connectable indoor units shall be in accordance with the plan drawings. One branch selector box per fan coil to allow each fan coil individual heating or cooling control.

B. Unit Cabinet:

1. Units shall have a galvanized steel plate casing.
2. Each cabinet shall house multiple refrigeration control valves and a liquid gas separator.
3. The cabinet shall contain a tube in tube heat exchanger.
4. The unit shall have sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene.

C. Refrigerant Valves

1. The unit shall be furnished with 5 electronic expansion valves to control the direction of refrigerant flow.
2. The refrigerant connections shall be of the braze type.

D. Drainage: The branch selector unit shall not require any condensate drainage connection.

2.5 CONTROLS

- A. Each fan coil unit shall be provided with a room mounted zone controller that includes an integral room temperature sensor. The sensor shall have an LCD display and room temperature setpoint capability.
- B. Control wiring between room sensor, fan coil unit, branch selector unit and outdoor unit shall be 16VDC non-shielded, stranded 2 conductor cable.
- C. A graphical central user interface control panel will be used to allow building operator to monitor all system fan coils and outdoor heat recovery unit. The user interface will include an LCD screen with graphical representation of each fan coil and outdoor unit. The Graphical User Interface will allow the building operator to view individual fan coil and outdoor unit diagnostics and set points. The Graphical User Interface will allow the building operator to set the operating schedule of the equipment through the scheduling function.
- D. Provide main controller with BACNET IP controller.

2.6 REFRIGERANT

- A. Unit shall utilize one of the following refrigerants:
 1. R-410a

2.7 DEFROST CYCLES

- A. The condensing unit shall have the option of a continuous heating defrost cycle.

2.8 ACCESSORIES

- A. Provide a 12” tall condensing unit stand from the unit manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- B. Install ground-mounted, compressor-condenser components on concrete pad. If the manufacturer requires condensing units to be mounted on a stand for condensate runoff, the manufacturer shall provide the appropriate stand.
- C. Provide vibration isolation for Ceiling Suspended Fan Coil Units.
- D. Refer to VRF system detail on HVAC drawings for additional installation information.
- E. Provide mounting stand for vertical Multi-Position Air Handling Unit type fan coil units.
- F. Provide additional refrigerant charge as required for system to function properly.
- G. Provide all required control wiring and power to control components.
- H. Install and program wireless communication device and assist owner with set-up of phone application.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections.
- B. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new components, and retest.
- D. Startup and configuration of the Graphical User Interface shall be provided by the unit manufacturer. Training on use of the control system is to be part of 1 day owner training provided by the unit manufacturer

END OF SECTION 23 8126

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SECTION 23 8239 - UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cabinet unit heaters with centrifugal fans and **[hydronic hot-water] [electric-resistance heating]** coils.
2. Propeller unit heaters with **[hydronic hot water] [electric-resistance heating]**.
3. Wall & ceiling mounted unit heaters with propeller fans and electric-resistance heating coils.

1.2 SUBMITTALS

- ##### A. Product Data:
- Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
- ##### B. Shop Drawings:
- Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Equipment schedules include rated capacities, furnished specialties, and accessories.
 2. Plans, elevations, sections, physical dimensions, weight, and details.
- ##### C. Operation and maintenance data.

1.3 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. ASHRAE/IESNA 90.1-2004 Compliance:
- Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

PART 2 - PRODUCTS

2.1 PROPELLER UNIT HEATERS

- ##### A. Fan:
- Direct driven propeller type fan with aluminum wheel and single speed permanent split capacitor motor with internal overload protection. Units shall have a wire fan guard.
- ##### B. Electrical Disconnect:

1. Toggle disconnect switch furnished and mounted on cabinet.
- C. Heating Coil:
 1. Hydronic – Seamless copper tubes with bonded aluminum fins, hydrostatically tested at 300 psi.
 2. Electric Resistance – Copper clad steel sheath element with continuously brazed steel fins formed to allow side draw through air flow. Overcurrent protection and limits controls for high-temperature protection.
- D. Cabinet: Galvanized steel, 18 gauge, with baked enamel finish. Horizontal units shall be equipped with adjustable discharge louvers.
- E. Controls: Low voltage transformer, on-off switch, 24v 2-way 2 position ball valve and wall mounted thermostat.
- F. Manufacturers:
 1. Electric Resistance
 - a. Berko
 - b. Chromalox, Inc.
 - c. Indeeco
 - d. Markel Products
 - e. Marley Engineered Products
 - f. QMark Electric Heating
 - g. Raywall

2.2 WALL & CEILING MOUNTED ELECTRIC RESISTANCE UNIT HEATERS

- A. Fan: Direct driven propeller fan and single speed permanent split capacitor motor with internal overload protection. Units shall have a wire fan guard.
- B. Electrical Disconnect:
 1. Toggle disconnect switch furnished and mounted on cabinet.
- C. Heating Element: Steel sheathed block with fin element. Overcurrent protection and high temperature protection.
- D. Cabinet: Galvanized steel, 18 gauge, with extruded aluminum frame. Unit is recessed in wall.
- E. Safety: Automatic thermal overload cut-off to deenergize the unit if an over-temperature situation occurs.
- F. Controls: Integral temperature control thermostat.
- G. Manufacturers:
 1. Berko
 2. Chromalox, Inc.
 3. Indeeco
 4. Markel Products

5. Marley Engineered Products
6. QMark Electric Heating
7. Raywall
8. TPI Corporation
9. Trane.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to drawings for arrangement, type, capacity, motor characteristics and other requirements.
- B. Mounting
 1. Install unit heaters to comply with NFPA 90A and manufacturer's recommendations.
 2. Horizontal, vertical and concealed suspended unit heaters shall be suspended from all four corners, from building structure with steel hanger rods and auxiliary angles and fastening devices.
 3. Propeller unit heaters shall be suspended from all four corners, from building structure with steel hanger rods and auxiliary angles and fastening devices or provide ceiling or wall mounted bracket as required.
 4. Wall mounted heaters that are recessed into the wall shall be provided with lintels as required by the Structural Engineer. Coordinate wall type, location and size as required.
 5. Wall mounted heaters shall be provided with rough-in box and secured as required.
 6. Ceiling mounted heaters shall be provided with rough-in boxes and secure as required.
 7. Ceiling mounted heaters shall be suspended as required from the structure above ceiling. Coordinate with ceiling type.
- C. Access
 1. Install hot water piping adjacent to the machine to allow for service and maintenance.
 2. Cabinet unit heaters shall be provided with lockable access covers as required for disconnecting means and service.
 3. Concealed unit heaters mounted above inaccessible ceiling shall be provided with an appropriate ceiling access panel.
- D. Temperature Controls
 1. Wiring between the unit and wall mounted thermostats shall be run in conduit, furnished and installed by the HVAC contractor. See Section 23 0914 "Control Wiring".
 2. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
- E. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

END OF SECTION 23 8239

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DIVISION 26 ELECTRICAL

26 0000 General Requirements for Electrical Systems

- 26 0001 Basic Electrical Requirements
- 26 0004 Firestopping for Electrical Systems
- 26 0005 Excavation, Backfill and Surface Restoration

26 0500 Common Work Results for Electrical

- 26 0519 Low-Voltage Electrical Power Conductors and Cables
- 26 0526 Grounding and Bonding for Electrical Systems
- 26 0529 Hangers and Supports for Electrical Systems
- 26 0533 Raceway and Boxes for Electrical Systems
- 26 0537 J-Hook Pathways for Electrical Systems
- 26 0543 Underground Ducts and Raceways for Electrical Systems
- 26 0553 Identification for Electrical Systems
- 26 0563 Specific Wiring Applications
- 26 0590 Electrical Specialties

26 0900 Instrumentation and Control for Electrical

- 26 0923 Lighting Control Devices
- 26 0936 Modular Dimming Controls

26 2000 Low-Voltage Electrical Distribution

- 26 2213 Low-Voltage Distribution Transformers
- 26 2416 Panelboards
- 26 2726 Wiring Devices
- 26 2813 Fuses
- 26 2816 Enclosed Switches and Circuit Breakers
- 26 2913 Enclosed Motor Controllers

26 3000 Facility Electrical Power Generating and Storing Equipment

- 26 3100 Photovoltaic Panels
- 26 3213 Engine Generators (Pre-Purchased by Owner)
- 26 3330 Photovoltaic Inverters
- 26 3623 Automatic Transfer Switches (Pre-Purchased by Owner)
- 26 3630 Generator Docking Station

26 4000 Electrical Cathodic Protection

- 26 4313 Surge Protective Devices (SPD) for Low-Voltage Electrical Power Circuits

26 5000 Lighting

- 26 5113 Interior Lighting Fixtures
- 26 5600 Exterior Area Lighting

26 6000 **Electronic Safety and Security**

26 6101 Fire Detection and Alarm System

SECTION 26 0001 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section Includes the following:

1. General Requirements
2. Definitions
3. Scope of Work
4. Drawings and Specifications
5. Reference Standards
6. Allowances, Unit Prices and Alternates
7. Site Visit
8. Permits, Regulations and Inspections
9. Project Management and Coordination
10. Temporary Electric Services
11. Workmanship
12. Protection
13. Painting
14. Cleaning
15. Equipment Selection
16. Shop Drawings
17. Testing
18. Final Inspection and Punch List
19. Operation and Maintenance Manuals
20. Record Drawings
21. Warranties
22. Operation and Adjustment of Equipment
23. Operating Demonstration and Instruction

1.2 GENERAL REQUIREMENTS

- A. All provisions of Division 00 Front End Documents and Division 01 General Requirements apply to work specified in this Division.
- B. Specification provisions of other relevant Divisions shall apply where applicable work is required to be performed under this Electrical work.
- C. A complete and functional Electrical system installation shall be provided under this Division. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect. In such event, none of the trades or their suppliers shall assume that he is relieved of the work which is specified under his branch until instructions in writing are received from the Architect.

- D. The Mechanical and Electrical drawings and specifications assign work (labor and/or materials to be provided by the General, Plumbing, Fire Suppression, HVAC or Electrical Contractor or their sub-contractors. Understanding that the contractors for mechanical and electrical work are sub-contractors to the (General) Contractor, such assignments are not intended to restrict the Contractor in assignment of work among the sub-contractor to accommodate trade agreements and practices or the normal conduct of the construction work.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SCOPE OF WORK

- A. The scope of the electrical work includes furnishing, installing, testing and warranty of all electrical work and complete electrical systems shown on the electrical drawings and specified herein, including Division 00, Division 01, Division 26 and applicable provisions of other relevant Divisions.

1.5 DRAWINGS AND SPECIFICATIONS

- A. The drawings indicate the general arrangement of the work and are to be followed insofar as possible. The word "provide", as used shall mean "furnish and install". If significant deviations from the layout are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Architect for approval before proceeding with the work.
- B. Make all necessary field measurements to insure correct fitting. Coordinate work with all other trades in such a manner as to cause a minimum of conflict or delay.
- C. The drawings and specifications shall be carefully studied during the course of bidding and construction. Any errors, omissions or discrepancies encountered shall be referred immediately to the Architect for interpretation or correction, so that misunderstandings at a later date may be avoided. The contract drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Having equipment, wireways and fittings

fabricated and delivered in advance of making actual measurements shall not be sufficient cause to avoid making offsets and minor changes as may be necessary to install wireways, fittings and equipment.

- D. The Architect shall reserve the right to make minor adjustment in locations of system runs and components where he considers such adjustments desirable in the interest of concealing work or presenting a better appearance where exposed. Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work, or unduly delay the work. Coordinate work in advance with all other trades and report immediately any difficulties which can be anticipated.
- E. Equipment, ductwork and piping shall not be installed in the dedicated electrical space above or in the working space required around electrical switchgear, motor control centers or panelboards as identified by NEC 110.26 Spaces About Electrical Equipment – 600 Volts Nominal or Less. For Equipment rated over 600 volts nominal – 110.32 Work Space About Equipment – 110.33 Entrance and Access to Work Space – 110.34 Work Space and Grounding. The Electrical Contractor shall caution other trades to comply with this stipulation.
- F. Where any system runs and components are so placed as to cause or contribute to a conflict, it shall be readjusted at the expense of the Contractor causing such conflict. The Architect's decision shall be final in regard to arrangement of equipment, conduit(s), devices, wireways etc., where conflict arises.
- G. Provide offsets in system runs, additional fittings, necessary conduit, pull boxes, conductors, switches and devices required to complete the installation, or for the proper operation of the system. Each contractor shall exercise due and particular caution to determine that all parts of the work are made quickly and easily accessible.
- H. Should overlap of work among the trades become evident, this shall be called to the attention of the Architect. In such event, none of the trades or their suppliers shall assume that he is relieved from the work which is specified under his branch until instructions in writing are received from the Architect.

1.6 REFERENCE STANDARDS

- A. Where standards (NFPA, NEC, ASTM, UL, etc.) are referenced in the specifications or on the drawings, the latest edition is to be used except, however, where the authority having jurisdiction has not yet adopted the latest edition, the edition so recognized shall be used.

1.7 ALLOWANCES, UNIT PRICES AND ALTERNATES

- A. Refer to Sections 012100 Allowances, 012200 Unit Prices and 012300 Alternates.

1.8 SITE VISIT

- A. Refer to Section 017300 Execution.

- B. Each bidder shall visit the project site to understand the existing conditions and compare the conditions with information shown on the drawings. Report immediately to the Architect any issues or discrepancies which are discovered that affect the bid. Changes to contract price will not be considered for site condition issues that are readily apparent from a thorough site review.

1.9 PERMITS, REGULATIONS AND INSPECTION

- A. Work must conform to applicable local, state and federal laws, ordinances and regulations. Where drawings or specifications exceed code requirements, the drawing and specifications shall govern. Install no work contrary to minimum legal standards.
- B. Except where the permit application is made by the Architect or the Engineer, the Electrical contractor shall be responsible to file for and obtain all required permits from the governing inspection agencies for the Electrical work. Where the Architect or Engineer is the Architect or Engineer of record, they will furnish sealed and signed drawings and specifications required by the permit authorities except fire alarm permit documents shall be prepared and submitted by an approved, licensed fire alarm subcontractor.
- C. Include payment of all permit and inspection fees applicable to the work in this Division.
- D. All work shall be subject to inspection and approval of Federal, State and local agencies as may be appropriate as well as the Architect and Engineer.
- E. Furnish for the Owner certificates of approval from the governing inspection agencies as a condition for final payment.

1.10 PROJECT MANAGEMENT AND COORDINATION

- A. Refer to Section 013100 Project Management and Coordination.
- B. The HVAC Contractor shall initially prepare and be responsible for ¼” scale coordination drawings. These drawings shall be reproduced and distributed to the Plumbing, Fire Suppression and Electrical Contractors for their input and revisions. Assure that all contractors work together to obtain finish coordinated drawings and no work being installed until all contractors have approved and signed-off with their approval and drawings have been submitted and reviewed by the Engineer.

1.11 TEMPORARY ELECTRIC SERVICES

- A. Refer to Section 015000 – Temporary Facilities and Controls for division of responsibilities for temporary utilities.
- B. The temporary service and temporary lighting for construction is provided by the Electrical Contractor.
- C. The Electrical Contractor is cautioned to carefully consider the possible sources of temporary electric service and the probable location of the General Contractor's office.

- D. The General Contractor will make application to the local utility company for the temporary electric service and will pay for all electric power used during construction, including electric heating.
- E. The Electric Contractor shall furnish, install and pay for all necessary conduit, wire, metering, poles, switches, receptacles, lights and accessories to provide a 400 amp, 120/230 volt, 3 phase, 4 wire temporary electric service with the main disconnect switch, meter, and a 42 circuit load center at a location specified by the General Contractor.
- F. Consult the utility company for fees required and include same in Electrical Contract.
- G. Labor, receptacles, boxes, fixtures, wire, etc. required by the various Contractors inside their offices shall be paid for by the respective Contractors.
- H. Lighting fixtures shall be placed every 40 ft. along each corridor or where corridors do not occur, along the long axis of all rooms. Provide a minimum 800 lumen lamp in a commercial grade molded plastic socket and lattice wire guard temporary lighting assembly with extra heavy duty "ST" 3-wire cord. Lamps shall be spaced a minimum of 10 ft. apart. For large open areas or during the early stages of construction, 250 watt metal halide fixtures (or LED equivalent) with wire guards may be utilized. Receptacle circuits shall consist of 1-gang cast "FS" type box with grounded duplex receptacles a maximum of 50 ft. on center with a maximum of 4 per circuit. All receptacle circuits shall be protected by its own overcurrent device in a panel board. Install wiring and equipment above 6'-6" and below the finished ceiling. Extend circuits as required. Provide GFCI protected receptacles and circuits as required by NEC and OSHA.
- I. Contractors requiring extension cords shall provide their own cords and plugs up to capacity of 20 amperes. For services to larger items of equipment and welders, this Contractor shall extend proper feeders as requested at the expense of the Contractors requiring the service.
- J. The Electrical Contractor shall maintain the temporary light and power system for the duration of the work and shall remove it from the site when directed. Temporary wiring and equipment shall remain the property of the Electrical Contractor.
- K. The use of the permanent electrical system for temporary services during the latter stages of construction shall be allowed. Expedite completion of system as practicable to this end. Maintain the system during this period.
- L. Warranty periods on equipment, materials and systems shall commence upon Owner acceptance of the building or systems. Temporary use shall not jeopardize or alter warranty requirements.
- M. The complete temporary service shall comply with Power Company, OSHA, and all Code requirements.

1.12 WORKMANSHIP

- A. Refer to Section 01400 Quality Requirements.
- B. Materials and equipment shall be installed and supported in a first-class and workmanlike manner by mechanics skilled in their particular trades. Workmanship shall be first-class in all

respects, and the Architect shall have the right to stop the work if highest quality workmanship is not maintained.

- C. Electrical work shall be performed by a licensed Electrical Contractor in accordance with requirements of the jurisdiction.

1.13 PROTECTION

- A. Each Contractor shall be entirely responsible for all material and equipment furnished in connection with his work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Architect.
- B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide plastic sheeting, drop cloths or similar barriers where dust and debris is generated, to protect adjacent areas.
- C. Contractor shall protect all equipment and materials from detrimental effects of weather or construction activity. All items shall be stored and secured in a protected location away from the daily work area. Equipment or materials shall be placed on raised skids to protect from surface moisture. Where appropriate, provide plastic sheeting or similar vapor barrier underneath the stored products to reduce the effects of ground moisture or curing concrete on the local humidity levels. Where unfinished ferrous products or finished ferrous products with raw edges are stored, provide local, dry heat to maintain ambient relative humidity levels below 65% RH to prevent rust.
- D. All equipment shall retain the original packaging until required to be removed for installation or operation. Open ends of ducts, piping, conduit, etc. shall be capped or sealed and ventilation openings into equipment shall be wrapped and sealed in plastic sheeting to prevent dust or dirt entry both when stored and after installation but still open to the effects of construction activity. Stored items as well as installed equipment shall be covered with plastic sheeting at all times until placed in service or until dust generating activity in the area has ceased.

1.14 PAINTING

- A. In addition to any painting specified for various individual items of equipment, the following painting shall be included in the Electrical Contract:
 - 1. All metal which is not factory or shop painted and which remains exposed to view in the building including finished areas, mechanical rooms, storage rooms and other unfinished areas shall be given a prime coat of paint.
 - 2. All metal installed outside the building which is not factory or shop painted shall be given a prime coat of paint.
 - 3. Equipment and materials which have been factory or shop coated (prime or finished painted or galvanized), on which the finish has been damaged or has deteriorated, shall be cleaned and refinished equal to its original condition. The entire surface shall be repainted if a uniform appearance cannot be accomplished by touch-up.
 - 4. Apply Z.R.C. Cold Galvanizing Compound, or approved equal, for touch-up of previously galvanized surfaces.

5. Paint, surface preparation and application shall conform to applicable portions of the Painting section of Division 09 Finishes. All rust must be removed before application of paint.

B. Finish painting is included in the General Contract. Refer to the Cutting and Patching paragraph in this Section for finishing requirements.

1.15 CLEANING

A. Debris, dust, dirt, etc shall be removed daily, particular attention shall be paid to areas that the Owner is continuing to occupy or use; any mess created in corridors, stairwells and egress paths that are maintained during construction shall be cleaned immediately.

B. The Owners dumpsters and trash receptacles shall not be used. If a dumpster is required, it shall be provided by the contractor and located where approved by the Owner. Coordinate dumpster requirements with other contractors.

C. Before turning an area back over to the Owner, thoroughly clean the space to leave the area in a similar condition before the start of the project where finishes are to remain.

D. Before placing each system in operation, the equipment shall be thoroughly cleaned; cleaning shall be in accordance with equipment manufacturer's recommendations.

E. Refer to appropriate Sections for cleaning of other equipment and systems for normal operation.

1.16 EQUIPMENT SELECTION

A. Materials and equipment furnished under this contract shall be in strict accordance with the specifications and drawings and shall be new and of best grade and quality. When two or more articles of the same material or equipment are required, they shall be of the same manufacturer.

B. All electrical equipment and wiring shall bear the Underwriters Laboratories, Inc. label where UL label items are available, and shall comply with NEC (NFPA-70) and NFPA requirements.

C. The selection of materials and equipment to be furnished under this contract shall be governed by the following:

1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specification, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be first quality line of manufacturers listed.

2. Where the words "or approved equal" appear after a manufacturer's name, specific written approval must be obtained from the Engineer during the bidding period in sufficient time to be included in an addendum. The same shall apply for equipment and materials not named in the specifications, where approval is sought.

3. Where the words "equal to" appear, followed by a manufacturer's name and sometimes a model or series designation, such designation is intended to establish quality level and

standard features. Equal equipment by other manufacturers will be acceptable, subject to the Engineer's approval during shop drawing submittal.

- D. Substitute equipment of equal quality and capacity will be considered when the listing of such is included as a separate item of the bid. State the deduction or addition in cost to that of the specified product.
- E. Before bidding equipment, and again in the preparation of shop drawings, the Contractor and his supplier shall verify that adequate space is available for entry and installation of the item of equipment, including associated accessories. Also verify that adequate space is available for servicing of the equipment and that required NEC (and other applicable Code's) clearances are met. The Contractor and his supplier shall also verify compatibility of equipment specified with available system/service voltages, etc.
- F. If extensive changes in conduit, equipment layout or electrical wiring and equipment are brought about by the use of equipment or existing site conditions which are not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in the contract.

1.17 SHOP DRAWINGS

- A. Refer to Section 016000 Product Requirements.
- B. One set of shop drawings, in electronic format (pdf), with descriptive information shall be assembled by each Contractor of equipment and materials furnished in his contract, and submitted to the Architect and/or Engineer for review as stated in Division 01. These shall be submitted as soon as practicable and before special equipment is manufactured and before installation.
- C. Shop drawings for equipment fixtures, devices and materials shall be labeled and identified same as on the Contract Documents. Failure to do so may be cause for rejection of shop drawings.
- D. The review of shop drawings by the Architect or Engineer shall not relieve the Electrical Contractor from responsibility for errors in the shop drawings. Deviations from specifications and drawing requirements shall be called to the Engineer's attention in a separate clearly stated notification at the time of submittal for the Engineer's review.
- E. Shop drawings of the following electrical equipment and materials shall be submitted:
 - 1. Firestopping.
 - 2. Wireway.
 - 3. Cable trays.
 - 4. Miscellaneous cabinets.
 - 5. Plenum cable.
 - 6. Seismic Restriant.
 - 7. Wiring devices and coverplates.
 - 8. Service/Distribution panelboard.
 - 9. Dry type transformer – secondary.
 - 10. Panelboards and associated distribution equipment.

11. Fuses.
12. Motor controllers (VFD's) and disconnects.
13. Lighting Controls including layout plans of Occupancy Sensors.
14. Low voltage switching/lighting control system
15. Lighting fixtures.
16. Lighting standards.
17. Fire alarm system with schematic and point to point wiring diagrams.
18. Solar Carport
19. Photovoltaic Panels
20. Photovoltaic Inverters

- F. Submittals of the Standby Generator and associated ATS and remote annunciator (furnished by the Owner) will be shared with the awarded Electrical Contractor as early as possible for coordination and installation requirements.

1.18 TESTING

- A. As each wiring system is completed, it shall be tested for continuity and freedom from grounds.
- B. As each electrically operated system is energized, it shall be tested for function.
- C. The Contractor shall perform megger and resistance tests and special tests on any circuits or equipment when an authorized inspection agency suspects the system's integrity or when requested by the Architect or Engineer.
- D. All signaling and communications systems shall be inspected and tested by a qualified representative of the manufacturer or equipment vendor. Submit four (4) copies of reports indicating results.
- E. Tests shall be witnessed by field representatives of the Architect or Engineer or shall be monitored by a recorder when appropriate. Furnish a written record of each system test indicating date, system, test conditions, duration and results of tests.
- F. Instruments required for tests shall be furnished by the Contractor.

1.19 FINAL INSPECTION AND PUNCH LIST

- A. Refer to Section 017700 Closeout Procedures.
- B. As the time of work completion approached, the Contractor shall survey and inspect his work and develop his own punch list to confirm it is complete and finished. He shall then notify the Architect and request that a final inspection be made. It shall not be considered the Architect's or Engineer's obligation to perform a final inspection until the Contractor has inspected the work and so states at the time of the request for the final inspection.
- C. Requests to the Architect, Engineer or Owner for final inspection may be accompanied by a limited list of known deficiencies in completion, with appropriate explanation and schedule for completing these; this is in the interest of expediting acceptance for beneficial occupancy.

- D. The Architect and/or Engineer will inspect the work and prepare a punch list of items requiring correction, completion or verification. Corrective action shall be taken by the Contractor to the satisfaction of Architect and Engineer within 30 days of receipt of the Architect/Engineer's punch list.

1.20 OPERATING AND MAINTENANCE MANUALS

- A. Refer to Section 017823 Operation and Maintenance Data.
- B. Two copies each of operating and maintenance manuals shall be assembled for the Electrical work by the Contractor.
- C. All shop drawings and installation, maintenance and operating instruction pamphlets or brochures, wiring diagrams and other information, along with warranties, shall be obtained from each manufacturer of the principal items of equipment. In addition, the Contractor shall prepare a chart listing all items of equipment which are furnished under his contract and indicating the nature of maintenance required, the recommended frequency of checking these points and the type of replacement material required. Major items of equipment shall consist of not less than the following:
 - 1. Distribution switchgear.
 - 2. Fire Alarm System.
 - 3. Specialty equipment.
- D. Standard NEMA publications on the operation and care of equipment may be furnished in lieu of manufacturer's data where the manufacturer's instruction is not available.
- E. These shall be assembled into three-ring loose leaf binders or other appropriate binding and also combined into a single electronic file in .PDF format. An index and tabbed sheets to separate the sections shall be included. These shall be submitted to the Architect or Engineer for review. Upon approval, manuals shall be turned over to the Owner.

1.21 RECORD DRAWINGS

- A. Refer to Section 017839 Project Record Drawings.
- B. The Electrical Contractor shall maintain a separate set of prints of the contract documents and shall show all changes or variations, in a manner to be clearly discernible, which are made during construction. Upon completion of the work, these drawings shall be turned over to the Architect. This shall apply particularly to underground and concealed work, and to other systems where the installation varies to a degree which would justify recording the change.

1.22 WARRANTIES

- A. Refer to Section 017700 Closeout Procedures.

- B. This Contractor shall warrant all workmanship, equipment and material entering into this contract for a period of one (1) year minimum from date of final acceptance or date of beneficial use, as agreed to between Contractor and Architect. Any materials or equipment proving to be defective during this warranty period shall be made good by this Contractor without expense to the Owner.
- C. This provision is intended specifically to cover deficiencies in contract completion or performance which are not immediately discovered after systems and placed in operation. These items include, but are not limited to, motor controller malfunction, heater element changes required for motor controller, fuse replacement where fuses blow due to abnormal shorts, adjustments and/or replacement of malfunctioning equipment and adjusting special equipment and communication systems to obtain optimum performance.
- D. This provision shall not be construed to include maintenance items such as making normally anticipated adjustments or correcting adjustment errors on the part of the Owner's personnel.
- E. Provisions of this warranty shall be considered supplementary to warranty provisions under General Conditions.
- F. Extended warranties shall be provided where indicated in the equipment specification Sections.

1.23 OPERATION AND ADJUSTMENT OF EQUIPMENT

- A. As each system is put into operation, all items of equipment included therein shall be adjusted to proper working order. This shall include balancing and adjusting voltages and currents and adjusting all operating equipment.
- B. Caution: Verify that all bearings of equipment furnished are lubricated, all motors are operating in the right direction, and correct overload heater elements are provided on all motors. Do not depend wholly on the other trades judgment in these matters. Follow specific instructions in regard to lubrication of equipment furnished under this Contract.

1.24 OPERATING DEMONSTRATION AND INSTRUCTIONS

- A. Refer to Section 017900 Demonstration and Training as well as individual Division 26 Sections for requirements.
- B. The Contractor shall set the various systems into operation and demonstrate to the Owner and Architect that the systems function properly and that the requirements of the Contract are fulfilled.
- C. The Contractor shall provide the Owner's representatives with detailed explanations of operation and maintenance of equipment and systems. A thorough review of the operating and maintenance manuals shall be included in these instructional meetings.
- D. A minimum of 8 hours shall be allowed for instructions to personnel selected by the Owner. Instructions shall include not less than the following:
 - 1. Show locations of items of equipment and their purpose.

2. Review binder containing instructions and equipment and systems data.
3. Coordinate written and verbal instructions so that personnel understand each.
4. Separate instructions shall be given by manufacturer's representatives for the various special and communications systems.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION – NOT APPLICABLE

END OF SECTION 26 0001

SECTION 26 0004 – FIRESTOPPING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

1.2 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
- B. Rated Systems: Firestopping assemblies shall be tested and rated in accordance with ASTM E814 (ANSI/UL 1479) Fire Tests of Through-Penetration Fire Stops (minimum positive pressure of .01 inches of water column) and E119 (ANSI/UL 263) Fire Tests of Building Construction and Materials Time-Temperature Curve. Firestopping shall provide an “F” fire rating equal to that of the construction being penetrated. Firestop systems shall meet all requirements of the Ohio Building Code.
- C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
 - 1. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.
 - 2. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
- D. For through-penetration firestop systems exposed to view or above ceilings in air return plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each through-penetration firestop system, submit documentation, including illustrations, from a qualified testing and inspecting agency, showing each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Firestopping materials shall be manufactured and/or supplied by:

1. Hilti, Inc.
2. Johns Manville.
3. Nelson Firestop Products.
4. Specified Technologies Inc.
5. 3M; Fire Protection Products Division.
6. Tremco; Sealant/Weatherproofing Division.

2.2 FIRESTOPPING

A. Materials shall be in the form of caulk, putty, sealant, intumescent material, wrap strip, fire blocking, ceramic wool and other materials required for the UL listed assemblies. These shall be installed in conjunction with sleeves and materials for fill and damming.

PART 3 - EXECUTION

3.1 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

- A. General: Installation of all materials and assemblies shall be in accordance with UL assembly drawings and the manufacturer's instructions.
- B. Installation shall be done by an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having the necessary training and experience.
- C. Provide firestop system for every conduit or opening at penetration of all fire resistance rated walls and horizontal assemblies.
- D. Provide rigid supports for conduit on both sides of the fire resistance rated wall or assembly where required as part of the fire stop assembly.
- E. Coordinate opening size and additional framing requirement with the General Contractor for each opening to meet the firestop installation requirements.
- F. Refer to 26 0533 Raceway and Boxes for Electrical Systems for sleeve requirements and treatment of penetrations not requiring firestopping.
- G. Annular space of penetrations of nonfire-resistant-rated floor, floor/ceiling assemblies, or the ceiling membrane of a nonfire-resistant rated roof/ceiling assembly shall be filled with an approved firestopping material to resist the free passage of flame and products of combustion.
- H. Smoke Barriers:
 1. Penetrations shall be sealed with a firestopping system to prevent the passage of smoke.

- I. Smoke Partitions:
 1. Penetrations shall be sealed with a caulking material to prevent the passage of smoke.
Non-rated smoke partitions do not require a fire stopping system.

END OF SECTION 26 0004

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SECTION 26 0005 – EXCAVATION, BACKFILL AND SURFACE RESTORATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Excavating and backfilling for all in-grade underfloor conduit, exterior ducts, conductors, conduit, lighting standard bases, manholes, handholes, pullboxes, utility trenches and any incidental work included in the Electrical Contract.

1.2 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over conduit or duct in a trench, including haunches to support sides of conduit.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Bedding Course: Course placed over the excavated sub-grade in a trench before laying manhole, pullbox or conduit.

C. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

D. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

E. Fill: Soil materials used to raise existing grades.

F. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

G. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below topsoil materials.

H. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.

1.4 GENERAL

- A. Excavate for all in-grade underfloor conduit, exterior ducts, conductors, conduit, lighting standard bases, manholes, handholes, pullboxes, utility trenches and any incidental work included in the Electrical Contract.. Backfill to finish grade or to levels consistent with the General Contractor's and Site Contractor's activities. Cut existing street, drive and parking lot paving, walks, curbs and other permanent hard surfaces which are to be encountered. Repair or restore exterior surfaces to original condition where such are not affected by Division 2 – Site Work. Cut existing floor slabs and replace slabs in conformance to 26 002 Basic Electrical Materials and Methods. All work shall comply with requirements set forth in Division 2.
- B. Excavation and trench wall supporting, cribbing, sloping and stepping of excavations required for safety shall be done in accordance with OSHA and local requirements. Pumping of water from excavations and trenches which may be required during construction shall be included in this contract.
- C. Contact the Ohio Utilities Protection Service (1-800-362-2764) well in advance of the start of any excavation to determine if any of the utility companies or departments have underground utilities in or near the project area.
- D. Contact local water and sewer departments, gas company, electric company, telephone company, etc., regarding the possibility of encountering existing utilities. The integrity of all existing utilities shall be respected.
- E. Existing utilities encountered during excavation work shall be protected in a manner acceptable to the utility owner. Any utilities that are damaged shall be repaired or replaced by the Contractor to the full satisfaction of the utility owner.

PART 2 - PRODUCTS

- 2.1 Refer to Division 31 Earthwork for bedding and backfill materials

PART 3 - EXECUTION

3.1 EXCAVATION FOR UTILITY TRENCHES

- A. Interior and exterior trenches shall be over-excavated and the conduits, ducts or conductors shall be laid on 6" minimum depth sand bed.
- B. Backfilling of excavations and trenches inside the building and outside under paved or other hard surfaced areas, shall be with graded pea gravel, graded coarse sand or crushed limestone,

3/4" maximum size, to prevent undue settlement. Backfill material for plastic piping shall be pea gravel or sand. Other excavations and trenches shall be backfilled with similar materials up to 18" above the top of the conduit or conductor. The remainder shall be with similar materials or with excavated material having no large clods, stones or rocks.

- C. Maintain in place adequate barricades, guards, planking, plating signage, warning lights, etc., at and around excavations.
- D. Backfill shall be mechanically compacted in layers not over 6" deep. Water settling will not be permitted. Where excavations have not been properly filled or where settlement occurs, they shall be refilled, compacted, smoothed off, and finally made to conform to the initial requirements. Excess excavated materials shall be removed from the site or disposed of as directed by the General Contractor. Refer to Division 31 Earthwork for compaction requirements.
- E. Concrete floor slabs, paving, sidewalks, curbs sodded and other finished surfaces which have been damaged or removed in order to install the underground work shall be replaced but this Contractor equal to original conditions. Refer to Division 32 for Surface Restoration requirements. This requirement is not applicable in areas where the General Contractor or the Site Contractor is obligated to provide new surfaces.
- F. Excavation, backfill, surface repair and traffic control within the public right-of-way shall be in accordance with governing agency rules and regulations. Any fee for activity in the roadways shall be included in this contract so that no additional cost will accrue to the Owner.
- G. All exterior underground direct buried conductor, conduit and concrete encased ducts shall be protected against future excavation damage by placing a plastic tape warning marker in each trench during backfill. Tape shall be 6" wide with black letters identifying the type of service. Tape shall be equal to that manufactured by Seton. Install tape full length of the trench approximately 18' above and on the centerline of the conductor, conduit or duct.
- H. In addition to a warning tape, concrete encased ducts shall have a concentrated red dye poured on top of the concrete before fully cured.

END OF SECTION 26 0005

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SECTION 26 0519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 VAC and less.
 - 2. Connectors, splices, and terminations rated 600 VAC and less.
 - 3. Photovoltaic wires and cables rated for 1500 VDC or less.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.

1.3 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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Copper Conductors: Comply with NEMA WC 70.
- B. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.
- C. Multiconductor Cable: Comply with NEMA WC 70 for armored cable, Type AC and metal-clad cable, Type MC with ground wire.
- D. Photovoltaic Wiring: Comply with NEMA WC 70 for PV Wire.

2.2 CONNECTORS AND SPLICES

- 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:
 - 1. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; EGS Electrical Group LLC.
 - 4. 3M; Electrical Products Division.
 - 5. Tyco Electronics Corp.

- C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR SIZE

- A. Refer to schedule on drawings.

3.2 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Stranded for No. 8 AWG and larger.
- B. PV Strings: Copper. Stranded for No. 12 AWG and larger.

3.3 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. PV Strings: Type PV Wire with MC4 connectors.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.
- D. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- E. Class 2 Control Circuits: Power-limited cable, in raceway.
- F. Use conductors such as type FEP with high temperature insulation as identified in the NEC for connections to resistance heating elements or in other areas subject to temperature exceeding the rating of THWN, XHHW or THHN.
- G. In addition to the conduit system, a separate grounding conductor shall be installed with all feeders and branch circuitry.
- H. Equipment grounding conductors shall be green, or completely taped green, at all accessible points.

- I. Wire size ampacity shall equal or exceed its overload protective device. Where sizes shown on the drawings are greater than the apparent ampacity requirements, the size shown shall prevail to compensate for voltage drop. In no instance shall conductors be installed that are less than required by the N.E.C. Minimum conductor size shall be No. 12 AWG except No. 14 AWG may be used for control wiring or where otherwise specifically indicated.

3.4 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Conduit systems shall be clean and clear before pulling wires. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway. Pulling of branch circuit conductors shall be performed by manual means without the use of levers or heavy pulling devices that may compromise the conductor's or insulation integrity.
- D. A maximum of 8 conductors shall be installed in a branch circuit conduit unless specifically noted otherwise on the drawings. Equipment ground conductors are not counted when determining maximum fill.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Wiring in vertical raceways shall be supported with strain relief devices; Kellems grips or approved equal.
- G. Support cables according to Division 26 Sections "Hangers and Supports for Electrical Systems."
- H. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."
- I. 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.
- J. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- K. Underground splices (including splices in exterior pullboxes and manholes) shall be made using sealing kits or wire nuts U.L. listed and approved for the application.
- L. Where fireproofing of cables is noted on the drawings or required by Code, each cable shall be arc and fireproofed with on (1) half-lapped layer of Scotch Brand 77 Electric Arc and Fireproofing Tape. Tape shall be secured with a 2-layer band of Scotch Brand 69 Glass Electrical Tape over the last wrap. Installation shall comply with manufacturer's recommendation.

- M. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack. Refer to additional notes on plans for branch circuitry installation requirements.

3.5 TESTING

- A. As each wiring system is completed, it shall be tested for continuity and freedom from grounds.
- B. As each electrically operated system is energized, it shall be tested for function.
- C. On all electric services including change-outs, backfeeds, etc. the Contractor shall verify phase rotation and voltage readings to assure the final installation is proper. Submit to the Engineer in writing a record of voltage readings and current readings taken at no-load and fully loaded conditions.
- D. The Contractor shall perform megger and resistance tests and special tests on any circuits or equipment when an authorized inspection agency suspects the system's integrity or when requested by the Engineer.
- E. Tests shall be witnessed by field representatives of the Engineer or shall be monitored by a recorder. Furnish a written record of each system test indicating date, system, test conditions, duration and results of tests. Copies of all test reports shall be included in the O&M manuals.
- F. Instruments required for tests shall be furnished by the Contractor.

END OF SECTION 26 0519

SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.

1.3 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. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.2 GROUNDING RODS

- A. Grounding Rods shall be copper clad, molten welded copper to steel; unless otherwise designated, 3/4" diameter X 10 ft. long.

2.3 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Clamps and continuity devices shall be non-ferrous material, UL approved. Connections to ground rods and all underground connections shall be made with welded connections (“Thermoweld” or “Cadweld”).

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.

8. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Wiring devices shall be connected with grounding jumper from ground pole on device to grounding screw (or grounding pigtail) in the outlet box.
- D. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 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 1/4-by-2-by-12-inch grounding bus.
 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
- C. Main service neutral shall be grounded to the street side of the building water service. A bonding jumper shall be installed around the water meter. In addition to using the water service as a grounding electrode, effectively grounded building steel, driven ground rods outside or buried electrode shall be provided and connected. Bond to interior metallic water, gas and all other metallic lines.
- D. The complete metal conduit system shall be used for the equipment grounding system. Conduit systems and associated fittings and terminations shall be made mechanically tight to provide a continuous electrical path to ground and shall be safely grounded at all equipment by bonding all metallic conduit to the equipment enclosures with locknuts cutting thru paint of enclosures. Bond all conduits entering service entrance switchboard with a ground wire connecting the grounding bushings to the equipment ground bar. Conductors shall be sized per NEC Tables 250-66 and 250-122. Bond all communications conduit systems to ground.
- E. In addition to using the conduit system for grounding, a complete auxiliary green wire equipment grounding system shall be installed, continuous from main ground, thru distribution

and branch circuit panelboards and paralleling all feeders and branch circuit wiring. Grounding conductor sizes shall comply with NEC Table 250-122, minimum size shall be #12 copper except #14 on control circuits. This shall apply to all circuits rated 100 volts or more above ground potential.

- F. Ground neutral of all transformers for separately derived systems.
- G. Motor frames shall be bonded to the equipment grounding system by an independent green wire, sized as shown.
- H. Cord connected appliance frames shall be grounded to the equipment grounding system thru a green wire in the cord.
- I. A green grounding conductor shall be installed in each non-metallic conduit and all flexible conduits, including exterior underground conduits.
- J. System neutral connections shall be insulated from metal enclosures except at the neutral of the service entrance equipment and on the neutral of a separately derived system. Connections to the main service enclosure shall be by means of bonding jumpers.
- K. The building neutral shall be identified throughout with white conductors for 280/120 volt systems and grey conductors for 480/277 volt systems. Where there are neutral conductors from a separately derived system (such as 120/208 volt, 3 phase, 4 wire where the main building service is 277/480 volt, 3 phase, 4 wire) the neutrals of the two systems shall be separately identifiable per NEC Article 200.
- L. A minimum #6 ground wire shall be run from each telephone backboard/data rack back to the main building ground. Or where indicated on the drawings or in the specifications, a separate communications grounding system shall be provided and bonded to the electrical grounding system at the main ground bar.
- M. Bond the generator neutral to the generator equipment grounding conductor. Bond the generator frame to the equipment grounding conductor. Provide signs at the grounding locations per NEC Article 701.
- N. Where metal covers on pull boxes and junction boxes are used, they shall comply with the grounding and bonding requirements of NEC Article 250.
- O. Connections to driven ground rods or other such electrodes shall be a minimum of 3 feet from the building foundation wall or beyond the roof drip line, whichever is greater.
- P. The ground rods of the electrical grounding system shall not be used as the electrodes (ground rods) of the lightning protection system (where specified) and vice versa. However, the lightning protection system (where specified) shall be bonded to the electrical grounding system at one point per NEC.

END OF SECTION 26 0526

SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Hangers and supports for electrical equipment and systems.

1.2 PERFORMANCE REQUIREMENTS

- A. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. Thomas & Betts Corporation.
 - e. Unistrut; Tyco International, Ltd.
 - f. Wesanco, Inc.
2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.

- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for 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.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) 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.
 - 2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 5. Toggle Bolts: All-steel springhead type.
 - 6. Hanger Rods: Threaded steel.

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. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Utilize supports with swivel type attachments to maintain true vertical support from sloped structure or inclined structural elements (such as beam clamp with swivel option).

- D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
- E. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 6. To Light Steel: Sheet metal screws.
 - 7. 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 blocking attached to substrate by means that meet anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 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.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.4 CONCRETE BASES

- A. Provide dowel rods to connect concrete bases to concrete floors/slabs/substrates. Unless otherwise indicated, install dowel rods on maximum 18-inch centers around the full perimeter of concrete base.
- B. Provide epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor/slab/substrate, unless concrete bases are installed directly on grade. Place and secure anchorage devices. Using setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast galvanized or stainless-steel anchor-bolt inserts into bases.
- D. Indoor bases shall be at least 4” thick and shall have straight and finished sides and a 1”-45 degree chamfer at the top perimeter. Reinforcing steel bars shall be placed in both directions of the bases. Where required for supplemental support, provide lateral support work to adjacent wall(s). Provide concrete bases/housekeeping pads beneath all electrical power and systems distribution equipment that is floor mounted or wall mounted within 4” of the floor.
- E. Outdoor bases shall be at least 6” thick and shall have straight and finished sides and a 1”-45 degree chamfer at the top perimeter. Perimeter of pads shall extend down below the frostline. Reinforcing steel bars shall be placed in both directions of the bases and a mesh overlay shall be provided. Where required for supplemental support, provide lateral support work to adjacent wall(s). Provide concrete bases/housekeeping pads beneath all electrical power and systems distribution equipment that is slab or grade mounted or mounted within 6” of slab or grade.
- F. Unless indicated otherwise in specifications or on drawings, use minimum 3000-psi, 28-day compressive-strength concrete. Size and provide concrete bases so expansion anchors will be a minimum of 10 bolt diameters from the edge of the concrete base.
- G. Forms: As required for equipment pads or other special applications in field, provide forms made of steel, wood, or other suitable material of size and strength to resist movement during concrete placement, and to retain horizontal and vertical alignment until removal. Use straight forms, free distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends. Do not remove forms for 24 hours after concrete has been placed. Set forms to required grades and lines, rigidly braced and secured. Provide sufficient quantity of forms to allow continuous progress of work, and so that forms can remain in place at least 24 hours after concrete placement. Clean forms after each use, and coat with form release agent as often as required to ensure separation from concrete without damage. Form areas that involve termination of spare conduits below grade, or that involve continuation of conduits by others, accordingly to accommodate easy future access to the ends of conduits for future extensions.
- H. Reinforcement: Cut bars true to length with ends square and free of burrs. Provide metal expansion caps for one end of each dowel bar in expansion joints. Design caps with one end closed and minimum length of 3” to allow bars movement of not less than 1”, unless otherwise indicated. Provide these for joining applications where continuous pouring cannot be accomplished.

- I. Concrete Placement: Remove loose material from subbase surface immediately before placing concrete. Check subbase and forms for line and grade before placing concrete. Moisten subbase if required to provide a uniform dampened condition at time concrete is placed. Place concrete using methods that prevent segregation of mix. Use splash boards to divert the flow of concrete away from the trench sides, and to avoid dislodging soil and stones. Coordinate with Owner's Representative at least 72 hours prior to placing concrete. Line up concrete trucks as required to achieve one continuous pour where applicable. Do not backfill until a minimum of 48 hours have passed.
- J. Concrete Finishing: Smooth surface by screeding after striking-off and consolidating concrete. Provide Class A finishing. Broom finish concrete pads, and aprons around pullboxes and structures. Protect concrete from damage until acceptance of work. Exclude traffic over affected areas for at least 14 days after placement.

3.5 PLYWOOD EQUIPMENT BOARDS

- A. Plywood Equipment Boards: Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent. Provide plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than $\frac{3}{4}$ inches deep. Provide marine grade plywood where subject to moisture conditions. Provide Simpson Strong Tie (or equal) expansion screw anchors.
- B. Unless otherwise noted, boards shall be painted with two coats of good grade weatherproof flat gray non-conductive fire-retardant paint on all sides and edges (prior to mounting) and plumbed in a true vertical position. Provide nominal $\frac{1}{2}$ " rustproof spacers between back of plywood and wall. Cut, fit, and place plywood equipment boards accurately in location, alignment, and elevations to support and anchor electrical materials and equipment. 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. Attach to substrates as required to support applied loads. Maintain at least 4 inches from bottom of plywood equipment boards and the finished floor surface.
- C. Unless directed otherwise in field, plywood equipment boards shall be 8 feet high by $\frac{3}{4}$ inches deep by length shown on drawings (as dimensioned or as scaled) or length as required to accommodate equipment if not indicated on drawings. Unless directed otherwise in field, provide plywood equipment boards for all indoor surface mounted panelboards and systems "head-end" equipment for all applications where located in mechanical or electrical rooms/areas and only where specifically shown on drawings for all other applications.

END OF SECTION 26 0529

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SECTION 26 0533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, details, and attachments to other work.

1.3 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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1.
- B. IMC: ANSI C80.6.
- C. EMT: ANSI C80.3.
- D. FMC: Zinc-coated steel.
- E. LFMC: Flexible steel conduit with PVC jacket.
- F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
 - 2. Fittings for EMT: Steel only; set-screw or compression type.

2.2 NONMETALLIC CONDUIT AND TUBING

- A. ENT: NEMA TC 13.
- B. RNC: NEMA TC 2, unless otherwise indicated.
- C. LFNC: UL 1660.
- D. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.
- E. Fittings for LFNC: UL 514B.

2.3 CABLE TRAY (Wire Basket Type)

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cooper B-Line, Inc.
 - 2. Mono Systems.
 - 3. MP Husky.
 - 4. Thomas & Betts.
 - 5. Cablofil.
 - 6. Cope.
 - 7. Wiremaid.
- B. Description: Basket tray shall be steel wire structure, welded at all wire intersections and zinc plated after construction. 12” wide with 4” load depth (unless size is indicated otherwise on the plans), supported at 12 ft. intervals at a minimum or as required by manufacturer to meet load rating and as field conditions and structure dictate.
- C. General: Except as otherwise indicated, provide metal basket trays, of types, classes and sizes indicated, with splice plates, bolts, nuts and washers for connecting units. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.
- D. All field formed bends or transitions shall be either a UL listed and approved assembly or where the tray is modified in the field, shall be Field Evaluated and approved by UL.
- E. Splice connectors shall be the bolted type. The resistance of fixed splice connections between adjacent sections of tray shall not exceed .00033 ohms. Splice connector construction shall be such that a splice may be loaded anywhere within the support span without diminishing rated load capacity (and grounding capacity) of the basket tray. Splice plates shall be furnished with straight sections and fittings or with clamp fittings to enable field cut and formed bends as recommended by the manufacturer.
- F. Cable Tray Supports: Shall be placed so that the support spans do not exceed maximum span as recommended by the manufacturer. Supports shall be constructed from 12-gauge steel formed shape channel members with necessary hardware such as trapeze support kits. Basket trays installed adjacent to walls shall be supported on wall mounted brackets.

- G. Trapeze hangers shall be supported by 3/8" (minimum) diameter rods or cable suspension system listed and approved for use by the tray manufacturer. Provide PVC sheath on threaded rod section passing thru basket when center-hung type supports are utilized to protect cabling.

2.4 SURFACE RACEWAYS

- A. Surface Metal Raceways: Brushed Aluminum with snap-on covers.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Mono Systems.
 - b. Walker Systems, Inc.; Wiremold Company (The).
 - c. Hubbell Wiring Systems.

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, aluminum, Type FD, with gasketed cover.
- C. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- D. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- E. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- F. Cabinets:
 - 1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
 - 1. Exposed Conduit: Rigid steel conduit.
 - 2. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
 - a. Mechanical rooms.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT except FMC may be utilized in existing walls.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
6. Damp or Wet Locations: Rigid steel conduit.
7. Raceways for Optical Fiber or Communications Cable: EMT.
8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. EMT: Use all steel, compression type or all steel setscrew type, concrete tight.
3. Flexible conduit: Use malleable iron, “squeeze” type, non-insulated. (For lighting fixture whips only: Use all steel or die-cast screw-in connector).
4. Liquid-tight conduit: steel or malleable iron.

3.2 CABLE OR BASKET TRAY APPLICATION

- A. Locate tray such that a minimum 12” clearance is maintained above and to one side of tray to accommodate installation of cabling. Carefully coordinate installation with other trades to maintain this clearance.
- B. For wire basket type tray, follow the manufacturer’s installation details for cutting methods and locations for field formed connections, bends and offsets.

3.3 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter. Generally run conduit and conductors as high as practicable against underside of floor slab in concrete construction or immediately below the **top chord** of bar joist construction unless otherwise shown or noted. This high level zone shall be used for running electrical raceways and shall be grouped or

racked together wherever feasible. Runs at bottom chord level or ceiling grid level are not acceptable.

- B. 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.
- C. Complete raceway installation before starting conductor installation. Plan raceway routing to minimize the number of offsets and junction boxes.
- D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- F. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated. All conduit shall parallel building lines.
- G. Conduit shall be run overhead and shall not be run below concrete slabs unless specifically indicated on the drawings and in the legend on the drawings.
- H. Conduit crossing building expansion joints shall have expansion provisions with grounding continuity, use special expansion fittings listed for the application. Refer to the Architectural and Structural floor plans and details for locations of expansion joints.
- I. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- J. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- K. Raceways for Data, Audio Visual and Communications Cable: Install as follows:
 - 1. 1-Inch Trade Size and Smaller: Install raceways in maximum lengths of 75 feet.
 - 2. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
 - 3. Raceway shall be installed continuously from outlet box to above edge of nearest cable tray above accessible ceiling.
 - 4. Bond raceway to cable tray with approved grounding bushing, bonding jumper and necessary fittings.
- L. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 1. Use LFMC in all locations except MC may be used for lighting fixture whips.
- M. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

- N. Do not install wall-mounted boxes back-to-back in opposite sides of wall; in stud walls, boxes shall be on opposite side of studs.
- O. Provide access to all junction and pull boxes.
- P. Set metal floor boxes level and flush with finished floor surface. Provide trim ring compatible with finish floor system.
- Q. Pull mandrel or large swab thru conduit to assure freedom from debris before pulling wires. Use listed pulling lubricants where necessary.
- R. Provide four (4) 1 inch diameter spare conduits for each flush mounted branch circuit panelboard; extend from top of panelboard to above an accessible ceiling for future use.
- S. Contractor shall record carefully on a set of “as-built” prints, the exact location of all feeder conduits (100 amps and larger).
- T. Unless noted otherwise on the drawings, a maximum of 8 conductors shall be installed in a branch circuit conduit. This maximum is a count of all phase and neutral conductors only.

3.4 INSTALLATION OF EXPOSED CONDUIT OUTDOORS

- A. Only install conduit exposed outdoors when it is impossible to do otherwise, or only if specifically indicated for such installation case-by-case elsewhere in documents. Installation convenience, financial considerations, lack of coordination with other trades and similar rationale are not sufficient reasons for conduit sizes per NFPA 70 (National Electrical Code, NEC). Provide expansion fittings, which are Listed and labeled for the respective applications, at all building expansion joints and at maximum distances of 100 feet. Paint all such conduits with at least two coats of UV-resistant weatherproof paint. Provide colors to match respective surrounding surfaces; submit colors to Design Professional for review in advance of procuring paint.

3.5 INSTALLATION OF EXPOSED CONDUIT ON ROOFS

- 1. Only install conduit exposed on rooftops when it is impossible to do otherwise, or only if specifically indicated for such installation case-by-case elsewhere in documents. Installation convenience, financial considerations, lack of coordination with other trades and similar rationale are not sufficient reasons for doing so. In cases where conduits must be installed on rooftops, de-rate conductors and modify conduit sizes per NFPA 70 (National Electrical Code, NEC). Provide expansion fittings, which are Listed and labeled for the respective applications, at all building expansion joints and at maximum distances of 100 feet. Paint all such conduits with at least two coats of UV-resistant weatherproof paint. Provide white paint of flat rooftops that have finishes white in color, and for otherwise-colored roof finishes that are not visible from the building interior or from the ground outdoors. Elsewhere select colors to match surrounding surfaces; submit colors to Design Professional for review in advance of procuring paint.

END OF SECTION 26 0533

SECTION 26 0537 – J-HOOK PATHWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 GENERAL

- A. Conduit/Raceway/Pathway: “Conduit”, “raceway”, “pathway” and similar terms shall be taken to mean “conduit” unless specifically indicated otherwise in project manual documents, or unless specifically directed otherwise in field by Owner or Design Professionals. All such terms shall be considered synonymous for the general purposes of installation means and methods.
- B. Provide J-Hook pathway systems only for the following limited applications: Class 2 (“low voltage”) control wiring above accessible finished-ceiling systems.
- C. Coordination Drawing Submittals: Prior to commencing with any related work, submit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Routing.
 - 2. Scaled layout and relationships between components and adjacent structural, electrical, and mechanical elements.
 - 3. Vertical and horizontal offsets and transitions.
 - 4. Clearances for access above and to side of pathways.
 - 5. Vertical elevation of pathways above the floor or below bottom of ceiling structure.
 - 6. Structural members in paths of conduit groups with common supports.
 - 7. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

PART 2 - PRODUCTS

2.1 J-HOOK PATHWAYS

- A. Acceptable Manufacturers: Subject to being equivalent and subject to compliance with requirements, provide product by one of the manufacturers listed below, or equivalent NRTL listed and labeled equivalent.
 - 1. Cooper B-Line (basis of design, model numbers as specified further below).
 - 2. Mono-Systems, Inc.
- B. Materials Description:
 - 1. Provide J-Hook system components that are plenum-rated (regardless of whether air plenum ceilings exist on the project). Provide J-Hooks, not Cable Fasteners, and not Bridle Rings. Provide open-top hooks, so cables can be laid into J-Hooks rather than threaded through. Provide tool-less cable retainer clips (do not use cable ties). Provide hooks sized for maximum 40% fill (in cross section) based on outside diameter of cables. Accordingly, provide multiple sets of J-Hooks along any given pathway as applicable.
 - 2. Provide necessary factory hooks, cable retainers, fasteners, attachment kits, etc. as required for complete installations.

2.2 MATERIALS AND FINISHES

- A. Provide steel units with rolled hook edges to prevent damage to cable jackets and insulation.
- B. 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.
- C. Cable hooks for corrosive areas shall be stainless steel, AISI Type 304.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide J-Hook support along “free-air” cable pathway routes. Provide J-Hooks at four-foot intervals and at offsets. Route J-Hooks above ceilings through corridors and similar open areas wherever possible to minimize above-ceiling wall penetrations.
- B. Layout and install all electrical work in strict compliance with Chapter 1, Part B, Section 110.26 of the latest adopted edition of NFPA 70. Locations and routing that may be shown on plans are schematic and diagrammatic in nature. Layout all proposed pathway routing, elevations, installation methods, etc. on coordination drawings and coordinate all proposed routing with all affected trades prior to commencing with work. In addition, review the information with Owner and Design Professionals for all areas where pathways will be visible after completion of construction, to ensure a neatly organized installation occurs. Where exposed in finished areas, install in a manner that minimizes detrimental effects on room aesthetics. Install as out of site as reasonably possible.
- C. Keep pathways at least 24 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal runs above liquid and steam piping. Level and square runs, and install at proper elevations and heights. Do not begin installation of cables until J-Hook pathway installations are complete and until installations locations (end to end) are in a weatherproof environment. Install pathways so that they are accessible for cable installation after construction is complete. Install pathways with enough workspace to permit access for installing cables. Strictly adhere to factory load capacities and fill capacity. Provide factory cable retainers, fasteners, attachment kits, and other accessories as required for a complete installation.
- D. Securely anchor (mechanical, not adhesive) J-Hooks directly to structural components of the building. Do not anchor J-Hooks to ductwork, conduit, piping, fixtures, equipment, ceiling supports (rods, wires, T-bars), etc. Comply with requirements in Section 260529 and related sections for hangers and supports. Support using factory-approved methods. Fasten cables on horizontal runs with factory cable clamps, retainers, fasteners, attachment kits or flexible Velcro-secured wraps compliant with to NEMA VE 2. Tighten clamps/wraps only enough to secure the cable, without indenting the cable jacket. Use of synthetic or plastic “tie-wraps”, “zip ties”, “wire ties” and similar products are not permitted as a permanent means of anchoring, securing, supporting or otherwise installing any cables, conductors, conduits, raceways, devices equipment or other electrical work. Do not use perforated strap.

- E. Coordinate work prior to rough-in with respective equipment and cable installers, and with Owner's Representative. Carefully coordinate proposed routing, including elevations, with affected installers and entities prior to rough-in. Neatly route paths parallel and perpendicular to building architectural lines, plumb on walls, and at a consistent elevation wherever possible. Install paths in a uniform plane/elevation wherever possible. Keep horizontal and vertical offsets to an absolute minimum. Route paths so that a minimum of 24 inches exists between cables and potential EMI sources such as lighting ballasts, motors, power wiring, dimmer circuits, etc.

- F. Provide a minimum of two (2) 4-inch bushed conduit sleeves where pathway is routed above inaccessible ceilings, and at penetrations of floors, masonry walls, fire rated walls, smoke-tight partitions, smoke-related partitions, and similar elements. Provide smoke and fire stopping at such penetrations as applicable in (see Section 260502). Provide EMT conduit for "drops" from paths to outlets and equipment, with sweep bends, insulated throat fittings and 200-pound pull string.

END OF SECTION 26 0537

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SECTION 26 0543 –UNDERGROUND DUCTS AND RACEWAYS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.
2. Handholes and boxes.
3. Manholes.

1.2 SUBMITTALS

A. Product Data: For accessories for manholes, handholes, and boxes.

B. Shop Drawings for Factory-Fabricated Handholes and Boxes: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Cover design.
3. Grounding details.
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

C. Field quality-control test reports.

1.3 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: Type EPC-40-PVC **Type EPC-80-PVC**, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B. Utilize galvanized rigid steel for 90 degree bends (long sweep type) with proper adapters between PVC duct and galvanized steel.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Cantex, Inc.
 2. CertainTeed Corp.; Pipe & Plastics Group.
 3. Heritage Plastics.
 4. Carlon Electrical Products.
 5. Manhattan/CDT; a division of Cable Design Technologies.
 6. Spiraduct/AFC Cable Systems, Inc.
- B. Duct Accessories:
1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, to provide minimum duct spacings while supporting ducts during concreting or backfilling.

2.3 HANDHOLES AND BOXES

- A. Description: Comply with SCTE 77.
1. Color: Gray /Green.
 2. Configuration: Units shall be designed for flush burial and have open /closed bottom, unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, As indicated for each service.
 6. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 7. 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.
- B. Polymer Handholes and Boxes: Molded of fiberglass-reinforced polymer concrete, with matching covers.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Carson Industries LLC.
 - b. Quazite (Hubbell).
 - c. Highline Products, Inc.

PART 3 - EXECUTION

3.1 EARTHWORK AND RESTORATION

- A. Refer to Division 26 Section “Excavation, Backfill and Surface Restoration”.

3.2 DUCT INSTALLATION

- A. Slope: Pitch ducts 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 at other locations, unless otherwise indicated.
- C. Joints: Stagger couplings so those of adjacent ducts do not lie in 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.
- E. Sealing: Provide temporary closure at terminations 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. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators 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 ducts or duct groups.
 - 2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
 - 3. 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.
 - 4. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. 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.
 - 5. Identify Ductbank with one of the following methods:

- a. Mark the top of all underground duct runs with concentrated red dye or powder on top.
- b. Provide 6” wide yellow plastic tape, with black letters indicating “Electric”; place approximately 18” above and continuously along the centerline of duct bank.

3.3 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST 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 sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: Set covers of handholes 1 inch above finished grade and boxes with bottom below the frost line.
- D. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.4 GROUNDING

- A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.5 CLEANING

- A. Pull mandrel through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 26 0543

SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Identification for conductors and communication and control cable.
 - 2. Wiring device circuit identification.
 - 3. Warning labels and signs.
 - 4. Equipment identification labels.

1.2 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.

1.4 COORDINATION

- A. 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.

PART 2 - PRODUCTS

2.1 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

- A. Marker Tape: Vinyl or vinyl -cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.2 WIRING DEVICE CIRCUIT IDENTIFICATION

- A. Marker Tape: Self-laminating, clear polyester, 3/8" high tape with black lettering.
- B. Provide label on every wiring device cover plate, indicating panel and circuit breaker fed from. Utilize 12 pt. font. Mount label on face of device cover plate, centered near the top .

2.3 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- C. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 mm)."

2.4 EQUIPMENT IDENTIFICATION LABELS

- A. Self-Adhesive, Engraved, Laminated Phenolic Label: Adhesive backed, with black letters on a white background. Minimum letter height shall be 3/8 inch.

2.5 PHOTOVOLTAIC WARNING LABELS

- A. Refer to 'PV' series drawings for project required labels and quantity.
- B. Self-Adhesive, Engraved, Laminated Phenolic Label: Adhesive backed, shall follow labels indicated on drawings.
- C. Minimum letter height shall be 3/8".
- D. Labels shall conform with NFPA 70 chapters 690 and 705.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Electrical and Auxiliary Systems Box, Conductor and Cable Identification: Use marker tape to identify field-installed branch circuit, alarm, control, signal, sound, intercommunications, voice, and data wiring connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and cable pull points. Identify by system and circuit designation.
 - 2. Identify panel and branch circuit number(s) on all junction box covers permanently clearly printed with bold black indelible marker.

3. Use system of designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

B. Conduit and junction boxes:

1. Color code or label all junction boxes and exposed conduit at 20 ft. intervals. Coding shall be painted or labels of the pre-manufactured type permanently mounted with metal or plastic band.
2. Label panelboard and branch circuit number(s) on outside of junction box cover at all junction boxes containing branch circuit wiring. Labelling shall be neatly done utilizing black indelible ink markers.
3. Paint all junction boxes and covers for fire alarm wiring red.
4. Provide a color identification scheme under heavy plastic cover hanging in the electrical rooms; identification shall be:

PRODUCT DATA SHEET 1 - b) Normal - Black

A. Branch circuit panelboards:

1. Identify panel designation on directory card within the panel.
2. Fill out branch circuit directory indicating circuit number and area served, rooms, group of rooms, lighting, convenience outlets, motors, etc. Card index shall be neatly typed.
3. Replace branch circuit directory in existing panelboards in areas of alteration.
4. Branch circuit phase conductor color format shall be permanently identified inside each panelboard.

B. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

1. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

C. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

- a. Indoor Equipment: Self-adhesive, engraved, laminated phenolic label. Unless otherwise indicated, provide a single line of text with 1/4-inch- high letters on 5/8-inch- high label; where 2 lines of text are required, use labels 1 inch high.

2. Equipment to Be Labeled:
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Electrical switchgear and switchboards.
 - c. Transformers.
 - d. Motor-control centers.
 - e. Disconnect switches.
 - f. Enclosed circuit breakers.
 - g. Motor starters.
 - h. Lighting Relay Panel(s).
3. Label shall include equipment name, voltage and where fed from. Where equipment is located in finished spaces, accessible to the public, in addition to adhesive, secure labels with screws, one on each end.

3.2 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- F. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded feeder, and branch-circuit conductors.
 1. Color shall be factory applied.
 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White
 3. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow
 - d. Neutral: Grey.

END OF SECTION 26 0553

SECTION 26 0563 – SPECIFIC WIRING APPLICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Various items of equipment require additional electrical connections, wiring and/or interlocks that are not specifically identified on the drawings or in the specifications. Included, but not limited to, are the following items:
 - 1. Mechanical/HVAC Equipment and motors.
 - 2. Exterior Lighting Control Equipment.
 - 3. Motorized Doors.
 - 4. Security/Access Control Equipment.
 - 5. Fire Protection/Suppression Equipment.

1.2 COORDINATION

- A. Coordinate wiring requirements and interlocks for equipment provided by other Contractors. Obtain copies of approved Shop Drawings and/or manufacturer's wiring diagrams to determine exact wiring requirements.
- B. This Contractor shall inquire of the Engineer during bidding, or at the earliest practical date, any questions which may arise regarding the intention and scope of this work.

PART 2 - PRODUCTS

- 2.1 Materials and equipment shall be as indicated on the drawings and in the specifications.

PART 3 - EXECUTION

- 3.1 Final connections to fixture pigtails shall be made with approved pressure connectors such as IDEAL “Twister” or T&B “Freespring Winged”.

3.2 Miscellaneous Equipment Connections

- A. Various items of equipment such as kitchen, laboratory, laundry, HVAC, Plumbing, etc. will be furnished and set in place by other trades. This equipment, unless otherwise shown on the drawings, will be furnished with necessary electrical outlets, operating and control switches, terminating in an electrical outlet box, or equivalent electrical connector located on the equipment. This contractor shall furnish power wiring to these various items of equipment and connect them up complete for full operation.

- B. Where disconnect switches are indicated or where otherwise required, they shall be mounted in an accessible location. In the case of labs, kitchens, laundries and finished areas, provide NEMA 4X Stainless Steel enclosure and locate in as inconspicuous a place as possible. Locate disconnect switches under counters where feasible and accessible in lieu of above counter, however, this contractor shall ensure that the installation of equipment does not interfere with access and operation of such switches.
- C. Where necessary to expose conduit in finished spaces, rigid aluminum conduit and conduit body (“LB”) fittings shall be utilized.
- D. Coordinate and provide any additional 120 volt power connections required for special low voltage systems devices or equipment panels such as Security System/Door Access System control panels, door strikes, surveillance cameras, security/fire shutters or doors, temperature control system panels/transformers, etc.
- E. Roughing-in drawings for equipment shall be obtained from the Architect or Contractor providing the equipment with substantial time prior to the installation of such equipment to enable proper electrical rough-in equipment.

3.3 Miscellaneous Wiring Interlocks

- A. Various items of work are required in connection with interlocking motor and starter/VFD operations and providing wiring to serve equipment which is furnished by other trades.
- B. Interlocks between motor controllers for purposes of accomplishing sequence control or simultaneous operation of motors are all to be included in the Electrical Contract. Requirements for a simple simultaneous motor operation interlock are indicated by a schedule on the drawings or by specific notes. These interlocks consist of auxiliary contacts on the starter/VFD of the lead motor wired in, according to standard diagrams of the motor starter/VFD manufacturer to energize the holding coil of the starter or VFD control input for the motor. These interlocks shall be thru the “automatic” position only of the starter/VFD where HOA switches are supplied. Furnish extra contacts on external relays as required for interlocks. Where interlocks, other than the simple sequence above, are required, they shall be as described as follows in this section.
- C. Air handling unit motors shall lead and exhaust fans and moving media air filters (if applicable) follow. Chiller pumps shall lead, followed by chiller, condenser pump and cooling tower, in that order. Condenser pumps shall lead and chemical feeder shall follow. Hot water pumps shall lead and boilers follow.
- D. All safeties, such as freezestats and firestats for air handling systems or high temperature/pressure switches for pumping systems, where required to be wired by the Electrical Contractor, shall be wired thru both the “Hand” and “Automatic” positions.
- E. The following is a list of equipment and systems requiring wiring. Note that these are in addition to standard interlocks scheduled on the drawings.
 - 1. Exterior lighting shall be controlled via a lighting control relay system as scheduled on the drawings. Refer to specification section 26 0943 for system requirements.

2. Motorized backdraft dampers on exhaust fans and power roof ventilators shall be connected to their respective associated motor leads to energize the backdraft damper motor and open the damper when the fan operates. Dampers, operator and transformer, if required, will be furnished by the fan supplier, install transformer and wire to damper.
3. Motorized Doors: Door controls, including door switches (pressplates, prox sensors, etc.), limit switches, relays, etc. will be furnished by the door equipment supplier. This equipment shall be turned over to the Electrical Contractor and installed for a complete and operational motorized door operator system per the equipment supplier wiring diagrams. Provide additional boxes, conduit and wiring as required per the supplier's diagrams and to meet field conditions. Where motorized door operators are located in fire walls and/or smoke partitions, provide a signal from the fire alarm system to disable the door controls to allow it to be manually operable while maintaining it's latching feature. Where motorized door operators are located on exterior doors and are required to open doors for smoke evacuation, provide a signal from the fire alarm system to open and hold doors during the course of smoke evacuation sequence.
4. Independently mounted controllers furnished by others: Where starters/VFD's are furnished by other trades, and are required to be mounted remote from the motor, the Electrical Contractor shall accept and mount them and perform all power and control wiring between the controls and motors indicated. Motor controllers equipped with automatic alternators shall have two independent circuits and control sources to preclude loss of operation when one circuit fails.

END OF SECTION 26 0563

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SECTION 26 0590 – ELECTRICAL SPECIALTIES

PART 1 - GENERAL – (NOT APPLICABLE)

PART 2 - PRODUCTS

2.1 ELECTRICAL SPECIALTIES

A. Reel-Mounted Drop Cords

1. Provide Insul-8 1200 Series powereel reels with cord (or equivalent by Woodhead) with length of #12/3-250V cord as determined in field (coordinate with Owner and field conditions). Provide matching heavy-duty NEMA 5-20R (field-verify with Owner) cord-cap receptacle with heavy-duty strain relief.
2. Cord reel shall be white (field-verify with Owner).
3. Provide reel-mounted drop cord units where indicated on the drawings. Field-verify locations with Owner.
4. Connect each reel unit to a separate 20A/1P, 120V GFCI circuit breaker. Wire circuits with separate neutrals for each circuit.
5. Provide cord-ball-stop on drop cord to limit cord return to height above finished slab as directed by Owner.
6. Adjust cord reel to permit maximum extension of receptacle to be 24 inches above floor if so require by AHJ.

B. Electrically Operated Overhead Doors

1. Provide power wiring to motor assembly.
2. Provide local disconnect (and starter if not furnished with door operator) at each motor.
3. Provide identified flush mounted local disconnecting means within sight of each controller location.
4. Install and wire wall mounted control stations.
5. Install and wire associated control, safety and accessory devices.
6. Field-verify locations of switches and controller with Design Professional.

C. Projection Screens

1. Provide power and control wiring to operate each unit.
2. Install/wire flush wall mounted 120V key operated power supply local disconnect switches and provide 120V wiring and connections “downstream” to the wiring in the internal screen junction box and to the low voltage control module. Provide 3-conductor 24V cable (black/red/white) from the low voltage control module to each 24VDC flush wall mounted control switch. Install and wire the control switches.
3. Provide identified flush mounted local disconnecting means within sight of each controller locations.
4. Field-verify locations of switches and controller with Design Professional.

D. Residential Type Washers and Dryers

1. Provide power to washer and dryers. Provide either direct connections or cord & plug connections (including cords, plugs and receptacles) as determined in field.
2. Provide dedicated 20A/1P, 120V circuit and GFCI receptacle for washers.

3. Wherever a residential style dryer power outlet is indicated, provide a flush NEMA 14-30R wall outlet receptacle and matching 30A dryer cord-set 6 feet long and include the connection of this cord-set to the equipment. Provide dedicated 30A/2P circuit.
 4. Note that the washer and dryer may be separate residential type units, or a single stacked washer/dryer unit. Field-verify electrical requirements for the Washer/Dryer equipment with equipment installer prior to rough-in. provide GFCI source breaker if hard-wired connections are required.
 5. If cord & plug dryer vent booster fans are provided by Owner or under Division 23, provide GFCI duplex receptacle near each fan and connect to the 20-ampere/120V laundry circuit that serves the washer.
- E. Residential Type Dishwashers
1. Provide flush wall switch (plate engraved: “Dishwasher”) above counter and provide power wiring and connections. Provide dedicated 120V circuit.
- F. Disposals
1. Provide flush wall switch (plate engraved: “Disposal”) above counter and provide power wiring and connections. Provide dedicated 120V circuit.
- G. Emergency-Power-Off for Kitchen Equipment
1. See detail(s) on drawings.
- H. Turn-Out Gear Washer/Extractor and Similar Equipment
1. Coordinate with Owner prior to commencing with any procurement of materials or roughing in of work to determine exact electrical requirements based on the final selection of equipment made by the Owner. Provide power wiring and connections to equipment and associated accessories. Provide identified stainless-steel local disconnecting means within sight of each.
- I. SCBA Equipment
1. Coordinate with Owner prior to commencing with any procurement of materials or roughing in of work to determine exact electrical requirements based on the final selection of equipment made by the Owner. Provide power wiring and connections to equipment and associated accessories. Provide identified stainless-steel local disconnecting means within sight of each.

PART 3 - EXECUTION – REFER TO APPLICABLE “PRODUCTS” SUB-SECTIONS ABOVE

END OF SECTION 26 0590

SECTION 26 0923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Indoor occupancy sensors.
- B. See Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

1.3 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.

PART 2 - PRODUCTS

2.1 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Current.
 - 2. Leviton Mfg. Company Inc.
 - 3. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 4. Watt Stopper (The).
 - 5. Sensorswitch.
 - 6. Greengate.
- B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
 - 1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.

2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 6. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.
- C. Dual Technology Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
1. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.
 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
 3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot- high ceiling.
- D. Emergency Bypass Relays:
1. Where an emergency power system is available and plans indicate control of emergency lighting via occupancy sensor controls, provide U.L. 924 Listed emergency bypass relay(s) to illuminate emergency lighting from emergency power system during a normal power outage.
- E. Application:
1. Utilize sensor type to best apply to the area it controls (i.e. office, corridor, restrooms, etc.) and provide proper quantity and spacing of sensors to adequately cover the entire area it serves.
 2. Sensors shall be located and adjusted in private office to prevent incidental activation from passerby in hallways or sensor shall utilize 'adaptive' technology to recognize usage patterns and adjust sensitivity.
 3. Provide override switch where indicated on plans to disable operation of sensor and leave lights off.

2.2 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 95 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
- B. After construction period and just prior to turn-over of facility for beneficial use, reset all sensors that are "Adaptive Technology" (or "Smart Technology") to initiate their "learning mode" while in use by the Owner during move-in and beneficial use. Follow up with necessary sensor adjustments within 15 working days.
- C. When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.2 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch.
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.3 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections:
 1. After installing sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 2. Operational Test: Verify operation of each lighting control device, and adjust time delays.
- B. Lighting control devices that fail tests and inspections are defective work.

END OF SECTION 26 0923

SECTION 26 0936 - MODULAR DIMMING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes manual modular dimming controls.

1.2 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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 GENERAL DIMMING DEVICE REQUIREMENTS

- A. Compatibility: Dimming control components shall be compatible with other elements of lighting fixtures, ballasts, transformers, and lighting controls.
- B. Dimmers and Dimmer Modules: Comply with UL 508.
 - 1. Audible Noise and Radio-Frequency Interference Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or radio-frequency interference. Modules shall include integral or external filters to suppress audible noise and radio-frequency interference.
 - 2. Dimmer or Dimmer-Module Rating: Not less than 125 percent of connected load unless otherwise indicated.

2.2 MANUAL MODULAR MULTISCENE DIMMING CONTROLS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Leviton Mfg. Company Inc.
 - 2. Lightolier Controls.
 - 3. Lutron Electronics, Inc.
 - 4. Lehigh, Inc.
- B. Description: Factory-fabricated equipment providing manual modular dimming control consisting of a wall-box-mounted, master-scene controller and indicated number of wall-box zone stations. Controls and dimmers shall be integrated for mounting in one-, two-, or three-

gang wall box under a single wall plate. Each zone station shall be adjustable to indicated number of scenes, which shall be recorded on the zone controller.

- C. Operation: Automatically change variable dimmer settings of indicated number of zones simultaneously from one preset scene to another when a push button is operated.
- D. Each manual modular multiscene dimming controller shall include a master control and remote controls.
- E. Each zone shall be configurable to control the following:
 - 1. Fluorescent lamps with electronic ballasts.
 - 2. Incandescent lamps.
 - 3. Low-voltage incandescent lamps.
- F. Memory: Retain preset scenes through power failures for at least seven days.
- G. Device Plates: Style, material, and color shall comply with Division 26 Section "Wiring Devices."
- H. Master-Scene Controller: Suitable for mounting in a single flush wall box.
 - 1. Switches: Master off, group dim, group bright, and selectors for each scene.
 - 2. LED indicator lights, one associated with each scene switch, and one for the master off switch.
- I. Fluorescent Zone Dimmer: Suitable for operating lighting fixtures and ballasts specified in Division 26 Section "Interior Lighting," and arranged to dim number of scenes indicated for the master-scene controller. Scene selection is at the master-scene controller for setting light levels of each zone associated with scene.
 - 1. Switch: Slider style for setting the light level for each scene.
 - 2. LED indicator lights, one associated with each scene.
 - 3. Electrical Rating: 1000 VA, 120 V minimum or as noted or scheduled on the drawings.
- J. Incandescent Zone Dimmer: Suitable for operating incandescent lamps at line-voltage or low-voltage lamps connected to a transformer and arranged to dim number of scenes indicated for the master-scene controller. Scene selection shall be at the master-scene controller for setting light levels of each zone associated with scene.
 - 1. Switch: Slider style for setting the light level for each scene.
 - 2. LED indicator lights, one associated with each scene.
 - 3. Voltage Regulation: Dimmer shall maintain a constant light level, with no visible flicker, when the source voltage varies plus or minus 2 percent in RMS voltage.

2.3 CONDUCTORS AND CABLES

- A. Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

- B. Class 2 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- E. 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. Comply with requirements in Division 26 Section "Identification for Electrical Systems" for identifying components and power and control wiring.
- B. Label each dimmer module with a unique designation.
- C. Label each scene control button with approved scene description.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Continuity tests of circuits.
 - 2. Operational Test: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.

- a. Include testing of modular dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

- C. Remove and replace malfunctioning modular dimming control components and retest as specified above.

- D. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

- E. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

END OF SECTION

SECTION 26 2213 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.

1.2 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Shop Drawings: Indicate dimensions and weights.
1. Wiring Diagrams: Power, signal, and control wiring.
- C. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- D. Field quality-control test reports.
- E. Operation and maintenance data.

1.3 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. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ACME Electric Corporation; Power Distribution Products Division.
 2. Eaton Electrical Inc.; Cutler-Hammer Products.
 3. Siemens Energy & Automation, Inc.

4. Sola/Hevi-Duty.
5. Square D; Schneider Electric.
6. ABB.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
 1. Internal Coil Connections: Brazed or pressure type.
 2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Provide transformers that are constructed to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Cores: One leg per phase.
- D. Enclosure: Ventilated, NEMA 250, Type 2.
 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- E. Transformer Enclosure Finish: Comply with NEMA 250.
 1. Finish Color: ANSI 49 gray.
- F. Taps for Transformers Smaller Than 3 kVA: One 5 percent tap above normal full capacity.
- G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- I. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 1. Complying with NEMA TP 1, Class 1 efficiency levels.
 2. Tested according to NEMA TP 2.
- J. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
 2. Indicate value of K-factor on transformer nameplate.
- K. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
- L. Wall Brackets: Manufacturer's standard brackets.

2.4 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic nameplate. Nameplates are specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
- B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions and requirements in Division 26 Section "Hangers and Supports for Electrical Systems."
- C. Furnish and install a vibration isolation pad at each corner of each transformer to isolate from structure or support frame. Vibration isolation pads shall be selected for appropriate weight and bearing area; by Mason or B-Line or equal.

3.2 ADJUSTING

- A. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

END OF SECTION 262200

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SECTION 26 2416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes distribution panelboards and lighting and appliance branch-circuit panelboards.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Include evidence of NRTL listing for series rating of installed devices.
 - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- C. Panelboard schedules for installation in panelboards.
- D. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA PB 1.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Flush- and/or surface-mounted cabinets, as indicated on the drawings.
 - 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/Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 4. Directory Card: Inside panelboard door, mounted in transparent card holder.
- B. Incoming Mains Location: Top and/or bottom as Project condition dictates.
- C. Phase, Neutral, and Ground Buses: Hard-drawn copper, 98 percent conductivity.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Main and Neutral Lugs: Mechanical type.
 3. Ground Lugs and Bus Configured Terminators: Mechanical type.
 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.
- F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.
- H. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cutler-Hammer.
 2. Siemens.
 3. Square D.
 4. ABB.
- 2.2 DISTRIBUTION PANELBOARDS
- A. Panelboards: NEMA PB 1, power and feeder distribution type.
 - B. Doors: Secured with vault-type 3 point latch with tumbler lock; keyed alike.
 - C. Mains: Lugs only as identified on the drawings.
 - D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- B. Mains: Circuit breaker and/or lugs only as identified on the drawings. Sized to have 225 amp bussing unless indicated otherwise on drawings.
- C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units. Sized to accommodate 42 poles unless indicated otherwise on drawings. Furnish number of breakers shown.
- D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents listed on the drawings.
 - 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. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
 - 4. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 - 5. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 - 6. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles. Where more than one pole is used, they shall employ a common trip.
 - b. Lugs: Mechanical style, 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. Type HACR for feeding heating, air conditioning and refrigeration equipment.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 - f. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - g. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Receive, inspect, handle, store and install panelboards and accessories according to NEMA PB 1.1.
- B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Mount top of lighting and appliance panelboard trim 72 inches above finished floor; distribution panelboard trim 90 inches above finished floor, unless otherwise indicated.
- D. 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.
- E. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges and ground fault settings as applicable.
- F. Install filler plates in unused spaces.
- G. Stub four 1-inch empty conduits from flush mounted panelboard into accessible ceiling space or space designated to be ceiling space in the future.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.
- I. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads and incorporating Owner's final room, area or equipment designations. Temporary conditions of occupancy shall not be utilized as circuit descriptions. Indicated spare circuits shall be specifically labeled as such. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Panelboards will be considered defective if they do not pass tests and inspections.

END OF SECTION 26 2416

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SECTION 26 2726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Wall-box motion sensors.
 - 3. Snap switches and wall-box dimmers.
 - 4. Solid-state fan speed controls.
 - 5. Wall-switch and interior occupancy sensors.
 - 6. Communications outlets.
- B. See Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
 - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 - 3. Leviton Mfg. Company Inc. (Leviton).
 - 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Legrand).

2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

- a. Cooper; 5351 (single), 5352 (duplex).
- b. Hubbell; 5361 (single), 5362 (duplex).
- c. Leviton; 5351 (single), 5352 (duplex).
- d. Pass & Seymour; 5361 (single), 5362 (duplex).

2.3 GFCI RECEPTACLES

- A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
- B. All receptacles installed outdoors shall be weather resistant type.
- C. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper.
 - b. Pass & Seymour/Legrand.
 - c. Leviton.
 - d. Hubbell.

2.4 TAMPER RESISTANT STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, NEC 406.12 & 517.18(C) and UL 498.
- B. Where indicated on plans to provide Tamper Resistant type receptacle, device shall have non-conductive dual mechanical shutter mechanisms on 120V connection ports, compliant with NEC requirements. This is in addition to required device configuration indicated (ie: Standard Straight Blade, Hospital Grade, GFCI, etc.).

2.5 USB CHARGING TYPE RECEPTACLES

- A. Convenience Receptacles, 125V, 20A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498.
- B. Where indicated on plans to include USB Type Charging ports, device shall include Dual-Port USB Type A-C charging ports with minimum 5 Amps combined charging power (minimum 25 watts), in addition to required device configuration indicated (ie: Standard Straight Blade, Hospital Grade, GFCI, Tamper-resistant, etc.).

2.6 NIGHT LIGHT ACCESSORY

- A. Where indicated on plans to include night light accessory (“NL”), device shall have LED night light, integral with the face of device and photo-sensor for control of night light function. This is in addition to required device configuration indicated (ie: Standard Straight Blade, Hospital Grade, GFCI, Tamper-resistant, etc.).

2.7 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
 - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
- C. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 1995.
 - b. Hubbell; HBL1557.
 - c. Leviton; 1257.
 - d. Pass & Seymour; 1251.

2.8 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, 0-10V, solid-state units with integral, quiet on-off switches. Unit listed and compatible for type of lighting controlled and rated for connected load unless larger rating is indicated for future capacity.
- B. Control: Continuously adjustable slider, with separate on-off switch; single-pole or three-way switching capability. Comply with UL 1472.

2.9 OCCUPANCY SENSORS

- A. Wall-Switch Sensors:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, manufacturer shall match that submitted for ceiling mounted occupancy sensors.
 - 3. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft..

2.10 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: **Nylon**.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.
 - 1. Outdoor receptacle covers shall be “In Use” type rated “Extra Duty”.

2.11 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Round, die-cast aluminum with satin finish.
- D. Power Receptacle: NEMA WD 6 configuration 5-20R, black finish, unless otherwise indicated.
- E. Voice and Data Communication Outlet: As noted on plans or as indicated in applicable specification section.

2.12 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
 - 1. Wiring Devices: White, unless otherwise indicated or required by NFPA 70 or device listing. Switches, receptacles and coverplates for emergency lighting shall match color and type of normal lighting switches.
 - 2. Device plates: Nylon, to match color of wiring devices.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
 - 1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 4. Install wiring devices after all wall preparation, including painting, is complete.
 5. All 15 or 20 amp-120V wiring devices located within 6 feet from the edge of a sink, located in Kitchens or Bathrooms or serving electric water cooler shall be GFCI protected type device.
- C. Conductors:
1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 2. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 3. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted provided the outlet box is large enough.
- D. Device Installation:
1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
 2. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 3. When there is a choice, use side wiring with binding-head screw terminals.
 4. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 5. Tighten unused terminal screws on the device.
- E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Dimmers:
1. Install dimmers within terms of their listing.
 2. Verify that dimmers used for fan speed control are listed for that application.
 3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.2 “PLUG CONNECT/PLUG TAIL” DEVICES

- A. In lieu of terminal screw connected receptacles and switches as specified above, specialized plug-in type devices may be provided as long as it is offered by the same manufacturer and listed equivalent to the same product line specified. Permanent wiring pigtails shall be of sufficient length to enable replacement of device with standard terminal screw type device as required by Code.
- B. Where plug-in type wiring devices are provided, furnish a minimum of five (5) of each type and color device installed to the Owner as spares. Where more than one hundred (100) of any type is installed, provide a minimum of ten (10) spare devices.

3.3 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.

END OF SECTION 26 2726

SECTION 26 2813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Cartridge fuses rated 600-V ac and less for use in, enclosed switches, panelboards, enclosed controllers and motor-control centers.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Cooper Bussman, Inc.
 - 2. Mersen.
 - 3. Littelfuse.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 FUSE APPLICATIONS

- A. Feeders: Class RK1, time delay.
- B. Motor Branch Circuits: Class RK1, time delay.

- C. Other Branch Circuits: Class RK1, time delay.
- D. Control Circuits: Class CC, fast acting.

3.2 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.3 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 and holder.

END OF SECTION 26 2813

SECTION 26 2816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Molded-case circuit breakers (MCCBs).
 - 4. Enclosures.

1.2 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 FUSIBLE/NON-FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cutler-Hammer.
 - 2. Siemens.
 - 3. Square D.
 - 4. ABB.
- B. All starters and disconnect switches shall be of the same manufacturer unless otherwise approved.
- C. Type HD, Heavy Duty, Single Throw, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses specified when so indicated on

the drawings, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. 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. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Suitable for number, size, and conductor material.
5. Service-Rated Switches: Labeled for use as service equipment.

2.2 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cutler-Hammer.
2. ABB.
3. Siemens.
4. Square D.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. 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.

D. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Suitable for number, size, trip ratings, and conductor material.
3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
4. 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.
5. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.

2.3 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. Kitchen/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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at 6'-0" A.F.F. unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Install fuses in fusible devices.
- D. Coordinate location of devices to allow working clearances and to avoid interference with other equipment and trades.
- E. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each enclosure with engraved laminated-plastic nameplate.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

END OF SECTION 262816

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SECTION 26 2913 - ENCLOSED MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:
 - 1. Across-the-line, manual and magnetic controllers.
 - 2. Multispeed controllers.
- B. Refer to “Disconnect Switches” section for switch requirements.

1.2 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100.
- B. Comply with NFPA 70.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.
- D. Motor starters and disconnects shall be manufactured and rated in accordance with NEMA, UL and IEEE Standards. IEC rated contactors and overloads are not acceptable.

1.3 COORDINATION

- A. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
- B. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Allen-Bradley Co (Bulletin 509)
 - 2. Cutler-Hammer (Class AN16).

3. Siemens (Class 14).
4. Square D Type S (Class 8536).
5. ABB.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

- A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED." Manual Controllers furnished for fractional horsepower, single phase motors unless otherwise indicated on plans.
 1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.
- B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated. Provide Magnetic Controllers on all motors one horsepower and greater or any 3 phase motor, unless indicated otherwise on plans.
 1. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity. Provide fusing on control transformer primary and secondary, each phase, and grounded on the secondary.
 2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
 3. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 30 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
- C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.
 1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL. Provide fusible disconnect only where specifically indicated on the drawings or where required by Code.
 2. Nonfusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.
 3. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

2.3 MULTISPEED ENCLOSED CONTROLLERS

- A. Multispeed Enclosed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:

1. Compelling relay to ensure that motor will start only at low speed.
2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
3. Decelerating relay to ensure automatically timed deceleration through each speed.

2.4 ENCLOSURES

- A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated.
 1. Outdoor Locations: NEMA 250, Type 3R.

2.5 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, LED Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
- C. A Hand-Off-Auto selector switch shall be mounted in the face of each starter enclosure. The selector switch shall be so wired that when it is in the Hand or Auto position, all safety controls are wired in series with the selector switch. All control devices shall be wired in the Auto position only.
- D. Provide a green LED pilot light mounted in the face of enclosure. Wire pilot light so that light will be on when motor is energized.
- E. Provide a red LED pilot light mounted in the face of enclosure. Wire pilot light so that light will be on when starter power supply is energized.
- F. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock control circuit open.
- G. Control Relays: Auxiliary and adjustable time-delay relays. Provide adjustable 0-60 second “on” time delay relay on starters where indicated on drawings and wire into the “Auto” position of the selector switch to delay starting.
- H. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting. Provide on all 3 phase motor starters 5 HP and larger; wire ahead of the H-O-A switch.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

3.2 INSTALLATION

- A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide floor set unistrut frame to mount adjacent to equipment being controlled. Allow proper service clearances to equipment.
- B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

3.3 IDENTIFICATION

- A. Identify enclosed controller, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.4 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Bundle, train, and support wiring in enclosures.
- B. Install all other control and interlock wiring in the field that cannot be factory pre-wired and is indicated on the plans or other specification sections as wired by the Electrical Contractor.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 - 2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
 - 3. Test electrical phase rotation of 3-phase supply feeders.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Correct malfunctioning units and retest to demonstrate compliance; otherwise, replace with new units and retest.

END OF SECTION 26 2913

SECTION 26 31 00 PHOTOVOLTAIC MODULES

PART 1 - GENERAL

1.1 SUMMARY

- A. Photovoltaic (PV) inverter modules.
- B. Rapid Shutdown System
- C. Accessories and Other Devices

1.2 RELATED SECTIONS

- A. Section 26 33 00 – Inverters

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's data sheets for each PV module type.
 - 2. Electrical characteristics including peak power, voltage, current, efficiency, and temperature characteristics.
- B. Shop Drawings:
 - 1. Layout of PV modules.
 - 2. PV module stringing.
- C. Warranty
- D. Test Reports:
 - 1. Results from factory performance test.

1.4 QUALITY ASSURANCE

- A. IEC 61215 – Crystalline Silicon Terrestrial Photovoltaic (PV) Modules – Design Qualification and Type Approval.
- B. IEC 61730 – Photovoltaic (PV) Module Safety Qualification
- C. UL 61730-1 & UL 61730-2
- D. Comply with NFPA 70.

1.5 WARRANTY

- A. Provide a manufacturer’s warranty for a period of 25 years from the date of installation.

PART 2 - PRODUCTS

2.1 PHOTOVOLTAIC MODULE MANUFACTURERS:

- A. Jinko – Basis of Design #JKM580N-72HL4-BDV
- B. Q.Cell
- C. REC
- D. Silfab

2.2 ELECTRICAL CHARACTERISTICS

- A. Refer to schedule on drawings for electrical characteristics.
- B. MC4 connectors.
- C. Maximum Series Voltage: 1500 VDC
- D. Maximum Series Fuse Rating: 30A

2.3 PHYSICAL CHARACTERISTICS

- A. Refer to schedule on drawings for physical dimensions and weight.
- B. No. of Cells: 144 (2 x 72)
- C. Front Glass: Anti-Reflection Coating, 2.0 mm
- D. Back Glass: Heat Strengthened Glass, 2.0 mm
- E. Frame: Anodized Aluminum Alloy

2.4 ENVIRONMENTAL CONDITIONS

- A. Performance based on Standard Temperature Conditions (STC).
 - 1. Minimum Temperature: -25 Deg. Celsius
 - 2. Maximum Temperature: 50 Deg. Celsius
- B. Operating Temperatures: -40 Deg. C to 85 Deg. C.
- C. Wind Pressure Rating: 2400 Pa
- D. Snow Pressure Rating: 5000 Pa
- E. Hailstone Test: 45mm Hailstone at 30.7 m/s (meters per second).

2.5 MOUNTING SYSTEM

- A. Type: Carport mounted system
- B. Material: Galvanized Steel or Aluminum.
- C. Capable of anchoring panel frame to carport structure.

2.6 RAPID SHUTDOWN DEVICES

- A. MANUFACTURERS
 - 1. AP Smart
 - 2. Tigo
 - 3. SMA
- B. Capable of performing a rapid shutdown to lower array voltage within the specified limits of NFPA 70 690.12.
- C. Refer to schedule on drawings for electrical data.
- D. Connector Type: MC4.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install Photovoltaic Modules per manufacturer's recommendation.
- B. Secure photovoltaic panels at 4 points on panel frame, two per side, to carport manufacturer's structure. Coordinate final connection point and type with carport manufacturer.
- C. String modules per single line diagram. Secure stringing wire to carport structure utilizing J-Hooks. Strings shall not hang free from structure.
- D. Provide all required components and accessories to ground the PV array modules. This includes any jumpers, grounding wiring, grounding rods, etc. Refer to electric specifications for additional information.
- E. Test all photovoltaic modules before installation. Verify unit performance. Replace any panels that are defective.
- F. Clean all photovoltaic modules upon completion of installation with water spray.
- G. Install rapid shutdown devices to all photovoltaic modules. Secure device to photovoltaic module frame per manufacturer's instructions.

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SECTION 26 33 00 PHOTOVOLTAIC INVERTERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Photovoltaic (PV) inverter modules.
- B. Accessories and related components.

1.2 RELATED SECTIONS

- A. Section 26 31 00 – Photovoltaic Modules
- B. Section 26 05 33 – Raceways and Boxes for Electrical Systems

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's data sheets for each inverter type. Includes electrical characteristics including power ratings, voltage, current, and efficiency.
- B. Shop Drawings:
 - 1. Layout of inverter modules.
 - 2. Wiring diagrams.
- C. Warranty
- D. Test Reports:
 - 1. Results from factory performance test.

1.4 QUALITY ASSURANCE

- A. IEEE 1547 – Standard for Interconnecting Distributed Resources with Electric Power Systems.
- B. IEC 62109 – Safety of Power Converters for Use in Photovoltaic Power Systems
- C. UL 1741 – Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources.
- D. Comply with NFPA 70.

1.5 WARRANTY

- A. Provide a manufacturer’s standard 10 year product warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Yaskawa-Solectria – PVI-60TL
- B. Sungrow – SG60CX
- C. SMA – Core1

2.2 ELECTRICAL CHARACTERISTICS

- A. Refer to schedule on drawings for AC & DC electrical requirements.
- B. Maximum AC/DC Ratio: 1.50.
- C. Maximum Power Point Trackers: 3
 - 1. Inputs per Tracker: 5.

2.3 EFFICIENCY

- A. Minimum Efficiency: 98%
- B. TARE Loss: Less than 1W.

2.4 ENVIRONMENTAL

- A. Operational Temperature Range: -22 Deg. F. to 140 Deg. F.
- B. Relative Humidity: 0-100% (Non Condensing)

2.5 COMMUNICATIONS

- A. Web Based Monitoring Platform: SolrenView
 - 1. Provide cloud-based gateway controller to connect inverter to web-based monitoring platform.
- B. Communication Interface: RS-485

2.6 SMART GRID FEATURES

- A. Volt-Ride Thru
- B. Freq-Ride Thru
- C. Ramp-Rate
- D. Specified-PF
- E. Volt-Var

- F. Freq-Watt
- G. Volt-Watt
- H. Watt- Var

2.7 WEB BASED MONITORING PLATFORM

- A. Provide an inverter manufacturer’s web-based monitoring platform and all required accessories to setup monitoring platform.

2.8 ACCESSORIES

- A. AC and DC Disconnect Switches.
- B. Wire Box:
 - 1. 20A MC4 string connections.
 - 2. Integrated rapid shutdown control.
- C. Weather station which monitors solar irradiance, wind speed, temperature, and wind direction.

PART 3 - EXECUTION

3.1 INVERTER INSTALLATION

- A. Equipment Mounting: Install inverter per manufacturer’s instructions on carport vertical beam utilizing Unistrut framing.
- B. Maintain manufacturer’s recommended service clearances.
- C. Install all accessories not factory installed.
- D. Connect inverter monitoring platform facility internet. Coordinate location with owner IT department to connect inverter to internet. Coordinate with owner project manager to setup platform account. Provide owner with 1 year subscription.

3.2 ELECTRICAL INSTALLATION

- A. Connect all wiring in accordance with the approved wiring diagram.
- B. Utilize MC4 connectors on all PV string connections to wirebox.
- C. Install and wire all weather station components to the carport.
- D. Ensure proper grounding of the inverter.

3.3 STARTUP

A. Inspection:

1. Inspect inverter for damage or defects.
2. Verify AC & DC disconnect switches are functional.

B. Inverter Commissioning

1. Follow manufacturers commissioning steps provided in the IOM manual.
2. Provide all required programming and software updates.
3. Verify performance and compliance of Rapid Shutdown System.

C. Report:

1. Provide final inverter startup report.

SECTION 26 3213 – STAND-BY POWER SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. The Stand-by Power System, including Automatic Transfer Switches, shall be pre-purchased directly by City of Dayton and installed/wired by the awarded Electrical Contractor. The Stand-by System shall be delivered to the project site. The Electrical Contractor shall be responsible for offloading the Stand-by System and setting in place.
- B. Provide a standby power system to supply electrical power in event of failure of normal supply consisting of a liquid cooled engine, an AC alternator with main breaker and system controls, fuel system including fuel tank and piping, exhaust system with muffler and piping and cooling system. Refer to the drawings for capacities and electrical characteristics.
- C. Rating indicated on the drawings is for standby service with 100 hours or less per year operating time.
- D. The electric generating system, consisting of a prime mover, generator, governor, coupling and all controls, must have been tested as a complete unit, on a representative engineering prototype model of the equipment to be sold.
- E. See Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.
- F. See Division 26 Section "Generator Docking Station" for exterior portable connection station including relays to initiate automatic-starting and stopping signals for portable engine-generator sets.
- G. Manufacturer shall provide startup services, operational load test and demonstration to Owner as outlined in Parts 3.1, 3.2 and 3.3.

1.2 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 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with ASME B15.1.
- E. Comply with NFPA 37.

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- F. Comply with NFPA 70.
- G. Comply with NFPA 99.
- H. Comply with NFPA 101.
- I. Comply with NFPA 110 requirements for Level 2 emergency power supply system.
- J. Comply with UL 2200, package unit shall be listed and labeled.
- K. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
- L. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.3 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 2 year(s) from date of Beneficial Use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The generator set shall be of standard design with complete factory assembly by Caterpillar, Cummins-Onan or Kohler.

2.2 ENGINE-GENERATOR SET

- A. The engine set shall be diesel fueled, four cycle for heavy duty industrial application, rated to deliver the specified capacity at an ambient temperature of 104 degrees F (40 degrees C), and an elevation of 1000 ft. above sea level. Engine shall develop approximately 1.5 HP for each KW of generator, after deducting the HP required for the unit mounted fan and pump operation. Maximum speed at rating – 1800 RPM, ratings shall be those in standard published curves and data. Special test ratings for non-standard products will not be acceptable. Engine shall incorporate all standard equipment including:
 - 1. Liquid cooling radiator, engine mounted, with engine driven fan, duct flange and fan guard; engine driven water pump and closed coolant recovery system providing visual diagnostics means to determine if the system is operating with normal coolant level. The radiator shall be designed for operation in 110 degrees F ambient temperature.
 - 2. Engine mounted intake air filter(s) with replaceable element.

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3. Full pressure engine lubrication supplied by a positive displacement lube oil pump. Engine shall have a replaceable filter with internal bypass and replaceable elements.
4. Provide engine coolant and oil drain extensions to outside of the mounting base for cleaner and more convenient engine servicing.
5. The engine fuel system shall be designed for operation on No. 2 diesel fuel. A secondary fuel filter, water separator, manual fuel priming pump, fuel shutoff solenoid and all fuel lines must be installed at the point of manufacture.
6. Sensing elements shall be located on the engine for low oil pressure shutdown, high coolant temperature shutdown, low coolant level shutdown, over speed shutdown and over crank shutdown. These sensors are to be connected to the control panel using a wiring harness with the following features: wire number labeling on each end of the wire run for easy identification, a molded rubber boot to cover the electrical connection on each sensor to prevent corrosion and all wiring to be run in flexible conduit for protection from the environment and any moving objects.
7. Steel base for engine-generator with adjustable spring type vibration isolators.
8. Electronic governor capable of maintaining alternator frequency within 0.5% from no load to full load alternator output. Steady state regulation is to be 0.25% (Woodward 2301 Electro-Hydraulic governing system or equal by Barber-Coleman.)
9. Electric jacket water (block) heater(s) with 120 or 208 volt power source; each thermostatically controlled and used to aid in quick starting.

2.3 OVERCURRENT PROTECTION, INSTRUMENTATION AND ALARMS

- A. The Main Line Breaker shall be molded case solid state-electronic trip, 100% rated type for load circuit breaking and line protection. Breaker shall be sized for minimum 115 to 125% full capacity of generator output. Generator exciter field circuit breakers are not acceptable substitute.
- B. Control instruments and alarms (NFPA-110) shall be microprocessor based and shall be mounted in an engine mounted control panel and shall include the following:
 1. Oil pressure gauge and alarm light (pressure gauge can mount on engine).
 2. Water temperature gauge with high temperature alarm light (temperature gauge can mount on engine).
 3. Running time meter.
 4. Voltmeter with selector switch, phase to phase, phase to neutral and off.
 5. Ammeter with selector switch, each line and off.
 6. Frequency meter.
 7. Battery charging ammeter.
 8. Over speed shut down alarm light.
 9. Unit auto-run-stop with remote start from automatic transfer switch.

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10. Voltage level adjustment rheostat (can mount on engine).
 11. Safety shut offs for high water temperature, low oil pressure, over speed and engine over crank; fault light and alarm contact for each.
 12. Means for remote shutdown of generator per NEC 445.18(B) (provide maintained contact emergency stop button and means to wire button to unit).
 13. Alarm light for main storage tank low fuel level.
 14. Alarm light for intertank leak detection for main belly tank.
 15. Indication of all alarms required by NFPA 110; include provisions for remote annunciation.
 16. Main line circuit breaker(s) Circuit breaker(s) shall have means to lock in the open position per NEC .
 17. Relay with normally closed contact for damper control.
 18. Manual/off/auto switch; four LED's to indicate: not in auto, alarm active, generator running, generator ready.
 19. Provide monitoring of generator start signal control wiring, to provide audible and visual annunciation, as well as start generator, upon loss of start circuit integrity.
- C. Flush mounted remote annunciator(s) of all alarms required by NFPA 110; locate the annunciator(s) as shown on the floor plans. Include red and green lamps indicating position of each automatic transfer switch.

2.4 GENERATOR FEATURES

- A. Features include the following:
1. The AC generator shall be synchronous, four pole, optimum pitch, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan and directly connected to the engine with flexible drive disc or flexible steel coupling – provide guard.
 2. Consult tank manufacturers about capacities available for size of set in Project.
 3. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 130 degrees Centigrade.
 4. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5% above or below rated voltage.
 5. Determine applicable codes and regulations, and coordinate subparagraph below with Drawings.

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6. Design and construction conforming to NEMA, AIEE and ASA standards.
7. Static excited and static regulated, 12 lead brushless revolving field.
8. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.
9. Voltage regulation plus or minus 1%.
10. Radio interference suppression.
11. Capability to assume rated load in one step with less than 15% transient voltage dip with normal voltage recovery in one second.
12. Power factor 0.8; at 60 Hz.
13. For generator size with output greater than 400 Amps, provide isolated bus bar on each phase and neutral for landing the lugs on the outgoing feeder; oversize termination box on generator to meet NEC wire bending radius and space for bus bars and cable terminations.

2.5 ACCESSORIES AND WEATHERPROOF HOUSING

A. Furnish and connect the following engine accessories:

1. Heavy duty 12 volt or 24 volt lead acid starting batteries and charger. Battery charger shall be heavy duty potted assembly for waterproof and vibration resistance, designed for operation with an engine cranking battery. Universal voltage input with cord and plug connection and multi-stage charging modes of operation. The battery shall not be discharged through the battery charger.
2. Flexible stainless steel exhaust connection for each exhaust outlet.
3. Critical type exhaust silencer, Maxim #M51 or equal by Burgess, EM Products Inc., Universal "ENS", York "Y4" or Cowl. Provide crossover manifold where engine has more than one exhaust outlet. Provide ventilated roof/wall thimble to accommodate exhaust piping.

B. Sub-base mounted fuel oil tank shall be double wall constructed of steel plate of thickness required by applicable standards and shall be UL listed and constructed per NFPA requirements.

1. Tank shall include necessary vent, fill, fuel level gauge, supply and return openings, piping and accessories. Provide vent line to outside with approved cast iron screened rain shield; must be installed with proper clearance from all building openings.
2. Tank shall meet State of Ohio Fire Marshal requirements for venting, fuel fill spill containment, overfill protection, tank alarm, signage and associated specific requirements.

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3. Tank capacity shall be sized for 24 hour run-time at 80% load capacity at a minimum.
 4. Provide an intertank leak detector and alarm contact; connect alarm contact to control panel for local and remote annunciation.
 5. Provide fuel level gauge with alarm contacts; connect alarm contacts to control panel for local and remote annunciation.
 6. Base tank shall be fabricated separately from the base; after fabrication, tank shall be bolted to its base to form a complete unit that mates to the generator skid. Base tank shall not interfere with access to engine and generator for maintenance and shall be mounted to allow minimum 2 inches air space between bottom of tank and concrete pad.
 7. Complete assembly shall be prime and finish painted to match color of engine generator set.
 8. Generator sub-base mounted fuel tanks shall be provided with vehicular barrier protection on all sides of the tank subject to vehicular damage; located minimum 3 feet from edge of tank and minimum 3 feet tall above grade.
- C. Provide a factory installed weather protective type sound attenuating (75 db at 7 meters) housing around generator for outdoor installation (Skin-Tight Enclosure). Standard features associated with housing shall be as follows:
1. Hinged and removable side and rear panels for easy access to generator set.
 2. Vertical outlet hoods with 90 degree angles and baffles or turning vanes to redirect air and reduce noise; UL 94 HF1 listed acoustic insulation for flame resistant standards.
 3. Louvers on both the generator air intake and radiator air discharge ends for cooling; to prevent rain and snow entry.
 4. Lockable latches on each removable or hinged panel; all parts of latches and hinges and mounting hardware shall be stainless steel.
 5. Rugged galvanized steel or aluminum construction; painted with accepted manufacturer's painting process. Skid mounted. Color selected by Architect/Engineer.
 6. Battery rack.
 7. Insulated critical rated silencer with tail pipe and rain cap; mount silencer inside generator enclosure.
 8. Rodent barriers and insect screens over all openings including louvered openings.

2.6 SUBMITTALS

- A. Equipment supplier shall submit for approval with shop drawings, recommended fuel piping diagram, interconnection diagram showing all controls and alarms. Dimensioned drawings of the complete generator assembly including floor/isolation pad, isolators, main breaker location

and lug size, exhaust connections, inlet/exhaust shrouds, required clearances, exhaust assembly, batteries and rack, etc. Shop drawings submitted without all required information will be rejected. At the completion of the project, these drawings shall be included as part of the maintenance manuals, these drawings shall be specific to the actual project installation and shall not be standard manufacturer model drawings.

- B. Standard color chips shall be submitted with shop drawings for color selection by the Architect and Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION (Performed by Electrical Contractor)

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110. Confirm installation will allow full access, without removing connections or accessories, for periodic maintenance.
- B. Secure necessary permits and inspections from the Authority Having Jurisdiction for the installation of Aboveground Fuel Storage Tank(s) that comply with Ohio Administrative Code 1301, Ohio Fire Code, NFPA 30 & 30A as applicable. Provide a copy of approval documentation of tank(s) installation to the Inspection Agency prior to installation and notify the Fire Marshal when ready for inspection for compliance with Ohio Fire Code when applicable.
- C. Install packaged engine generator on 12" high steel reinforced concrete base (see seismic sentence below for base pad required sizing) with adjustable spring-type vibration dampeners or factory installed isolators between engine and skid. Bolt firmly to foundation. Where seismic restraint requirements are noted, the concrete base thickness and dimensions shall be either as recommended by the engine-generator manufacturer or as designed by the contractors retained specialty seismic consultant.
- D. Make external connections to generator and engine thru flexible connections.
- E. Connect auxiliary systems all in accordance with manufacturer's specific instructions for automatic and manual operation.
- F. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems." Neutral shall not be bonded to generator. Bonding of neutral and ground is accomplished in main switchgear. Provide signs at service entrance location and at grounding location per NEC 700.8.
- G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Furnish and install all control wiring and interlocking between the engine-generator, generator control panel, automatic transfer switch, day tank, rupture tank, fuel gauge for belly tank, remote annunciator, remote stop button (located adjacent to ATS's), damper control, auxiliary systems, etc.

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- H. Fill radiator and cooling system with the necessary solution of ethylene glycol, additives and water for freeze and engine component/cooling system protection as recommended by the manufacturer. Provide freeze protection rated to -40 degrees F.

3.2 FIELD QUALITY CONTROL (Performed by Electrical Contractor)

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections prior to start-up and to assist in testing.
- B. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- C. Operational Test: After electrical circuitry has been energized, start unit(s) to confirm proper motor rotation and unit operation.
- D. Coordinate tests with tests for automatic transfer switches and run them concurrently.
- E. Operational/Load Test:
 - 1. Adjust, test and demonstrate proper operation of the system after installation. Test shall demonstrate automatic operation, transfer, quick start and a minimum of 2 hours endurance under not less than 50% load, with not less than 4 hours at full load. Provide a resistance load bank for the test and all necessary temporary cabling, etc. Coordinate location of load bank with Owner and other trades to ensure safe operation of systems and protection of surrounding areas. Engineer/Associate Architect may require extended test time if system is deemed suspect.
 - 2. Engine-generator system shall pick up full load in less than 10 seconds.
- F. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- G. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. The supplier shall furnish a certified full load test certificate verifying that the generator has been tested prior to delivery and found to be in satisfactory working condition under test loads.
- H. All fuel piping, and base mounted fuel tanks shall be tested after installation and before filling with fuel. Tests shall comply with Ohio Administrative Code, Chapter 13.
- I. The Electrical Contractor shall provide fuel for testing and top off the tank after completing all tests and demonstrations.
- J. Provide sign at the service entrance indicating type and location of on-site legally required standby power sources per NEC 701.7(A). Coordinate with Authority Having Jurisdiction (AHJ).

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3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators, allow a minimum of 4 hours for training.

END OF SECTION 26 3213

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SECTION 26 3623 – AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes automatic transfer switches rated 600 V and less.
- B. The Automatic Transfer Switch shall be furnished as a part of the complete package from the Standby Power System and shall be installed/wired by the Electrical Contractor.

1.2 GENERAL

- A. Furnish and install Service Entrance Rated, electrically operated automatic switch to transfer loads to standby system upon failure of main source of electricity. Unit shall be complete with accessories in NEMA 1 enclosure as shown on the drawings.
- B. Switch shall be enclosed contact power switching unit with overcurrent protection (insulated case circuit breaker) on the utility side and insulated case switching unit on generator side.
- C. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based. Provided by Seismic Engineer based on site conditions and installation.

1.3 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. Comply with NEMA ICS 1.
- C. Comply with NFPA 70.

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- D. Comply with NFPA 99.
- E. Comply with NFPA 110.
- F. Comply with UL 1008 unless requirements of these Specifications are stricter.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Kohler, Cummins or Caterpillar. **400 Amps-480Y/277V-3Ph-4W.**

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated 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.
- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the available fault conditions indicated on the drawings, based on testing according to UL 1008.
- C. Microprocessor Controls: Microprocessor based controller with Control and Display Panel mounted on face of door, panel shall have LED source and switch indication lights and membrane interface panel for test and time delay bypass controls.
- D. 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.
- E. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. Utility Breaker shall be 100% rated with electronic trip overcurrent protection.
 - 2. Generator Switch shall be 100% rated.
 - 3. Switch shall have service disconnect(s), padlockable in the "off" position.
- G. Neutral Terminal: Solid and fully rated with lugs, unless otherwise indicated.
- H. Enclosures: General-purpose NEMA 250, Type 1 complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

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2.3 FEATURES AND ACCESSORIES

- 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. Signal-Before-Transfer Contacts: Three sets of normally open/normally closed dry contacts (rated 3 amps at 480 volts AC) operates in advance of retransfer to normal source (and in advance of transfer to emergency source when in auto and test mode). Timer intervals adjustable from 0 to 20 seconds for transfer in either direction and independently adjustable/programmable.
- D. Transfer Switches Based on Insulated-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.
- E. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated.
- F. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer.
- G. Features:
 - 1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
 - 2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
 - 3. Current Sensors for each phase and neutral of Load Source: Sensors shall be wired to LCD display to allow reading of current for each phase as well as RMS summary load.
 - 4. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
 - 5. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 15 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
 - 6. Test Switch: To simulate normal-source failure.
 - 7. Switch-Position Pilot Lights: Indicate source to which load is connected.
 - 8. Switch in Disconnect Pilot Lights/aux contacts: Indicate that switch is off and contacts to signal to BAS that service/switch is disabled.
 - 9. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

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- a. Normal Power Supervision: Green light with nameplate indicating "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate indicating "Emergency Source Available."
- 10. All pilot/indication lights shall be LED type for long life.
 - 11. Unassigned Auxiliary Contacts: Two normally open/normally closed, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
 - 12. Load Priority/Shed Control and Contacts: For setting (programming) of priority level of transfer switch(es) where more than one transfer switch is connected to emergency/standby power source. Priority 1 Transfer Switch (Life-Safety) shall be first to transfer to emergency source and last to disconnect from emergency source upon return of normal power. Load shed signal(s) shall originate from the generator controller.
 - 13. Terminal provisions for connection of remote test and serial communications port for remote monitoring/annunciation.
 - 14. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
 - 15. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
 - 16. Engine-Generator Exerciser: Microprocessor based, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 14 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - b. Push-button programming control with digital display of settings.
 - c. Integral battery operation of time switch when normal control power is not available.

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.

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PART 3 - EXECUTION

3.1 INSTALLATION (Performed by Electrical Contractor)

- A. Utilize each fastener and support to carry load indicated by seismic design requirements and according to seismic-restraint details as required by Seismic Design Engineer. See Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Floor Mounted Switch: Anchor to concrete base by bolting.
 - 1. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."
- C. Identify components according to Division 26 Section "Identification for Electrical Systems."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS (Performed by Electrical Contractor)

- 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."
 - 1. Connect automatic transfer switch(es) to initiate cranking of the emergency generator and to provide remote indication where specified or indicated on the drawings. Include installation of all wire and conduit associated with each automatic transfer switch.
 - 2. Connect automatic transfer switch (auxiliary contact) to Solar PV System Master Controller to signal that building is on generator power and to disable PV System.

3.3 FIELD QUALITY CONTROL (Included with Pre-Purchase Package)

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Coordinate tests with tests of generator and run them concurrently.
- C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- D. Remove and replace malfunctioning units and retest as specified above.

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3.4 WARRANTY

- A. Provide 5-year extended warranty (Parts and Labor). Provide the certificate directly to the Owner accompanied by a letter of transmittal. Provide a copy to the Architect/Engineer with shop drawings.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switch(es) and related standby equipment.

END OF SECTION 263601

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SECTION 26 3630 – GENERATOR DOCKING STATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes automatic transfer switches rated 600 V and less.
- B. The Generator Docking Station shall be furnished installed/wired by the Electrical Contractor.

1.2 GENERAL

- A. Furnish and install Service Entrance Rated, electrically operated automatic switch to transfer loads to standby system upon failure of main source of electricity. Unit shall be complete with accessories in NEMA 1 enclosure as shown on the drawings.
- B. Switch shall be enclosed contact power switching unit with overcurrent protection (insulated case circuit breaker) on the utility side and insulated case switching unit on generator side.
- C. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based. Provided by Seismic Engineer based on site conditions and installation.

1.3 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. Comply with NEMA ICS 1.
- C. Comply with NFPA 70.

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- D. Comply with NFPA 99.
- E. Comply with NFPA 110.
- F. Comply with UL 1008 unless requirements of these Specifications are stricter.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Trystar, Gus Berthold Electric or ESL.

2.2 GENERATOR DOCKING STATION GENERAL REQUIREMENTS

- A. Docking Station Ampacity-Voltage requirements shall be as indicated on the drawings.
- B. Enclosure shall be UL 1008 Listed, NEMA 3R rated with multiple single or 3-point latching and locking provisions, Factory applied finish in ANSI #61 Medium Light Grey. UL listed acrylic baked paint finish over a rust-inhibiting, corrosion-resistant primer on treated metal surface.
- C. Station shall have auxiliary contacts for remote monitoring of switch position and contacts for connection of engine start signal wiring (field wired to associated A.T.S. by E.C.).
- D. Station shall have provisions for Camlock cable connections. Spring-loaded or latching hinged flap for cable entry.
- E. Where switch utilizes manual, double-throw action to transfer load, means shall be available to padlock switch in all positions.

2.3 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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Utilize each fastener and support to carry load indicated by seismic design requirements and according to seismic-restraint details as required by Seismic Design Engineer. See Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

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- B. Wall Mounted Switch: Anchor to exterior wall per Manufacturer's requirements and per the requirements of Section 26 0529.
- C. Floor Mounted Switch: Anchor to concrete base by bolting.
 - 1. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."
- D. Identify components according to Division 26 Section "Identification for Electrical Systems."

3.2 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."
 - 1. Extend start signal wiring from automatic transfer switch to initiate cranking of the portable generator and to provide remote indication where specified or indicated on the drawings. Include installation of all wire and conduit associated with each automatic transfer switch.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Coordinate tests with tests of generator and run them concurrently.
- C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- D. Remove and replace malfunctioning units and retest as specified above.

3.4 WARRANTY

- A. Provide 5-year extended warranty (Parts and Labor). Provide the certificate directly to the Owner accompanied by a letter of transmittal. Provide a copy to the Architect/Engineer with shop drawings.

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3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain Docking Station and related standby equipment.

END OF SECTION 26 3630

SECTION 26 4313 – SURGE PROTECTIVE DEVICES (SPD) FOR LOW-VOLTAGE ELECTRICAL
POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes SPD's for low-voltage power equipment.

1.2 QUALITY ASSURANCE

- A. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer. The manufacturer shall have been engaged in the manufacture of SPD products specified and products shall have been in satisfactory service for not less than 5 years.
- B. 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.
- C. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."
- D. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices."
- E. Comply with UL 1283 5th Edition, "Electromagnetic Interference Filters," and UL 1449 3rd Edition, "Surge Protective Devices."

1.3 PROJECT CONDITIONS

- A. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
 - 2. Operating Temperature: 30 to 120 deg F.
 - 3. Humidity: 0 to 85 percent, non-condensing.
 - 4. Altitude: Less than 20,000 feet above sea level.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advanced Protection Technologies, Inc. (ASCO)
2. Current Technology, Inc. (ABB)
3. Cutler-Hammer, Inc. (Clipper)
4. Liebert Corporation.
5. Thor Systems, Inc.
6. Siemens Energy & Automation, Inc.
7. Square D.
8. LEA International.

2.2 SERVICE ENTRANCE SUPPRESSORS

- A. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:
 1. LED indicator lights for power and protection status.
 2. Audible alarm, with silencing switch, to indicate when protection has failed.
 3. Fuses/circuit breaker, rated at 200-kA interrupting capacity.
 4. Integral disconnect switch or circuit breaker to isolate entire suppressor components for repair/replacement.
 5. Redundant suppression circuits.
 6. Surge-event operations counter.
- B. Peak Single-Impulse Surge Current Rating: 150kA per mode (300 kA per phase).
- C. Connection Means: Permanently wired.
- D. SPD and overcurrent/disconnect device shall have a short circuit current rating greater than that available on the electrical system.
- E. Protection modes and UL 1449 voltage protection rating compatible with system voltage and configuration as indicated on the drawings for complete protection as follows:
 1. Line to Neutral.
 2. Line to Ground.
 3. Neutral to Ground.

2.3 PANELBOARD SUPPRESSORS

- A. Same characteristics and requirements as service entrance suppressors with the following exceptions:
- B. Surge-event operations counter not required.
- C. Peak Single-Impulse Surge Current Rating: 65kA per mode (130 kA per phase).

2.4 ENCLOSURES

- A. NEMA 250 (or better), with type matching the enclosure of panel or device being protected.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTION DEVICES

- A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.
- B. Install devices for panelboard and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible (not to exceed 18 inches). Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground. Twist input conductors together to reduce system inductance.
 - 1. Provide multipole circuit breaker or fusible disconnect switch as a dedicated disconnect for suppressor, fuse size and type as recommended by SPD manufacturer.

3.2 PLACING SYSTEM INTO SERVICE

- A. Do not energize or connect service equipment to their sources until surge protection devices are installed and connected.

3.3 FIELD QUALITY CONTROL

- A. Testing: Perform the following field tests and inspections and document on test reports:
 - 1. Complete startup checks according to manufacturer's written instructions.

END OF SECTION 26 4313

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SECTION 26 5113 - INTERIOR LIGHTING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Interior lighting fixtures, light engines (LED's) and drivers.
 - 2. Emergency lighting units.
 - 3. Exit signs.
 - 4. Lighting fixture supports.
- B. See Division 26 Section "Wiring Devices" for manual wall-box dimmers for LED fixtures or lamps.
- C. See Division 26 Section "Lighting Control Devices" for automatic control of lighting, including occupancy sensors, and multi-pole lighting relays and contactors.

1.2 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes and photometric data.
- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
- C. LED Fixtures: Fixtures with LED light source are noted on lighting fixture schedule with advertised lumen output of light source for fixture/manufacturer specified and color temperature. Listed equal manufacturer shall provide fixture with equivalent lumen output as listed product. If insufficient information is provided, the Engineer may require Project Specific, point-by-point photometric calculations of sample areas utilizing the submitted fixture to prove equivalent performance.
- D. Product Certificates: For each type of driver, signed by product manufacturer.
- E. Utility Company Energy Rebate Programs
 - 1. LED lighting fixtures shall be Energy Star or DLC listed to comply with local Utility Company Rebate Programs. Does not apply to track lighting fixtures. Fixture submittals that do not have either of these listings clearly indicated in the product data shall be rejected.
- F. Field quality-control test reports.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. All LED fixtures and components shall be tested and comply under the standards of IESNA LM-79-08, LM-80-08, LM-82-12 and TM-21-11 for measurement and publication of projected long term lumen maintenance, color stability, photometric performance and LED source operating lifetime. Fixture submitted shall meet the listed lifetime rating of the fixture specified, as a minimum.

1.4 WARRANTY

- A. Provide a written, five year replacement material warranty for defective or non-starting LED source assemblies. Warranty period shall begin on date of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In Lighting Fixture Schedule the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified on drawing schedule.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Recessed Fixtures: Comply with UL 1598 and NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Metal Parts: Free of burrs and sharp corners and edges.
- C. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- D. Polymer Components: Plastic or polymer housing/components of fixture assemblies shall be rated for the temperature (or plenum) environment installed and shall not degrade in structural integrity, shape, color or finish for a minimum of 10 years.
- E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit servicing without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during servicing and when secured in operating position.
- F. 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: Tempered glass, unless otherwise indicated.
- G. Servicing Access: Fixtures specified for installation in inaccessible (gypsum/drywall) ceilings/walls, etc. shall be fully serviceable/accessible from the fixture aperture.
- H. Disconnecting Means:
1. Lighting fixtures with luminaires that utilize double-ended lamps and contain driver(s) that can be serviced in place or luminaires that are supplied from multi-wire branch circuits and can be serviced in place shall have a local disconnecting means at/within the fixture complying with NEC Article 410.75.

2.3 DRIVERS

- A. Drivers for LED Light Sources:
1. Driver shall be separate component from LED light source and shall be replaceable utilizing mounting screws, factory provided clips and electrical connector bodies.
 2. Dimming (When noted or indicated on Fixture Schedule): 100 to 1 percent of rated lumens via separate 0-10V input (Dimmer) control. Line voltage dimming acceptable when noted on plans.
 3. Level Control/Step-Dimming (When noted or indicated on Fixture Schedule): Minimum capability of bi-level control (100%-50%-Off) or 1/3-2/3-Full on, as noted.
 4. Voltage input: 120-277 Volt multi-volt capability.
- B. Internal-Type Emergency Fluorescent Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with driver. Comply with UL 924.
1. Emergency Connection: Operate light source continuously at a minimum output of 1000 lumens. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture driver.
 2. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 3. Battery: Sealed, maintenance-free, nickel-cadmium type.
 4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 5. Voltage input: 120-277 Volt multi-volt capability.

- C. Where plans call for multi-level switching/lighting, provide appropriate driver in fixture as required to accommodate the switching level arrangement of fixture.

2.4 EXIT SIGNS

- A. Internally Lighted Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
 - 1. Light source for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
 - 2. Voltage input: 120-277 Volt multi-volt capability.

2.5 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 luminaire on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Luminaire automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects luminaire 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. Voltage input: 120-277 Volt multi-volt capability.

2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gauge.
- C. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- D. Recessed fixtures shall be supported at all 4 corners, independent of each other, from structure above with steel #12 single jack chains. Additionally, securely fasten each fixture to the ceiling framing member by mechanical means such as bolts, screws, rivets or approved clips; install a minimum of one on each four sides of fixture.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls.
- INTERIOR LIGHTING FIXTURES

- B. Comply with NFPA 70 for minimum fixture supports.
- C. Suspended Lighting Fixture Support:
 - 1. Single or Continuous Rows: Provide manufacturer required quantity of suspension cables at minimum intervals to support continuous row fixtures. The E.C. shall support suspended fixtures independently from the ceiling system and as specified by the fixture manufacturer.
- D. Surface or Flush Lighting Fixture Support:
 - 1. The E.C. shall coordinate fixture locations with the trade installing the ceiling system to assure support members are oriented and located to accommodate the lighting fixture layout.
 - 2. Surface or flush fixtures in ceilings of the suspended lay-in type shall be installed so that the long dimension of the fixture is supported on the main support members of the ceiling system.
- E. Luminaires installed in exposed or concealed locations under metal corrugated sheet roof decking shall be installed and supported so there is not less than 1-1/2” measured from the lowest surface of the roof decking to the top of the luminaire.
- F. Adjust aimable lighting fixtures to provide required light intensities.
- G. Where fixtures are suspended in Mechanical/Electrical/Storage/Technology or Utility spaces with no suspended ceiling, coordinate mounting heights and locations with exposed ductwork, piping, conduit/data cabling racks, equipment, etc. to provide optimal and even light distribution to service equipment.
- H. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Where applicable, verify transfer from normal power to battery and retransfer to normal.

3.3 SPARE LAMPS/FIXTURES

- A. For LED fixtures with LED source integral to the fixture assembly, provide one spare fixture for each type as noted on lighting fixture schedule.
- B. For fixtures with separate/replaceable LED luminaire (retrofit lamp), provide 5 spare lamps of each type utilized.

PART 4 - END OF SECTION 26 5113

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SECTION 26 5600 – EXTERIOR AREA LIGHTING

PART 1 - GENERAL

- 1.1 Work includes complete new exterior lighting including luminaires, lamps, poles, bases, conduit, conductors, fusing, control devices, etc. as shown on the drawings. Include all excavation, backfill, concrete bases and encasement of underground conduits as detailed on the drawings.

PART 2 - PRODUCTS

- 2.1 Refer to data on the drawings for fixture details.
- 2.2 Aluminum poles, when specified, shall include a vibration dampener provided by the manufacturer.
- 2.3 Exterior building mounted lights utilized for emergency egress shall incorporate multiple drivers/LED sources where a single fixture is utilized at an exterior exit.
- 2.4 Where noted on plans, fixture poles shall have provisions for receptacle(s), security camera(s) and wireless access point(s). Mounting height and location determined at time of submittal review.

PART 3 - EXECUTION

- 3.1.1 Concrete bases for standards shall be round extending above finish grade as detailed on the drawings with rounded corners and rubbed finish. Furnish anchor bolts as recommended by the manufacturer. Concrete bases shall be poured-in-place at the job site; steel reinforced concrete, minimum 3500 lb. test.
- 3.1.2 Provide a surge arrester behind the handhole in pole base of each lighting standard and connect to each phase conductor and 0.625" diameter by 10 ft. long copper clad driven ground rod providing a good grounding path. Connect the equipment grounding conductor to this grounding terminal. A separate ground rod is required for each lighting standard exceeding 15 ft. in height. Surge arresters shall be Square D Series SDSA, Joslyn Model Series 1250 or G.E. 9L15E and F Series. Install per NEC Article 280.
- 3.2 Provide Buss "KTK" fuses in HEB waterproof in-line holder ahead of the ballast in each "hot" leg; locate behind handhole in pole base.
- 3.3 Consult manufacturer of pole and fixture(s) for recommended installation methods.
- 3.4 Mount standards truly vertical. Shim and grout under fixture base to level standards, visible shims are not acceptable. Provide anchor bolt covers.

- 3.5 Splicing shall be made with approved and UL Listed, waterproof splicing kits and shall be located in base of poles behind handhole or in splice box if indicated on plans.
- 3.6 Install a green ground wire throughout the underground wiring system and bond to all standards.

END OF SECTION 26 5600

SECTION 26 6101 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This section covers fire alarm systems, including initiating devices, notification appliances, controls and supervisory devices.
- B. Work covered by this section includes the furnishing of labor, equipment and materials for installation of the fire alarm system as indicated on the drawings and specifications.
- C. The Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform the following functions:
 - 1. Fire alarm and detection operations.
 - 2. Control and monitoring of elevators, smoke control equipment, door hold-open devices, fire suppression systems, emergency power systems and other equipment as indicated in the drawings and specifications.

1.2 Acceptable Manufacturer

- A. Manufacturer: The equipment and service described in this specification are those supplied and supported by Notifier whose catalog numbers are used herein for establishing equipment criteria. Other acceptable manufacturers are Honeywell (Silent Knight), Mircom or Simplex Grinnell.
- B. Equipment manufacturer shall have a service organization within 60 miles of the project site and be a U.L. certified company. All equipment and materials necessary for proper operation of the system shall be deemed part of these specifications even if not specifically listed or described in this document.

1.3 Related Documents

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 1 and 26 Specification Sections, apply to this section.
- B. The work covered in this section is to be coordinated with related work as specified elsewhere in the specifications. Requirements of the following sections apply:
 - 1. Division 26: “Common Work Results for Electrical.”
 - 2. Division 26: “Control Voltage Electrical Power Cables.”
- C. The system and all associated operations shall be in accordance with the following:
 - 1. Guidelines of the following Building Code: BOCA
 - 2. NFPA 72, National Fire Alarm Code
 - 3. NFPA 70, National Electrical Code

4. NFPA 101, Life Safety Code
5. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems
6. Other applicable NFPA standards
7. Local Jurisdictional Adopted Codes and Standards
8. ADA Accessibility Guidelines

1.4 System Description

- A. System shall be a microprocessor based, double supervised, closed circuit fire alarm system of modular design utilizing addressable technology for remote devices. Wiring shall be Class “B” for signaling and notification circuits. Smoke detectors shall be analog, addressable units with control panel adjustable sensitivity. All equipment shall be labeled by U.L. for fire alarm signaling use.
- B. Operation of any addressable manual or automatic fire alarm initiating device shall initiate the following:
 1. Sound a Code-3 temporal pattern audible alarm signal (pattern programmable at the main panel) and illuminate fire signal lights (strobes) in a synchronous mode until alarms have been silenced. Alarm may be silenced at the main fire alarm system control panel or at a remote annunciator panel by means of an “alarm silence” switch or if the initiating device returns to normal and a system “reset” switch is manually actuated.
 2. Display the alarm condition on integral LCD display in the main control panel and remote annunciator(s). Display shall indicate the alarming device and its location. All alarm initiating devices shall be individually addressed.
 3. Print the assigned message with time and date at the control panel (or remote printer, if specified). Activate control-by-event functions listed in these specifications.
 4. Initiate a separate trouble and alarm signal for connection to remote monitoring service organization via dedicated telephone line(s) or as directed by Owner.
 5. Release all electromagnetic door holders.
- C. In the event of an operating power failure or an open or a grounded circuit in the system, a trouble signal and a trouble light shall be activated until the problem is corrected and the system is restored to normal. The trouble event shall be recorded in the system history log and printed on the system printer (when applicable). The trouble may be silenced by means of a button on the main control panel. Upon restoration of the system to a normal condition, the trouble light shall extinguish.

1.5 Submittals

- A. General: Submit two (2) sets of the following to the Architect/Engineer for review for conformance with the Bid Documents prior to submission to the AHJ for permit:
 1. Product data sheets for system components highlighted or marked to indicate the specific products, features or functions required to meet this specification. Alternate or as-equal

products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds or does not comply with this specification.

2. Wiring diagrams from Manufacturer's Vendor.
3. Shop drawings showing system details including location of FACP, all devices, circuiting and details.
4. System power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate per the prescribed backup time periods and under all voltage conditions per UL and NFPA standards.
5. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. A list of all input and output points in the system shall be provided with a label indicating location or use of IDC, NAC, relay, sensor and auxiliary control circuits.
6. Operating instructions for FACP.
7. Operation and maintenance data for inclusion in Operating and Maintenance Manual. Include data for each type of product, including all features and operating sequences, both automatic and manual. Provide the names, addresses and telephone numbers of service organizations.
8. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with specified requirements.

- B. Submission to Authority Having Jurisdiction: After Architect/Engineer review of routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of shop drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, make re-submissions if required to make clarifications or revisions to obtain approval.

1.6 Quality Assurance

- A. Installer Qualifications: Installer(s) shall meet State of Ohio and local Municipality requirements for certification and as a minimum, have one installer certified as a NICET Level 2. In addition, the fire alarm system supplier shall have on staff, one NICET Level 3 certified individual and be an UL certified company.
- B. Each and all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by UL Inc. and shall bear the UL label.

1.7 Extra Materials

- A. General: Furnish extra materials, packaged with protective covering for storage and identified with labels clearly describing contents as follows:
1. Strobe units: Furnish four (4) units, plus 50 ft. of wire for each device, installed at the Engineer's direction.
 2. Horn/Strobe units: Furnish four (4) units, plus 50 ft. of wire for each device, installed at the Engineer's direction.
 3. Smoke Detectors or Sensors: Furnish two (2) units.
 4. Detector or Sensor Base(s): Furnish two (2) units of each type installed, plus 50 ft. of wire for each, installed at the Engineer's direction.

5. Pull station(s): Furnish two (2) units, plus 50 ft. of wire for each device, installed at the Engineer's direction.
6. Addressable Circuit Interface Modules: Furnish two (2) units, plus 50 ft. of wire for each, installed at the Engineer's direction.

PART 2 - PRODUCTS

2.1 Control Unit

- A. Control unit shall contain all necessary components to provide complete control, testing and indicating facilities for the entire fire alarm system. Relays, where utilized, shall be pluggable type, sealed in dustproof containers to prevent failure from dust, dirt, tampering and accidental contact. Unit shall facilitate silencing of alarm from one addressable device and shall resound on subsequent alarm from another addressable device. Unit shall be double supervised, individually annunciated by addressable point with the following features: test switch, silencing switch(es), reset switch(es), control switch(es), power "on" lamp, minimum of 80 character LCD display, "Alarm" lamp and a means to simultaneously test all indicator lamps (LED's). "Trouble" signal shall be in integrally mounted alert signal with a SPL of 80 db at 4 ft. Trouble alarm silence switch (button) shall have ring back feature.
- B. An alarm shall be displayed on a two line, minimum 80 character LCD display. Display shall indicate alarms, supervisory service conditions and any trouble conditions. The top line of characters shall be the address/point label and the second line shall be the device type identifier. The system ALARM red LED shall flash on the main control panel and remote annunciator panels until the alarm has been acknowledged at any of the panels. Once acknowledged, this same LED shall latch on. A subsequent alarm received from another point, after acknowledged, shall flash the system ALARM red LED on the control panels. The LCD display shall show the new alarm information. A pulsing alarm tone shall occur within the control panel and the remote annunciator panels until the alarm is acknowledged.
- C. The control panel shall be sized to accommodate 250 addressable devices, expandable to 2000 addresses thru the addition of Idnet card(s) within this control panel. Power supplies shall be supplied with 100% capacity including provisions for 20% additional strobe lights and 20% additional audible devices. Provisions for spare capacity shall include additional data loop cards or signaling cards to support the specified capacity. Audible signals shall be master controlled from the fire alarm panel or permit master coded signaling in a Code-3 temporal pattern, panel selectable without making any modifications to remote devices. All visual alarm signals (strobe lights) shall be synchronized at the fire alarm panel. Notifier NFS2-3030 series with all necessary accessories.
- D. Cabinet shall be modular construction, shall be semi-flush mounted and shall accommodate all modules, cards, relays, terminal connections, batteries, etc., necessary for system operation. The outer door and frame assembly shall be equipped with a keyed lock and shall have a transparent door panel to enable viewing all alarm and trouble lights, as well as LCD display, without opening door. Provide manufacturer's standard enamel finish.
- E. The control panel shall communicate individually with addressable initiating and control devices. Each device shall be individually annunciated at control panel.

1. Annunciation shall include the following:
 - a. Alarm
 - b. Trouble
 - c. Open
 - d. Short
 - e. Device missing/failed
 2. All addressable devices shall be capable of being disabled or enabled individually.
 3. Smoke detectors shall utilize “Alarm Verification” operation.
 4. Smoke sensor sensitivity shall be field-adjustable from the control panel for the analog style detectors. Control panel shall have a self-test function such that each sensor is automatically tested once every 24 hours. Sensor shall notify control panel when maintenance is required. System shall automatically compensate for variations in environmental conditions.
- F. The control panel shall have a “Walk Test” feature.
- G. Operating power shall be supplied from a 120 volt, 60 Hz circuit while the supervisory power shall be supplied from an integral DC power supply. The low voltage DC power shall consist of power limited, filtered and regulated power supplies with maintenance-free, lead-calcium battery back-up with automatic recharger. Indication for normal power supply and power supply trouble shall be provided. Provide remote cabinet for batteries where size dictates need. Batteries shall be sized to maintain system operation, including trouble alarm, for 24 hours with sufficient reserve capacity to power all alarm sounding devices for 5 minutes. Battery capacities shall be sized to include provisions for the spare strobe light and audible devices in Para. 1.7. Door holders are not required to be maintained by the standby batteries. All batteries shall be supervised.
- H. Provide surge suppressors ahead of all 120 volt power connections to the fire alarm equipment. Locate suppressors within equipment enclosure or in a junction box directly above/adjacent to the unit. Suppressors shall be Leviton #51020-WM or equal. These suppressors are in addition to internal protection provided with the fire alarm system’s internal electronics.
- I. Provide surge suppressors on all initiating and notification circuits that enter or leave the building to/from remote locations.
- 2.2 Remote System Components
- A. Miniplex transponders will communicate with the Main Fire Alarm Control Unit to provide for centralized control of alarm and trouble signaling as well as output signaling. The transponder shall be capable of limited stand-alone operation in the even the communication link to the central system is lost. Each transponder shall be furnished with all necessary controls, power supplies and battery back-up.
 - B. Manual stations shall be addressable communicating devices, shall be non-coded, single action with break rod operation (glass rod not required to reset station), red finish semi-flush mounted with keyed reset switch. Notifier #NBG-12LX.
 - C. Fire signal lights (strobe lights) for synchronized operation shall provide visual indication of all alarms and shall illuminate in a flashing mode whenever system is in alarm state. Fire signal

lights shall be labeled in accordance with UL 1971 Standards and shall be 15 candela in corridors and 110 candela in all other areas unless specifically designated otherwise. Semi-flush mount signal lights on walls where shown on the drawings. Lens shall be installed in a horizontal alignment on a red back plate labeled “FIRE” and shall produce one flash per second. Strobes shall be System Sensor L Series. Exterior units shall be gasketed and labeled for exterior use, System Sensor SpectrAlert series UL 1638 compliant).

- D. Horns shall be semi-flush mounted, with red grille and field selectable output levels of 85 or 91 dB at 10 ft. (based on UL 464 reverberant test requirements). Horn operating power levels shall be set initially at 85 dB and adjusted upward as required for proper sound coverage during the final check-out. Power calculations shall be made using the current draw for all units operating at 91 dB. Outside assemblies shall be weatherproof. Combination (audible/visible) horn and fire signal lights shall utilize a compact, combination mounting base assembly. Horns shall be labeled “FIRE”. System Sensor L Series (utilize the continuous horn signal setting) with mounting accessories. Exterior units shall be gasketed for weatherproof rating. Combination strobe/horn signal units shall be factory assembled, System Sensor L Series.
- E. Combo horns with fire signal lights (strobe lights) for synchronized operation shall provide both audible and visual indication of all alarms and shall illuminate in a flashing mode whenever system is in alarm state. Fire signal lights shall be labeled in accordance with UL 1971 Standards and shall be 15 candela in corridors and 110 candela in all other areas unless specifically designated otherwise. Semi-flush mount horn/signal lights on walls where shown on the drawings. Lens shall be installed in a horizontal alignment on a red back plate labeled “FIRE” and shall produce one flash per second. Horns shall have a red grille with field selectable output levels of 85 or 91 dB at 10 ft. (based on UL 464 reverberant test requirements). Horn operating power levels shall be set initially at 85 dB and adjusted upward as required for proper sound coverage during the final check-out. Power calculations shall be made using the current draw for all units operating at 91 dB. All strobes shall be synchronized throughout the entire building utilizing control circuitry within the main fire alarm panel (and extender panels, if used). Exterior units shall be gasketed and labeled for exterior use, System Sensor L Series.
- F. Surface mounted fire alarm devices mounted on walls-such as manual stations, horns, strobes, etc. shall utilize finished backboxes. These backboxes shall be red metal and shall be field punched for conduit entrance (boxes shall not be stamped KO construction).
- G. Individual addressable monitor module shall be an addressable module used for monitoring N.O. contact devices such as water flow, tamper switches, etc. Notifier #FMM-101.
- H. Programmable relay control module shall be an individual addressable module used for control of auxiliary functions such as elevator control, door release, smoke damper shutdown, air handling unit shutdown, etc. Notifier #FRM-1.
- I. Photo-electric type, addressable, ceiling mounted smoke detectors, shall utilize all solid state components operating on the light scatter principle and shall have adjustable sensitivity set at the transponder to detect smoke at 0.5% to 3.7% light obscuration per foot. The sensors shall communicate actual smoke chamber sensitivity to the system control where it is constantly monitored. Each addressable detector is individual adjustable thru the control panel and environmentally adjusted. The system will indicate when individual sensors need cleaning. Detector head shall have a white finish and contain an integrally mounted LED pilot lamp that indicates detector status. Notifier #FSP-951 with B300 base. Provide remote LED alarm indicators when indicated on plans.

- J. Photo-electric type, addressable, duct mounted smoke detectors, shall utilize all solid state components operating on the light scatter principle and shall have adjustable sensitivity set at the transponder to detect smoke at 0.5% to 3.7% light obscuration per foot. The sensors shall communicate actual smoke chamber sensitivity to the system control where it is constantly monitored. Each addressable detector is individual adjustable thru the control panel and environmentally adjusted. The system will indicate when individual sensors need cleaning. Detector head shall have a white finish and contain an integrally mounted LED pilot lamp that indicates detector status. Notifier #DNR/FSP-951/DST/FRM-1. A remote LED “status” light shall be flush mounted at 54” mounting height in a convenient location within sight of air handling unit, Notifier #RA-400Z.
- K. Waterflow switches shall indicate the continuous flow of water in sprinkler pipes where indicated on drawings. Unit shall be equipped with retard mechanism, adjustable up to two minutes, to minimize false alarms due to pressure changes. Retard mechanism and allowable time delay shall be subject to local AHJ requirements. Unit shall be supplied and installed by the Fire Suppression Contractor and wired to the fire alarm system by the E.C. via a monitor module with a dedicated address.
- L. Gate valve switches (OS&Y) shall monitor the status of sprinkler valves where indicated on drawings and shall signal a trouble alarm when respective valve is closed. Unit shall be supplied and installed by the Fire Suppression Contractor. Each gate valve switch shall be wired to the fire alarm system by the E.C. via a monitor module with a dedicated address.
- M. Magnetic door holders shall be multi-voltage selectable for 24 VDC or 24/120VAC operation. Flush wall mounted, Notifier #FM-998; semi-flush mounted, Notifier #FM-997 for new construction or surface wall mounted, Notifier #FM-996 for remodel applications on existing walls. Floor mount models for single door, Notifier #FM-980 or double door, two Notifier #FM-980, where shown on plans or application requires such use.
- N. Remote Annunciator and Operator Control Panels shall be flush wall mounted where shown on plans. Each shall consist of an 80 character LCD display with control features similar in appearance and orientation as the main fire alarm control panel. Control buttons shall be locked behind a window (keyed the same as the main fire alarm control panel) to prevent unauthorized operation.
- O. Notification appliance power extender control panels shall be provided where shown on the drawings. These panels shall communicate with and be completely supervised from the main fire alarm control panel. They shall be capable of powering additional synchronized visual alarm signals (strobes) and/or audible alarm signal circuits. Each panel shall include supervisory modules, power supplies, batteries and chargers. At the Contractor’s option, additional extender panels may be utilized if deemed acceptable by and locations are coordinated with the Architect/Engineer during the bidding phase. Notifier #FCPS-24 Series panel with accessories.
- P. A digital communicator shall be located within the main fire alarm control panel to automatically transmit designated alarms, supervisory and trouble signals to a central station monitoring service via dedicated telephone lines. The digital communicator shall be compatible with the communications protocol of all major Central Station receivers, including: ADCOR, ADEMCO, FBI, Franklin, Osborne Hoffman, Radionics, SESCOA, Silent Knight, Varitech, DCI, Vertex, etc. The main fire alarm panel shall have all provisions for the installation of a digital communicator furnished and installed by the owner contracted Central Monitoring Service. The digital communicator shall be connected to one telephone line and a cellular dialer,

shall supervise both means of communication and shall be capable of sending alarm signals on both means of communications to the Central Monitoring Service. The fire alarm panel shall indicate a trouble alarm on any digital communicator equipment failure (including loss of telephone line connection for longer than 45 seconds). The digital and cellular dialer shall be powered and maintained by the main fire alarm control panel standby battery power supply. Provide surge suppression on the 120 volt power supply and on one telephone lines. Provide both digital and cellular dialers and one year of UL monitoring.

2.3 The digital communicator shall transmit the following event level information:

1. Fire Alarm Condition
2. Supervisory Condition
3. Trouble Condition
4. Daily Test Signal

B. Provide a recessed Knox-Box rapid entry system where indicated on drawings. Extend wiring from the Knox-Box tamper switch to a monitor module to signal a trouble to the building fire alarm system.

PART 3 - EXECUTION

3.1 Installation, General

A. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.

3.2 Equipment Installation

A. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans. Include sufficient control unit(s), annunciator(s), manual stations, automatic fire detectors, smoke detectors, audible and visible notification appliances, wiring, terminations, electrical boxes and all other necessary material for a complete operating system. Wall mounted devices shall utilize manufacturer recommended rough-in boxes with bushed conduit stubbed above accessible ceiling (as a minimum).

B. If the building has a legally required standby power generator or power system, the E.C. shall provide a 20 Amp-120 Volt emergency circuit from the nearest Life-Safety emergency panel to the main fire alarm panel and any additional Notification Appliance (Power Extender) Panels required by the system.

C. Coordinate door holder equipment connections and installation with door hardware supplier.

D. Locate duct mounted smoke detectors per UL and manufacturer's guidelines for accurate air sampling and to permit easy access for maintenance and testing. Coordinate installation with the H.C. Where required, provide access panels. The E.C. shall ensure accessibility to the entire assembly.

- E. Provide a system smoke detector at the location of each fire alarm control unit (this includes the main panel and extender panels/auxiliary control panels where initiation/notification circuits originate).

3.3 Wiring Installation

- A. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction (AHJ) and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70: National Electrical Code (NEC).
- B. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.
- C. Color Coding: Color code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuit wiring and a different color code for supervisory circuits. Color code notification appliance circuits differently from alarm initiating circuits. Paint fire alarm system junction boxes, conduit fittings and box covers red.
- D. The following wiring and conduit shall also be included in the fire alarm system work:
 - 1. Empty conduit with pull wire from the digital communicator to the main telephone backboard. Telephone wiring from the telephone backboard to the digital communicator is the Owner's responsibility (or provided under a separate contract). The E.C. shall assist in making the final connections at the digital communicator and verify transmission and receipt by the Central Station prior to final testing.
 - 2. From duct mounted smoke detector, control relay module or fire alarm panel to each air handling unit and exhaust fan for shutdown where required by OBC (606).
 - 3. From electro-mechanical door holders to associated smoke detectors and/or fire alarm panel or control relay.
 - 4. Wiring to supervisory monitor and control points.
- E. **Wire shall be plenum rated, install cabling in a separate J-hook system where accessible. Install conduit in areas that are inaccessible when construction is complete.**

3.4 Field Quality Control

- A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pre-testing, testing and adjustment of the system.
- B. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing. Test the system according to the procedures outlined in NFPA 72.

- C. Report of Tests and Inspections: Provide a written record of inspections, tests and detailed test results in the form of a test log.
- D. Final Test, Certificate of Completion and Certificate of Occupancy:
 - 1. Test the system as required by the Authority Having Jurisdiction (AHJ) in order to obtain a certificate of occupancy.
- E. Revise all wiring diagrams and floor plans to reflect final accepted “As-built” conditions for the project and include in the O&M Manuals for the owner’s use. In addition, the supplier shall include an electronic copy of the system’s operating program on a CD.

3.5 Cleaning and Adjusting

- A. Cleaning: Remove paint splatters and other spots, dirt and debris. Clean unit internally using methods and materials recommended by manufacturer.
- B. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels and adjusting controls and sensitivities to suit actual occupied conditions, in compliance with NFPA 72. Provide up to three (3) visits to the site for this purpose.

3.6 Training

- A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner’s designated personnel for a minimum of 4 hours training on-site.

PART 4 - END OF SECTION 26 6101

SECTION 270001.00 - GENERAL REQUIREMENTS FOR COMMUNICATIONS

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, Division 27 Specification Sections, and Division 28 Sections (if applicable) apply to all sections.
- B. Related Drawings
 - a. All Technology Drawings

1.2. GENERAL DIRECTION

- A. Submittal of a bid indicates that the contractor has examined the drawings, specifications, and had an opportunity to visit the site to be able to provide a comprehensive complete bid.
- B. The intent of these specifications and the accompanying drawings is to provide complete and workable systems as shown, specified and required by applicable codes. Interpret these specifications in conjunction with the drawings and provide all work described. If work is shown on drawings and not mentioned in the specifications, or vice versa, it is to be included in the work the same as though clearly set forth by both. Should there be a conflict between the specifications and drawings, provide the greater quantity or better quality. Immediately notify owners representative and design professional of such conflicts.
- C. The drawings that accompany these specifications are diagrammatic and although size and location of equipment is drawn to scale wherever possible, make use of submittal data and verify all dimensions on site. They do not show every conduit, offset or pull / junction box which may be required to install work in the space provided and avoid conflicts. Follow the drawings as closely as is practical and install additional pull / junction boxes and offsets where required by site conditions and codes at no additional cost. Install all new work in such manner as to conform to the structure, avoid obstructions, provide required service clearances and preserve headroom. Do not scale from drawings, measurements shall be taken in the field.
- D. Coordinate all new work with all other contractors and installers in addition to existing building obstructions and install accordingly. Refer to coordination drawings of other trades. Comply with requirements of architectural drawings including but not limited to mounting height and locations.
- E. Fully research peculiarities and limitations of space available for installation of work with materials being provided. Work around material lead times to not extend project schedule.

- F. Complete work, or part(s) thereof, at times as may be designated by the Owner's Representative, so that it can be used for temporary or permanent use. Do not construe such use of the system as an acceptance of it by Owner.
- G. During mobilization or construction, if an abnormal condition is uncovered either with existing conditions, equipment loads, submittal data, etc. bring these to the attention of the Design Professional for review.
- H. Owner's Representative or Design Professional may relocate fixtures, devices, equipment, etc. prior to installation within a 20-foot limit at no additional charge.
- I. Phasing - Where the scope of work dictates that the project shall be constructed in phases, all costs shall be incurred by this contractor for any temporary work required so that previous phases can be operational while construction is being done to adjacent spaces.
- J. Provide the services of locally licensed and authorized electrician(s) to perform that portion of the Work of this Division that is required by the applicable codes and/or the AHJ to be performed by licensed electrician(s).

1.3. GENERAL STANDARDS

- A. Provide work in compliance with applicable provisions of the following standards. Provide listing and labeling for all electrical materials, marked for respective intended uses, from UL or other Nationally Recognized Testing Laboratory (NRTL) that is acceptable to applicable Authorities Having Jurisdiction (AHJs).
- B. Provide materials, installation methods, workmanship, testing, etc., in strict accordance with the latest edition of applicable standards and adopted codes, including (but not limited to) the following.
 - 1. International Building Code
 - 2. State Building Code and applicable amendments
 - 3. State Energy Code
 - 4. Utility company requirements and standards as applicable
 - 5. All provisions and requirements of NFPA (National Fire Protection Association)
 - 6. National Electrical Code (NEC), NFPA 70
 - 7. Life safety code, NFPA 101
 - 8. Local governmental and other prevailing codes and ordinances
 - 9. ADA/ADAAG requirements (American with Disabilities Act) including all applicable Standards for Accessible Design.
 - 10. UL (Underwriters Laboratories Inc.)
 - 11. ETL (Intertek Testing Services NA, Inc.)
 - 12. CSA (CSA Group Testing and Certification Inc.)
 - 13. FM (Factory Mutual Insurance Company)
 - 14. ASME (American Society of Mechanical Engineers)
 - 15. NEMA (National Electrical Manufacturers Association).

16. NECA (National Electrical Contractors Association)
 17. IP (International Protection Rating / Ingress Protection Rating)
- C. Reference standards:
1. The latest revision of ANSI/TIA-568, including Generic Telecommunications Cabling for Customer Premises, ANSI/TIA-568.1 Commercial Building Telecommunications Infrastructure Standard.
 2. AT'S (Alliance for Telecommunications Industry Solutions) 0600313-Latest Version,
 3. Electrical Protection for Telecommunications Central Offices and Similar Type Facilities
 4. AT'S 0600318-Latest Version, Electrical Protection Applied to Telecommunications
 - a. Network Plant at Entrances to Customer Structures or Buildings
 5. AT'S 0600321 -Latest Version, Telecommunications — Electrical Protection For Network Operator Type Equipment Positions
 6. ATIS 0600333-Latest Version, Grounding And Bonding Of Telecommunications Equipment
 7. ATIS 0600334-Latest Version, Electrical Protection Of Communications Towers And Associated Structures
 8. IEEE C2-Latest Version, National Electrical Safety Code (NESC)
 9. IEEE Standard 1 100, Latest Version, "Recommended Practice for Powering and Grounding Electronic Equipment" (IEEE Emerald Book).
 10. IEEE Standard 142-Latest Version, "Recommended Practice for Grounding of Industrial and Commercial Power Systems" (IEEE Green Book).
 11. NFPA 70, "National Electrical Code" (NEC).
 12. 11 . UL 467, "Grounding and Bonding Equipment."
 13. NFPA National Electric Code Article 250, "Grounding."
 14. ANSI/TIA-568, Latest Version, Administration Standard for Commercial Telecommunications Infrastructure.
 15. The most current published edition of the "Telecommunications Distribution Methods Manual" published by the Building Industry Consulting Services International (BICSI).
- D. Acronyms and Abbreviations:
1. ADA: Americans with Disabilities Act.
 2. ANSI: American National Standards Institute.
 3. AWG: American Wire Gauge.
 4. BICSI: Building Industry Consulting Services International.
 5. BOM: Bill of Materials.
 6. Bps: Bits per second.
 7. LEC: Local Exchange Carrier.
 8. dB: Decibel.
 9. Device ID: A system specific label assigned to a product to uniquely identify it within a given system.
 10. DSL: Digital Subscriber Line.

11. EF: Entrance Facility.
12. EIA: Electronics Industries Association.
13. EMI: Electromagnetic Interference.
14. ER: Equipment Room (a type of Communications Room).
15. Gb/s (Gbps): Gigabits per second.
16. GHz: Gigahertz.
17. IDF: Intermediate Distribution Frame (Replaced by TR).
18. IEEE: Institute of Electrical and Electronics Engineers.
19. ISO: International Organization for Standardization.
20. ISP: Internet Service Provider.
21. LAN: Local Area Network.
22. MAC: Media Access Control.
23. Mb/s (Mbps): Megabits per second.
24. MDF: Main Distribution Frame (Replaced by ER).
25. MHz: Megahertz.
26. MPLS: Multi-Protocol Label Switching.
27. OFCI: Owner Furnished Contractor Installed.
28. OFE: Owner Furnished Equipment.
29. OFOI: Owner Furnished Owner Installed.
30. POE: Power over Ethernet.
31. PST N: Public Switched Telephone Network.
32. QoS: Quality of Service.
33. RAID: Random Array of Inexpensive Disks.
34. RAM: Random Access Memory.
35. RFC: Request for Comment.
36. RFI: Request for Information/ Radio Frequency Interference.
37. RFP: Request for Proposal.
38. RFQ: Request for Quotation.
39. SNMP: Simple Network Management Protocol.
40. SSD: Solid State Drive.
41. TB: Terabyte.
42. TCP: Transmission Control Protocol.
43. TCP/IP: Transmission Control Protocol/Internet Protocol.
44. TIA: Telecommunications Industries Association.
45. TR: Telecommunications Room (a type of Communications Room)
46. VoIP: Voice over Internet Protocol.

1.4. PERMITS AND REGULATIONS

- A. Obtain and pay for permits, fees, certificates of inspection and approval, etc. required for this branch of the work. Furnish Owner with certificates of final inspection and approval prior to final acceptance of this branch of the work.
- B. Laws and regulations which bear upon or affect the various branches of this work shall be complied with by this contractor and are hereby made a part of this contract.

1.5. DEFINITIONS

- A. Furnish - Procure, supply and deliver to project site, ready for installation, install and warrant (unless indicated otherwise on documents). Include warranty expenses.
- B. Install - Assemble, wire and connect loose-shipped components on site. Place in position for service or use, including material, labor, accessories, services, and testing. Wire, connect, and render fully operational for intended use.
- C. Provide - Furnish and Install. Similar Terms: "include", "shall", "equip with", "consisting of"
- D. Equal or Equivalent - Determination of equivalency to be made by design professional for all products not listed as basis-of-design.
- E. Substantial Completion - Where frontend documentation does not define, products and systems must be fully installed as designed, tested, adjusted, labeled, and functionally demonstrated to owner.
- F. High Voltage: For the sake of this Division, greater than 70.7vac RMS; greater than 100vac PP; greater than 49vdc.
- G. Low Voltage: For the sake of this Division, less than or equal to 70.7vac RMS; less than 100vac P-P; less than or equal to 49vdc.
- H. Structured Cabling: A standardized repetitive passive physical infrastructure of cables, conductors, terminations, hardware and supporting products that together are used to enable the conveyance of signals, information, and data between different locations. Such systems are commonly constructed in accordance with standards published by various standards organizations, including but not limited to the TIA, EIA and BICSI. In some cases, specialized derivatives of these standards are constructed to meet specialized system needs. Common usages of structured cabling systems include such things as computer or data networks (including wireless infrastructure), telephone systems, building automation systems, electronic safety and security systems, and building intercommunications systems. The structured cabling system does not include any active electronic equipment.
- I. Audio-Visual I Audio and Video Systems Work: That portion of the Project that involves the supply, installation, programming, or testing of products whose fundamental purpose is the reproduction, pickup, storage, transporting, processing, control of audio and/or video signals. Scope of this definition includes all incidentals that are regularly and fundamentally required to provide complete and working systems from the small and simple to the large and complex.

1.6. REQUESTS FOR INFORMATION

- A. Submit all questions, requests for information (RFIs) and similar queries through the formally established RFI process for the project that has been accepted by the Owners Representative, Design Professionals, Prime Contractor and subcontractors. Submit as a PDF file. Do not submit as text in an email.

1.7. ADMINISTRATION

- A. Progress Meetings:
 - 1. Progress meetings may be established to review progress of the Work, discuss anticipated progress during the following weeks, and review critical operations and existing and potential problems.
 - 2. Contractor(s) shall attend and shall be represented at every progress meeting by a person authorized with signature authority to make decisions regarding possible modification of the Contract Documents.

1.8. WARRANTY / GUARANTEE

- A. Provide a warranty/guarantee in written form as part of O&M manual stating that all work, materials, equipment and parts are warranted to be free of defect for a minimum period of one year from the date of Substantial Completion. Warranty period and requirements may be expanded in drawings or subsequent specification sections. Repair or replace (owner's option) any defects or failures at no cost to the owner within the warranty period. Issues arising within warranty period must be attended to in a timely manner and in no case exceed four (4) working days. State this in writing as part of O&M manual. Replace defective items to the satisfaction of the Owner's Representative and the Design Professional.

PART 2 PRODUCTS

2.1. GENERAL

- A. Materials, apparatus and equipment shall bear the Underwriter's Laboratory, Inc. label (or other nationally recognized testing laboratory label) where regularly supplied, and as additionally required by Code or the Contract Documents.
- B. Products furnished shall be new, full weight and of the best quality. Similar materials supplied shall be of the same type and from the same manufacturer.
- C. If a specified product is discontinued by the manufacturer and is no longer available for purchase, replacement product of equal or greater value, performance and function as the discontinued Basis of Design product shall be furnished. The replacement product shall be from the same manufacturer as the Basis of Design product unless written permission has been granted by the Designer. The Contractor is solely responsible for researching and

submitting proposed replacement product. The final decision as to whether a Contractor proposed replacement is acceptable lies solely with the Designer.

- D. Substitute products shall only be considered if the Contractor has strictly adhered to the guidelines set forth under "Substitutions" as defined in this Section.

2.2. BASIS OF DESIGN

- A. Some of the Contract Documents are prepared on the basis of specific products that are designated as the "Basis of Design."
- B. The Basis of Design products for the Work of this Division are designated explicitly within the specifications, and in the case of some products, designated by brand and model on the Drawings.
 - 1. Where a product brand and model is expressly identified on the Drawings, this product represents the Basis of Design for that instance of the product in the associated system.
- C. The combination of Basis of Design products and the interconnection thereof collectively represent a work that includes the feature set and performance intended by the Designer and the Owner. The specifications may identify additional manufacturers whose equipment may be used in the system, provided the use of such products achieves the same capabilities and performance as that of the specified combination of the Basis of Design products.
 - 1. Due to the varied and integrated nature of modern communications products, there is no guarantee that any single product manufactured by any one of the listed additional manufacturers will be an exact equivalent to a single Basis of Design product in terms of functionality, capability or performance. Therefore, where the use of substitute product is considered, the product shall be verified by the substituting party to include the capabilities, features and performance as that of the Basis of Design product.
 - a. In the case where a single product from an alternate approved manufacturer does not meet the design intent of the Basis of Design product, multiple products, all of the same alternate manufacturer or utilizing the same protocol (e.g. Dante), may be considered for substitution. The contractor is solely responsible for verifying clearances, power requirements, and any effect on other trades. These requirements shall be coordinated at no additional cost to the owner.
 - 2. Work of the Contract shall include covering the cost of additional products and labor necessary to achieve the same end results as would be achieved by using the specified combination of Basis of Design products, including additional costs for coordination, modifications to the building, pathway modifications, casework and furniture modifications, power modifications, licensing, or anything else that may cause additional expense to the Owner.

3. In addition, costs incurred by the Owner's design team to accommodate such changes shall be the responsibility of the party making the substitution.

2.3. SUBSTITUTIONS

- A. A substitution is the use of any product other than that identified as the "Basis of Design," the "Standard of Quality," or an "Additional Approved Product."
- B. Substitutions require pre-bid approval. Only substitutions authorized via addendum shall be considered.
- C. Substitutions are considered on a product-by-product and model specific basis.
- D. Substitution Submittal Requirements:
 1. Substitution requests must be received by the Designer sufficiently in advance of the scheduled bid date to allow time for review and issuance of an Addendum. If the timing of the request does not permit an Addendum, substitution shall not be considered or acceptable.
 2. Substitution requests shall consist of the following for each proposed substitution:
 - a. Substitution Request Letter
 - b. Product Datasheets/Brochures
 - c. Revised single line diagrams indicating the intended connections of the substitution product within the designed system.
- E. Costs that result from the use of substitute products and/or Additional Approved
 1. Manufacturer(s), including costs for additional equipment, coordination, accessories, modules, interface products, cables, software, and programming, as well as costs for any additional labor, materials, and products incurred by other trades or members of the project Design Team or Owner, are the sole responsibility of the Contractor making the substitution. This includes costs that may not be incurred or known until after Contract award or Work execution. Such costs shall be deducted from final sum payable to the Contractor.
- F. Post Contract award substitutions may be considered, but only if the proposed substitution includes substantial additional benefit to the Owner. Post award substitutions are considered solely at the discretion and convenience of the Designer. For a post Contract award substitution to be considered, one or more of the following shall apply:
 1. The Designer initiates the request for substitution.
 2. A basis of design product has become discontinued and is no longer available, and as a result, the use of a substitute product has become a necessity to meet the Owner's objectives for the Project. See "Discontinued Products."
 3. The request for substitution is accompanied by a proposal that identifies the benefits to the Owner, including a fair-market Contract price reduction.

2.4. DISCONTINUED PRODUCTS

- A. The availability of products shall be verified by the Contractor prior to submitting pricing for Work of the Contract.
- B. Products designated as "End Of Life" by the manufacturer prior to the ordering of product shall be considered discontinued and not be used except when that product is needed to expand or match existing equipment already installed in the project.
- C. In the event that a specified product is discontinued at any time and becomes unavailable for use on the Project, provide a replacement product deemed acceptable to the Designer. Replacement product shall be of equal or greater value, performance and functionality.
 - 1. Replacement product shall be from the basis of design manufacturer, from one of the additional product manufacturers identified for the product within the Section, or from another manufacturer deemed acceptable to the Designer.
- D. The cost for the supply and installation of suitable replacement product is the sole responsibility of the Contractor.
- E. Replacement products are considered substitutions and require Designer review and authorization. See "Substitutions."

PART 3 EXECUTION

3.1. WORK AND WORKMANSHIP

- A. Provide labor, materials, equipment and services necessary for complete installation of systems required to comply with the requirements of authorities having jurisdiction (AHJ), as indicated within the Contract Documents.
- B. Work shall be functional and complete in every detail, including items required to complete the system, regardless of whether each necessary item is fully enumerated in the Specifications or shown on the Drawings.
- C. Contractor and Subcontractors shall be knowledgeable of the details of Work to be performed by other trades and take necessary steps to integrate and coordinate Work of this Division with that of other Divisions and other trades.
- D. Wherever tables or schedules show quantities, they shall not be interpreted to represent the total contract quantity requirement, but instead a portion of the Contract requirement. The Contractor shall be responsible for the higher quantity communicated by the Drawings, within the Specifications and on the schedules/tables. Seek clarification from the Designer should a discrepancy be found.
- E. The Designer and Owner's Representative may, at their sole discretion, condemn or reject any Work, materials or equipment not in accordance with the Contract Documents or the manufacturer's specifications or drawings reviewed by the Designer or Owner.

- F. Work or equipment that is rejected shall be removed and replaced to the satisfaction of the Owner and Designer at the Contractor's expense. Work or equipment that is rejected shall be so stated in writing by the Owner or Designer.
- G. Work shall fully comply with the Contract Documents and manufacturer's recommended installation guidelines.
- H. Work shall be performed with the best practices of the trade for performance, functionality, safety, endurance and aesthetics.
- I. I. Coordinate ordering and installation of equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the schedule.
- J. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible. Consult the Designer for direction.
- K. Supply scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.
- L. Work shall be installed level and plumb, parallel and perpendicular to prevailing building lines, except as expressly detailed otherwise or required for proper form, function or Designer intended operation.
- M. Specialty tools shall be used for assembly, installation, termination, and removal of products as recommended by the product manufacturer.

3.2. TESTING

- A. General:
 - 1. Upon complete physical installation of products, align, balance, and adjust equipment to make it usable to the Owner for the intended purpose, and ensure compliance with the Contract Documents.
 - 2. Test each system and each component thereof, and correct deficiencies prior to scheduling acceptance testing.
 - 3. Replace malfunctioning or damaged products with new product, following immediately with retesting until satisfactory performance and specification compliant conditions are achieved.
- B. Operational Testing:
 - 1. Perform operational testing of supplied products individually and collectively to verify conformance with the Contract Documents, to ensure compliance with the product manufacturer's published specifications, and as additionally necessary for the system to meet the intended purpose.
- C. Performance Testing:

1. Perform measurements and testing necessary to demonstrate performance compliance.

3.3. TRAINING

- A. Training shall be supplied for each Section of this Division and for each unique system provided.
- B. The Owner shall have the right to use the total allocated training for a period of 1 year following final completion of onsite work, solely at its discretion.
- C. Training shall be supplied as expressly identified within individual Sections. Where training requirements are not otherwise expressly identified, the Contractor shall furnish a minimum of two (2) hours per unique system, per Section. The Contractor shall presume that at least two (2) discrete trips to the project site shall be required per unique system to conduct training.
- D. Training dates and times shall be coordinated with the Owner's designated training representative(s).
- E. Training shall cover the following:
 1. Normal system use and operation.
 2. Procedures and schedules involved in troubleshooting and performing routine preventative maintenance.
 3. Other facets as identified in individual Sections.
- F. Agenda and relevant training handouts shall be prepared and distributed to attendees at each training session.
- G. A sign-in sheet shall be created and used for each training session. The sheet shall identify the following, at a minimum:
 1. Specification Section reference and system(s) being trained.
 2. Date and starting time of the session.
 3. Signatures of attendees.
 4. Ending time of the session, along with a separate owner signature certifying the ending time.
 5. Training outline/agenda.
- H. Recording of Sessions:
 1. Recordings shall be supplied in a suitable electronic format media playable on standard and commonly available free software. Recordings do not need to be professionally edited but shall feature intelligible audio and a clear image of the subject trainer and any supplemental visual content material to the training.
 2. Recordings shall be turned over and signed for by an Owner's training representative at the end of each session. A copy of a signed delivery receipt shall be included as part of the closeout documentation.

3. Contractor shall require each attendee to sign-in at the start of each training session. The sign-in form shall summarize the training conducted, specification section reference and system being trained on, as well as the starting time and duration of training. Following training, a representative of the Owner shall sign the form, acknowledging the same. Contractor shall retain the original copy of these forms and turn over an electronic copy of the form to the Owner's representative as evidence of training. Training conducted without this official record of training shall not be considered as part of the Contractors training obligation.
- I. For a training session to count towards the training obligation, each of the following shall be met:
 1. Training occurs after Training Submittal review.
 2. Training session outlines / agenda are distributed at the session.
 3. Quality Assurance requirements for the instructor have been met.
 4. Training occurs after the system / section is complete and working as intended by the Contract Documents, usually following Acceptance Testing. Training in advance of this requires Designer approval.
 5. Sign-in sheets are used, completed and retained for the session.
 6. A master log of training conducted for the project is maintained.

END OF SECTION 270001.00

SECTION 270002.00 - QUALITY ASSURANCE FOR COMMUNICATIONS

PART 1 GENERAL

1.1. SUBMITTAL REQUIREMENTS

- A. Quality Assurance:
 - 1. Quality Assurance: General Qualifications.
 - 2. Quality Assurance: For Structured Cabling Systems Work.
 - 3. Quality Assurance: For Audio and Video Systems Work.

1.2. SUMMARY

- A. Section Includes:
 - 1. Quality Assurance requirements for Work of this Division.
- B. Related Requirements
 - 1. Related Sections
- C. All Division 27 Sections.

1.3. QUALITY ASSURANCE

- A. General Qualifications:
 - 1. Business history of the last five (5) contiguous years performing work of similar type, value and scope as that required of the Contract Documents.
 - 2. Capable of demonstrating through valid references and other means that it has successfully completed no less than six (6) projects of similar type, monetary size, and scope of work within the last twenty-four (24) calendar months.
 - 3. A "Factory-authorized" reseller (e.g., distributor, dealer, integration partner, value-added reseller, channel partner) for the products furnished for each Section.
 - 4. House substantial business operations within a 300-mile radius of the project site.
 - 5. Employ full-time service staff based within a 50-mile radius of the project site.
 - 6. Financial Disclosure of the Contractor: Prior to contract award, upon request.
- B. Superintendent/Project Manager Qualifications:
 - 1. Furnish the services of an experienced superintendent/project manager who shall be constantly in charge of the Work, together with a qualified foreman and technical specialists to properly install, connect, adjust, start, operate and test the Work involved.
 - 2. Qualifications are subject to the review and acceptance by the Designer and Owner. Unless the Designer and Owner grant prior permission, the same superintendent/project manager shall be utilized throughout the duration of the Project and shall remain responsible for the complete scope of the Work.

C. Subcontractor Qualifications:

1. If the Contractor, as a singular entity, does not meet 100-percent of the quality assurance requirements for each specification section, the Contractor shall enlist the services of qualified subcontractors to perform the Work of those specific section(s). This includes, but is not limited to, the supply of the products for the Section and the supply of the
2. project engineering services, preparation of shop drawings and section submittals, technical installation labor, training, warranty, post-installation support and service.
3. The Contractor shall ensure that each subcontractor supplies the services of a project manager to represent its interests at the same project meetings in which the Contractor participates.
4. The Designer and Owner reserve the right to disqualify the use of any subcontractor that does not meet the quality assurance requirements set forth in these specifications. Should a subcontractor be disqualified, the Contractor shall supply the services of a different subcontractor that complies with the published quality assurance requirements. The Contractor is solely responsible for costs incurred as a result. It is therefore incumbent upon the Contractor to pre-qualify subcontractor choice(s) prior to submitting pricing for work.
5. To achieve quality assurance compliance, an equipment vendor that is not performing the technical installation labor associated with work of a Section shall not be considered a subcontractor.

D. Training Qualifications:

1. Personnel conducting training shall be knowledgeable of the product, system and technology on which they train. Personnel shall be factory trained, factory certified and/or otherwise recognized by the Designer as possessing sufficient experience and knowledge in the subject area.

E. Additional Qualifications for Structured Cabling Systems Work:

1. Provide BICSI Certified Registered Communication Distribution Designer (RCDD) and BICSI Certified Technicians who shall be responsible for the Project.
 - a. The RCDD shall be a current BICSI member in good standing. The RCDD shall have sufficient experience in this project type and provide technical support to the field during installation, warranty period, and extended warranty periods and maintenance contracts. The RCDD shall also be specifically experienced in the installation of telecommunications Outside Plant (OSP) cabling and infrastructure systems.
 - b. The lead technician responsible for the Project shall be a BICSI member in good standing and shall be a BICSI Certified Technician.
 - c. Installers shall meet minimum certification requirements to meet the cabling and connectivity manufacturers' certifications and warranty requirements, as identified in individual specification sections.

2. The RCDD and Lead Technician(s) on the Project shall have a thorough understanding of the following, and Work performed shall be compliant with the following:
 - a. TIA/EIA-568-C, including TIA/EIA -568-C.O, Generic Telecommunications Cabling for Customer Premises; TIA/EIA -568-C.1 , Commercial Building Telecommunications Cabling Standard; TIA/EIA -568-C.2, Balanced Twisted-Pair Telecommunication Cabling and Components Standard; and TIA/EIA -568-C.3, Optical Fiber Cabling Components Standard.
 - b. TIA/EIA -569-C, or most current version, Telecommunications Pathways and Spaces.
 - c. TIA/EIA -590-A, or most current version, Standard for Physical Location and Protection of Below-Ground Fiber Optic Cable Plant.
 - d. TIA/EIA -606-B, or most current version, Administrative Standard for Commercial Telecommunications Infrastructure.
 - e. TIA/EIA -607-B, or most current version, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
 - f. The most current published edition of the "Telecommunications Distribution Methods Manual" published by the Building Industry Consulting Services International (BICSI).
 - g. TIA/EIA -758-B, or most current version, Outside Plant Cabling Systems.
 - h. The most current published edition of the "Outside Plant Design Reference Manual" published by the Building Industry Consulting Services International (BICSI)
 3. Staff, including RCDD(s), BICSI Technician(s), and installers, shall be manufacturer certified to meet the requirements to obtain the warranty specified for the systems.
 4. Installation practices shall be compliant with referenced and applicable standards, regulations, and codes.
 5. Submittals, including shop drawings, shall be prepared by, or under the direct supervision of the RCDD.
 - a. Each submittal, including shop drawings, shall be reviewed, signed and stamped with the RCDD stamp and signature of the responsible RCDD.
 6. Each as-built drawing shall be prepared by, or under the direct supervision of the RCDD.
 - a. Each as-built drawing shall be reviewed, signed and stamped with the RCDD stamp and signature of the responsible RCDD.
- F. Additional Qualifications for Audio and Video Systems Work:
1. AV Project Engineer:
 - a. AVIXA CTS-D Certified, and;
 - b. Manufacturer trained on key products being installed.
 2. AV Technician Qualifications:
 - a. AVIXA CTS-I or CTS-D Certified, and;
 - b. Manufacturer trained on key products being installed.

3. AV Installer Qualifications:
 - a. AVIXA International CTS-I Certified.
4. Shop drawings shall be prepared by, or under the direct supervision of a qualified AV Project Engineer. Each shop drawing shall be reviewed, signed and stamped with the CST-D@ stamp of the responsible AV Project Engineer.
5. Each as-built drawing shall be reviewed, signed and stamped with the CST-1@ stamp of the AV Technician responsible.
6. Installation performed by other than a qualified AV Technician shall be performed by qualified AV Installers. These Installers shall perform their work under the direct supervision of a qualified AV Technician. The ratio of AV Installers to AV Technicians shall not exceed 3 to 1.
7. System adjustments shall be made by qualified AV Technicians, AV Project Engineers, and manufacturer employees.
8. Cabling for Audio-Visual systems shall be installed by AV Technicians, AV Installers, or BICSI ITS certified technicians.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1. QUALITY ASSURANCE SUBMITTALS

- A. Provide documentation that demonstrates the qualification for each requirement articulated in this Section and in compliance with Section 270503 Submittals.

END OF SECTION 270002.00

SECTION 270100.00 - OPERATION AND MAINTENANCE OF COMMUNICATIONS

PART 1 GENERAL

1.1. SUBMITTAL REQUIREMENTS

- A. Closeout
 - 1. Operation and Maintenance Manual: For equipment and systems to include in operation and maintenance manuals.
- B. Shop Drawings
 - 1. As-Built Drawings: For recording installed conditions that deviate from design documents.

1.2. OPERATION AND MAINTENANCE MANUAL

- A. The contents of operating and maintenance manual shall include the following:
 - 1. Project Information Cover: Title of Project; Name and address of Owner, Design Professionals, Contractor of Record and Subcontractor; System name and specification references.
 - 2. Index: Contents of the manual.
 - 3. Warranty Statements: Furnish a warranty statement for each system, reiterating the terms of warranty identified within the Contract Documents, and identifying how the Owner is to obtain warranty service. Clearly identify which products are covered by Manufacturer warranties beyond the Contractor required minimum warranty period. The term of manufacturer warranty shall also be identified (e.g., 1-year parts and labor). Identify the date that the warranty for the system starts. This date shall be the date listed on the Certificate of Substantial Completion (if one was issued to the contractor specifically for the system) or the date listed on the Notice of Final Completion. Supply standard out-of-warranty service rates and service contact information.
 - 4. Bill of Materials: List of products supplied, and serial numbers of each product.
 - 5. Product Datasheets and Shop Drawings: Manufacturer datasheets and shop drawings for each product and system supplied.
 - 6. Manufacturer Owner / User Manuals: Manufacturer's Owner's or User's manual for each product, and Manufacturer's Installation instructions and other documentation supplied with the product.
 - 7. Extra Material Schedule:
 - a. Complete spare parts schedule for components of equipment furnished, which are not factory generic information, but accurate for the equipment provided.

- b. Itemized list of each piece of communications, architectural and Owner equipment having communications connections with termination locations; also, list related expendable equipment required for each item as applicable.
8. Maintenance Procedures: Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; testing, aligning and adjusting instructions.
9. Function and Operating Descriptions: Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
10. Operating Procedures: Manufacturer's printed operating procedures including start-up, break-in, normal operating instructions, regulation, control, stopping, shutdown, and emergency instructions.
11. Include Product Certificates, Source quality-control test reports and Field Quality-Control Reports
12. Test Reports and Checklists: Test reports, checklists, and other forms generated and completed for the Project.
13. Training Information: Copy of training outlines/agendas, training session handouts, training sign-in sheets, and signed delivery receipt for each training session recording; Separate USB drive, labeled, for audio/video-recorded instructions to Owner, for operations and maintenance for each system.
14. As-Built Drawings.
15. Software: Application and operating software documentation; Software licenses; Software service agreements; Manufacturer's operating specifications; design user's guide for software and hardware; Editable configuration files for system equipment; Software source code used in supplied products; Compiled versions of configuration files and source code; IP addresses of products configured to have static IP addresses; MAC addresses of products featuring network communication ports (wired and/or wireless); Network device names for products configured for DHCP; Software required for reviewing and editing supplied files.

1.3. AS-BUILT DRAWINGS

- A. Obtain two complete sets of communications prints and use them to provide progress record drawings which are separate, clean, prints reserved for the purpose of showing a complete picture of the work as actually installed (including routing of conduit and cables). These drawings also serve as work progress report sheets. Make notations, neat and legible thereon daily as work proceeds. Make these drawings available for inspection at all times and keep them at the job at a location designated by the Owner's Representative.
- B. Maintain the clean, undamaged set of prints of drawings as well as a set of submittal drawings and coordination drawings. Mark the sets to show the actual installation where the installation varies from the Documents as originally shown. Include locations of underground and concealed items if placed other than shown on the Documents. Where shop drawings

are used, record a cross-reference at the corresponding location on the Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.

- C. Show changes in: size, type, capacity, etc., of material, device or piece of equipment, location of device or piece of equipment; location of outlet or source of building service systems; routing of piping, conduit, or other building services. Record location of concealed equipment, by indication of measured dimensions to each line from readily identifiable and accessible walls, column lines or corners of building. Indicate approved substitutions, modifications, and actual equipment and materials installed.
- D. At the conclusion of the project, transcribe as-built information onto a digital copy of the communications plans to be submitted as part of the closeout documents. All notations shall be in a standard and legible font. Hand-written as-built documents shall not be accepted.
- E. Affix near the title block on each drawing the Contractor's Company Name(s), signature of Contractor's Representative(s) and current date.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1. INSTRUCTION OF THE OWNER'S PERSONNEL

- A. Provide instruction in the proper operation and maintenance of equipment that requires routine servicing. Include the following:
 - 1. Review of operation and maintenance manuals.
 - 2. Required tools.
 - 3. Extra Materials.
 - 4. Cleaning.
 - 5. Hazards.
 - 6. Warranties and maintenance agreements.
- B. Demonstrate equipment and systems operation including the following:
 - 1. Start-up.
 - 2. Shut-down.
 - 3. Emergency conditions.
 - 4. Safety procedures.
 - 5. Setpoint and schedule adjustments.
 - 6. Economy and efficiency adjustments.

END OF SECTION 270100.00

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SECTION 270501.00 - BASIC MATERIALS AND METHODS FOR COMMUNICATION

PART 1 GENERAL

1.1. SUMMARY

- A. Section Includes: Requirements applicable to work of this Division.
 - 1. Basic materials, methods and installation guidelines applicable to the installation of all communication systems.

1.2. QUALITY ASSURANCE

- A. Welding
 - 1. Welding at the project site, where necessary, shall be performed only by persons licensed to perform such work at the project site(s). Welding shall require a permit and the approval of the Owners Representative. Request for permission to perform onsite welding shall be submitted in writing through designated project channels.

PART 2 PRODUCTS

2.1. CABLE BUNDLING HARDWARE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Hellermann Tyton.
 - 2. Millepede, Inc.
 - 3. Panduit.
 - 4. Velcro.
- B. General: Provide reusable, adjustable cable straps.
 - 1. Hook and Loop Fastener:
 - a. Shall be utilized within all cabinets and racks and below the ceiling of Telecommunications and Equipment rooms.
 - 2. Provide plenum rated ties in plenum environments.
 - 3. Minimum cable strap width shall be 3/4-inch.
 - a. Basis of Design: Velcro One-Wrap Qwik Ties.

PART 3 EXECUTION

3.1. COORDINATION

- A. High Voltage Wiring
 - 1. Review all high voltage provisions for This Contractor's work with the Division 26 electrical contractor. Coordinate specific device termination, loading and circuiting requirements with the electrical contractor.
- B. Coordinate installation of new pathways with parties and the Work that will utilize the pathways, prior to installation.
- C. Review pre-existing pathways prior to installation of the Work, and report to the Designer any discrepancies between specified pre-existing pathway conditions and actual existing pathway conditions.
- D. Participate in coordination efforts through the preparation of shop drawings and details prior to fabrication or installation of any products. Coordinate actual clearance requirements of installed products.
- E. Begin coordination immediately upon award of contract. Coordinate the Work with other parties and adjust equipment locations accordingly. Participate in the preparation of coordination drawings.
- F. Devices and equipment shall be located symmetrical with architectural elements and shall be installed at the heights and locations shown on the Drawings. If a height or location is in question, seek immediate clarification from the Designer.
- G. Evaluate the Contract Documents and existing conditions to gain an understanding of the peculiarities and limitations of the spaces where the Work is to be performed. The final Work shall be accessible for servicing. Although the locations of equipment and conduit may be shown on the Drawings in certain positions, the architectural details and conditions existing on the Project shall guide the Contractor, coordinating the Work with that of others. Provide necessary offsets to provide a neat workmanlike arrangement.
- H. The Drawings are generally diagrammatic and indicate the design intent, required sizes, points of termination and, in some cases, suggested routes of raceways. However, it is not intended that the Drawings indicate fully coordinated routing and placement or necessary offsets.
- I. Refer to each Drawing, including enlarged plans, elevations, sections, and details for additional information that may include dimensions and greater resolution and notes that serve to refine the intent and further assist and guide installation.
- J. Work in harmony with other parties performing work at the project site so as not to cause any delays in pouring concrete or erecting masonry walls. Consult each Contract Drawing, including those predominately used by other trades, before installing Work so as to ensure that performance of Work will not interfere with or be adversely affected by Work of others.
- K. Take special care in the coordination of special rough-in requirements for equipment recess mounted in walls. Provide custom backboxes, enclosures, and other mounting hardware to

the rough-in contractor prior to the construction of the wall. Rough-in hardware or requirements not properly coordinated shall be corrected at the Contractor's expense.

- L. Attend each regularly scheduled project meeting as well as any special meetings called to coordinate and/or resolve special issues that arise during the course of the Project.
- M. Conflicts in equipment and materials shall be corrected prior to installation. Should there be a conflict with drawings of other trades, work with the other trades to correct the conflict while coordinating the Project (prior to installation). If a conflict cannot be resolved, seek the direction of the Owner's representative. Refer to the drawings used by other trades for details, dimensions and locations of their work and route around their work so as not to conflict. Work installed that creates a conflict shall be removed and readjusted to the satisfaction of the Owner's representative at the Contractor's expense.

3.2. INSTALLATION

A. General:

1. Cabling installed within open ceilings shall be ran in conduit or fully concealed from view behind the building structure.
2. Work installed in finished areas shall be concealed.
3. Sequence, coordinate, and integrate installations of communications materials and equipment with the work of other trades for efficient flow of the Work.
4. Install systems, materials, and equipment to conform to reviewed submittal data, including coordination drawings.
5. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and architectural/structural components (prevailing building lines), except as expressly detailed otherwise or required for proper form, function or Designer intended operation. Except where otherwise specified, detailed or directed by the Designer, install visible products level.
6. Install equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations.
7. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
8. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
9. Verify dimensions by field measurements. Take measurements and be responsible for exact size and locations of all openings required for the installation of work. Figured dimensions are reasonably accurate and should govern in setting out work. Where detailed method of installation is not indicated or where variations exist between described work and approved practice, direction of the owner's representative on job shall be followed.

10. If during construction it becomes apparent that certain minor changes in layout would result in a neater appearance or better arrangement, such alterations shall be made as part of the Contract. Designer's review shall be obtained before making such changes.
 11. Workmanship throughout shall conform to the standards of best practice. Marks, dents or finish scratches shall not be permitted on any exposed materials, fixtures or fittings. Interiors of panels and equipment boxes shall be left clean.
- B. Cabling
1. Use caution not to exceed the manufacturer allowed bending radius for cables and not to compromise the integrity of the cables during installation by pulling cable management devices too tightly, damaging cables. Raceway/cabling bending radii shall be minimum as directed by cable manufacturer. Use pulling compound or lubricant where necessary to ensure cable does not experience tension beyond manufacturer limits during installation. Compounds used shall be compatible with the cable and pathway products and shall not cause deterioration of either.
 - a. Where indicated, provide color-coded jackets to identify runs of different systems.
 2. See related specifications and drawings for applicable color coding.
 3. Neatly route cables parallel and perpendicular to building architectural lines.
 - a. Cables and cable assemblies shall be run as straight as possible and symmetrical (perpendicular to or parallel with) with architectural items and at a consistent elevation. Work installed diagonal to building members shall not be permitted.
 4. Neatly comb out multiple cable bundled runs to remove tangling and crossing of cables within the bundles. Neatly dress all cable work and provide vertical and horizontal cable management (or other approved method) for properly dressing all work at racks, control panels, backboards etc. See detail(s) if applicable.
 - a. To avoid Alien Crosstalk, do not cinch UTP cables into tight bundles.
 5. Cable shall be installed within approved pathways. Cables not installed within raceway, cable tray or ladder rack shall be supported by discrete cable supports. Support cables at box and faceplate.
 6. All penetrations to walls and floors designed to shall include metal sleeves. All sleeves shall be mechanically secured in place and sealed between the sleeve and structure. Apply firestop to the interior of the sleeve.
 7. Loosely bundle cables within racks, ladder racks, cable trays and in discrete cable supports. Utilize reusable cable bundling hardware. Utilize plenum-rated hardware in plenum spaces.
 8. Plenum-rated cable ties shall be used wherever wire ties are permitted and wherever plenum rated cable is used.
 9. Cable ties shall never be used in a manner that causes deformation of the cable jacket, damage to the cable, or has any adverse effect on the usability, specifications or longevity of the cable(s) on which it is applied.

10. Velcro type wire ties shall be used in non-plenum spaces; in equipment racks; in rack cabinets, and; in related equipment housing enclosures and backboards.

C. Cable Support

1. All cables shall be supported/anchored every 5 feet (or less) and within 12" of device boxes, outlets, racks/cabinets and cable tray.
2. Use J-Hook type cable supports for all cables run outside of conduit or cable tray. Bridle rings shall not be used for Communications Technology cables.
 - a. Use separate J-Hook cable support systems for cables belonging to different systems and for cables carrying different operating levels. See Cable Separation guidelines in this section.
3. Loosely secure cables at each J-Hook.
4. Cables shall not be directly or indirectly supported by a suspended ceiling or any other surface, support, material or structure not permissible for this use by all applicable codes and standards.
5. Cable pathway
 - a. Use and positioning
 - 1) Pathway shall be installed to form a reusable pathway system.
 - 2) Totally enclosed raceways (i.e. conduit, wireway, etc.) shall be utilized to span in-accessible spaces.
 - 3) Cable trays and discreet cable supports shall be utilized to support cables.
 - a) To form an open-top reusable pathway
 - b) Shall be used in accessible ceiling cavities and areas not accessible by the public (i.e. mechanical and service areas).
 - c) Shall follow corridors unless specifically noted otherwise.
 - d) Shall provide usable clearances above, below and beside for access space for the re-use of the pathway. Minimum 6" below and beside and 12" above.

D. Cable Separation:

1. Low-voltage cables shall be kept as far from electrical cables and equipment as possible. Avoid running low-voltage cables parallel to medium and high-voltage cables. When parallel runs cannot be avoided, keep low-voltage cables at least 24 inches away and cross cables at 90 degrees to minimize the risk of interference
2. Low-voltage cables shall not be permitted in the same conduit with high-voltage electrical cables.
3. Avoid running low-voltage cables any closer than 24 inches to any ballast type lighting fixture or other high RF energy producing device.
4. Cables for each system shall be installed separately and isolated from cables from other systems.

5. Cables carrying signals of different types and different nominal operating levels shall be kept separated to reduce the risk of undesirable interference and cross-talk between cables.
 - a. As a general rule, for each 25dBV difference in nominal operating level between cables, provide at least 6 inches of separation. Example 1: Cables with a 75dBV level difference between them shall be separated by 18 inches or greater.
 - b. Example 2: Cables with a 13dBV difference between them shall be separated by 3 inches or greater.
 - c. Contractor shall provide additional separation to prevent and to remedy any crosstalk that adversely affects the performance and usability of the system, or that exceeds specific crosstalk performance guidelines defined elsewhere in these specifications.
 - d. Provide greater separation than this guideline where the contractor believes and/or determines it is necessary to prevent or remedy interference between cables.
 6. Keep length of parallel runs to a minimum. Cross cables of different nominal levels at 90 degrees.
 7. In common areas where cables from multiple systems are run in general proximity to one another, cables from each system shall be labeled to identify the system the cables serve.
 8. Additional pathway devices/systems shall be provided as required to comply with cable separation requirements, including, but not limited to, conduits, sleeves, discrete pathway devices and cable tray.
- E. Cable Splices:
1. Splices shall not be permitted in any cable except where expressly specified and/or approved by the Designer.
 2. In cases where splices are specified and/or otherwise reviewed and permitted, splices shall be made within UL listed junction or device boxes. Open air connections shall not be permitted.
- F. Cable Terminations:
1. Termination types shall correctly match cable and device termination. As an illustration, if "spade lug" type of termination is appropriate, then the spade lug cable entry size shall match the cable used. The spade lug shall also have the correct stud size to match the terminal to which it is connected. Terminations shall be completed with tools designed and sized for the specific application and connector.
 2. Where field installed cables connect to manufactured products via pig-tails or connectorized cable assemblies, terminations shall be made within the product enclosure or within a UL approved box. Exposed and open-air splices shall not be permitted.
- G. Strain Relief:

1. Permanently installed cables shall be properly secured with an approved device. Strain relief shall be applied typically within 6 inches from the point of entry into a product enclosure, junction box, pull box, or device box. When properly applied, the strain relief device shall not damage the cable being secured and shall not permit movement of the cable in any way that may adversely affect the long-term integrity of nearby connections.

H. Identification:

1. General:
 - a. Identification shall be in English, except as otherwise noted.
 - b. Where identification is applied to surfaces that require a finish, install identification after the surface finish is applied.
 - c. Labeling products, color, sizes, nomenclature and location of the identification product are subject to the review of the Designer.
2. Cables:
 - a. Each cable shall be uniquely labeled at each end.
 - b. Labels shall be permanent and feature computer generated type-written text.
 - c. Label text shall be bold-type and clearly readable by a person with average sight, and under the lighting conditions typical within the area of installation.
 - d. Labels shall be applied approximately 4-6 cable-inches from the point of termination.
 - 1) Adjust application to make legible during service/maintenance of system
 - e. Systems cables installed for "Future Use" shall be clearly identified as such at both ends. Such cables shall be labeled to identify where the opposite end of the cable can be found.
 - 1) Not applicable for Structured Cabling for voice/data connectivity.
 - f. Each cable installed shall be recorded on the as-built drawings.
3. Boxes:
 - a. Junction boxes and pull boxes shall be labeled on their interior and on their exterior covers with the identity of the system(s) the box serves along with the function of the box. Interior markings shall be made using permanent marker. Permanent marker may also be used on the cover of boxes installed in concealed areas (above accessible ceilings, for example). Exposed boxes shall be labeled with engraved plastic labels. Labels shall closely match the color of the box.
 - b. Device boxes, when first installed, shall be identified on its interior as to the system(s) served and the device(s) the box will contain.
 - 1) Where conduit feeding the device box is concealed, label the exterior of the conduit with permanent marker.
4. Equipment Racks, Cabinets, Enclosures:
 - a. Equipment racks and enclosures shall be labeled.
 - b. The nomenclature, color, size, installed location, and type of labels are subject to the Designer's review.

5. System Equipment:
 - a. Each individual instance of system equipment shall be labeled.
 - b. Front panel controls of equipment shall be labeled with nomenclature meaningful to the end user based on the intended use of the equipment in the system.

Examples include, but are not limited to:

 - 1) Label router/matrix control panels with system specific input/output names.
 - 2) Label patch panels with meaningful input/output destination names.
 - 3) Label mixer input and output controls to identify the signal source and destination.
 - c. Professionally prepared, installed and readily visible "cheat sheets" may be acceptable under select circumstances with the approval of the Designer.
 - d. The nomenclature, color, size, installed location, and type of labels are subject to the Designer's review and approval.
- I. High Voltage Cabling (greater than 70.7 Volts):
 1. Cabling that carries voltages higher than 70.7 Volts RMS AC or DC shall be installed and terminated by persons licensed to perform such work.
- J. Plates and Panels:
 1. Box covers and faceplates shall be installed flush against the surface over which it is mounted. There shall be no visible gap between the backside of a plate/panel and the wall, ceiling or floor; there shall be no visible gap between the backside of plate/panel and a surface mount box to which the plate/panel mounts). Advanced craftsmanship and construction techniques shall be employed where necessary to achieve this.
 - a. The same shall apply to other wall and ceiling mounted products.
 2. Plates and panels shall be installed with all screw holes filled and fastened securely.
- K. Device Boxes, Pull-Boxes, Junction Boxes:
 1. Boxes installed in walls and ceilings shall be installed so that the box does not protrude out beyond the finished surface. Boxes shall be installed such that when the mounted devices and cover plates are installed, the backside of the cover plate rests flush with the finished surface of the wall or ceiling. Advanced craftsmanship and construction techniques shall be employed where necessary to achieve this.

3.3. GROUNDING

- A. Equipment shall be properly bonded to ground for the safety of personnel and property and as additionally necessary to ensure satisfactory performance of the equipment.
- B. Comply with Section "Grounding and Bonding for Communications."

3.4. CUTTING, PATCHING AND SEALING

A. General:

1. Perform cutting as required for the execution of the Work. Unless directed otherwise in the field, provide related patching and painting to match surrounding methods, materials and colors. Any damage caused during the progress of Work shall be remediated. Perform cutting, fitting, and patching and materials as required to:
 - a. Uncover Work to provide for installation of ill-timed Work.
 - b. Remove and replace defective Work.
 - c. Remove and replace Work not conforming to requirements of the Contract Documents.
 - d. Remove samples of installed Work as specified for testing.
 - e. Install equipment and materials within existing structures.
2. Upon written instructions from the Owner's representative, uncover and restore Work to provide for observation of concealed Work by Owner's representative or by inspection by the Authority Having Jurisdiction.
3. During cutting and patching operations, protect adjacent installations (e.g., structure, finishes, and furnishings). Where applicable, provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to system components and components of other trades.
4. Patch surfaces and building components using new materials matching existing materials and using experienced Installers. Refer to Division 01 for definition of experienced "Installer" or determine qualifications as directed in the field by the Owner's representative.
5. Patching through fire rated walls and enclosures shall not diminish the rating of that wall or enclosure. Materials used for patching shall be installed to meet or exceed the smoke and fire rating of the respective surface being patched.
6. Neatly cut and drill openings in walls and floors where openings are required for installation of the Work. Secure the approval of the Owner's Representative before cutting and drilling in existing facilities. Neatly patch any openings created.
7. Cutting and patching shall be held to a minimum by arranging with other parties for sleeves and openings before construction is started.
8. Provide factory-assembled watertight wall and floor seals, of types and sizes required, suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.
9. Pipe sleeves shall be fabricated from Schedule 40 rigid, heavy wall, full weight galvanized steel pipe; remove burrs. Use sleeves which are two standard sizes larger than conduit passing through respective sleeve.
10. Provide sleeve seals for piping that penetrates foundation walls below grade, or through exterior walls or roofs. Caulk between sleeve and pipe with non-toxic, UL-classified caulking material to ensure watertight seal. Elsewhere provide mechanical type seals, 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.

11. Install standard Schedule 40 black steel pipe sleeves two sizes larger than pipes passing through floors, bearing walls, fire walls and masonry construction. Furnish and set forms required in masonry walls or foundation to accommodate pipes.

B. Grout:

1. Provide non-shrink, nonmetallic grout, pre-mixed, factory-packaged, non-staining, noncorrosive, and non-gaseous grout, recommended for interior and exterior applications.

C. General Joint Sealer Application:

1. Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.
2. 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.
3. Clean affected surfaces, joints, etc. immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.
4. Apply sealant primer to substrates as recommended by manufacturer. Protect adjacent areas from spillage and migration of sealant, using masking tape. Remove tape immediately after tooling without disturbing seal.
5. Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.
6. Immediately after sealant application and prior to time shinning 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.
7. Colors for exposed seals shall be as selected by the Owner's representative from manufacturer's standard colors.

3.5. FIRESTOPPING

- A. Penetrations created in support of any work of this Division shall be fire stopped in accordance with locally applicable codes as acceptable to the Authority Having Jurisdiction.

END OF SECTION 270501.00

SECTION 270513.00 - COMMUNICATION SERVICE ENTRANCE

PART 1 GENERAL

1.1. SUBMITTALS

- A. Product Data:
 - 1. Bill of Materials (BOM).
 - 2. Product Datasheets.
- B. Shop Drawings:
 - 1. Site Plans, coordinated: depicting the planned pathways and routing of utility(s) service entrance(s).
 - 2. Floor Plans, coordinated: depicting the planned pathways and routing of utility(s) service entrance(s) and demarcation point(s).
 - 3. Wall Elevations.
- C. Closeout Submittal:
 - 1. Product Datasheets.
 - 2. As-Built Drawings.
 - 3. Provide additional closeout documentation as required in Division 01 and Division 27 "General Requirements for Communications."

1.2. REFERENCES

- A. Definitions:
 - 1. Duct: An underground or overhead enclosed raceway for conductors, wires or cables.
 - 2. Entrance Point: The point of emergence for cabling through an exterior wall, a floor, or from a conduit.
 - 3. OSP (Outside Plant): Communications spaces, pathways, cabling, and termination hardware required to connect two or more buildings or structures and includes work through the building or structure penetration to the point of termination.
- B. Reference standards:
 - 1. Comply with standards set forth in 27 00 01 - Common Work Results for Communications: References.

1.3. COORDINATION

- A. Review and coordinate requirements with the respective utility company(s) to provide service entrance work in strict accordance with regulations of the respective utility company(s) and of Authorities Having Jurisdiction (AHJ) for the following:
 - 1. Telephone/Data Utility service (where applicable).
 - 2. Cable TV (CATV) Utility service (where applicable).

3. Private Communications/Data service (where applicable).
- B. Review the pathway requirements for each system to ensure that the pathways shall fully satisfy the needs of each system, device and cable.
- C. Coordinate layout and installation with the Owner's telecommunications and LAN equipment and service providers.

1.4. SYSTEM DESCRIPTION

- A. Utility Entrance — Telecommunications Service:
 1. Provide three (3) 4-inch conduits with pull lines from the telecommunications backboard within the Entrance Facility (EF) to the outdoor utility pole or other location as directed by the locally operating utility company for utility service entrance to the building.
 2. Conduits to terminate in open bottom in-ground box.
 3. Extend conduit(s) from in-ground box to the designated utility pole to a minimum of 12 inches above final grade at the pole.
 - a. Plug conduits before and after installation of cable to prevent water entry.
 4. Provide a minimum of 12 inches of earth separation between disparate systems conduits and other conduits, or a minimum of 4 inches where encased in concrete.
 5. Provide minimum 200-pound test pull line in conduits.
 6. Install conduit at a minimum depth of 24 inches, and a maximum depth of 36 inches. Provide record documentation.
 7. Provide long sweeping bends for offsets, with radii not less than ten times the internal diameter of the conduit and with a maximum of 180 degrees of bends between pulling points. Provide flush grade mounted pull box (approved by the local utility company) if required bends exceed 180 degrees.
 - a. Provide pull boxes, including additional quantities as required, so that conduit runs do not exceed 200 feet.
 8. Extend conduit entering the building interior 4 inches above the finished floor elevation or 2" beyond the interior wall.
 - a. Further extensions may be accommodated utilizing continuous GRC (Galvanized Rigid Conduit) to extend the demarcation point.
 9. Provide a minimum 4-foot wide by 8-foot tall by 3/4-inch deep plywood equipment backboard within the building.
 10. Coordinate with Division 26 and provide two (2) NEMA 5-20R 20N120V duplex receptacles, connected to a common dedicated circuit on the plywood backboard.
 11. Provide continually accessible, well lighted and environmentally clean termination spaces. Provide termination spaces with duplex receptacles as described above. Configure termination spaces so that a minimum of 36 inches of working clearance is maintained in front of the backboard(s).

12. Provide related Work in compliance with federal, state and local building codes, including the National Electrical Code, the National Electric Safety Code and TIA-569 "Commercial Buildings Standard for Telecommunications Pathways and Spaces" as well as other codes and authorities having jurisdiction.

PART 2 PRODUCTS

- A. Comply with 27 05 43.00 - Underground Ducts and Raceways for Communications
- B. Comply with 27 11 10.00 -Wall Linings for Communication Rooms

PART 3 EXECUTION

3.1. GENERAL

- A. Secure applicable permits for work specified in this Section.
- B. Review and coordinate pathways prior to installation.
- C. Provide traffic control, as required, including flag and security personnel, signage, barricades, routing changes, and other requirements as specified or required.
- D. Locate, identify, and avoid existing utilities (public and private), including but not limited to electric, water, sewer, gas, and telecommunications.
 1. Repair damage occurring to existing underground utilities as a result of this Project
- E. Right-of-way will be secured by the Owner. Provide work specified within the requirements of the right-of-way agreement.
- F. Supply and erect proper barriers, signage, covers, fencing, supports, and any other protection necessary to prevent harm to persons within and near the area of construction.
- G. Provide proper electrical protection for Work.

3.2. UTILITY COORDINATION

- A. Coordinate with the Owner/Construction Manager/Project Manager/Designer to understand the Utility requirements for termination space necessary for incoming Communications Services.

3.3. WALL LININGS - COMMUNICATIONS BACKBOARDS

- A. Comply with Section 27 11 10 "Wall Linings for Communication Rooms."

3.4. GROUNDING AND BONDING

- A. Comply with Section 270526 "Grounding and Bonding for Communications" for grounding conductors and connectors.
 - 1. Coordinate placement of Primary Bonding Busbar (PBB) on backboard. Verify conductor size, and provide conductor sized to meet the referenced Standards within a continuous conduit, as required. Terminate as directed by the utility company and referenced Standards
 - 2. Provide a minimum of one (1) green-insulated ground conductor from the Telecommunications service entrance ground to the plywood backboard.
- B. Ground electrical systems and equipment as required by code, utility, local ordinances and requirements herein, including referenced Standards.

3.5. IDENTIFICATION

- A. Comply with Section 270553 "Identification for Communications."
- B. Identify system components and cabling in compliance with TINEIA-606-A, or most current version.

3.6. 3RESTORATION

- A. Restore affected areas to how they existed before construction.
 - 1. Where trenching has been performed, restoration shall include additional trench fill after settlement of original fill has completely subsided and reseeding as necessary for complete restoration.
 - 2. Where existing surface is removed, repair by backfilling with material equal in composition and density to the surrounding areas and replace removed surface such as asphalt pavement and concrete riprap with like material to equivalent condition.
- B. Provide erosion control, including bailed hay and sediment control fencing, as identified in the referenced Standards.

END OF SECTION 270513.00

SECTION 270526.00 - GROUNDING AND BONDING FOR COMMUNICATIONS

PART 1 GENERAL

1.1. SUMMARY

A. Section Includes:

1. Grounding and Bonding System for Communications, including:
 - a. Copper Conductors.
 - b. Busbars.
 - c. Grounding/Bonding termination devices.
 - d. Mounting, connection and supporting hardware.

B. Related Requirements:

C. Related Sections:

1. Section 260526 "Grounding and Bonding for Electrical Systems" additional grounding and bonding requirements.

1.2. REFERENCES

A. Definitions:

1. Bonding: The joining of metallic parts to form an electrically conductive path.
2. Bonding conductor (BC): A conductor that joins metallic parts to form an electrically conductive path.
3. Bonding backbone conductor (BBC): The conductor that interconnects elements of the telecommunications grounding infrastructure.
4. Common bonding network: Set of metallic components that are interconnected to form the principle means for effectively bonding equipment inside a building to the grounding electrode system.
5. Ground: 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.
6. Grounding Electrode Conductor (GEC): Conductor used to connect the grounding electrode to the equipment grounding conductor, or to the grounded conductor of the circuit at the service equipment, or at the source of a separately derived system.
7. Mesh Bonding Network: Bonding network to which all associated equipment (e.g., cabinets, racks, frames, trays, pathways) are connected using a bonding grid, connected to multiple points on the common bonding network.
8. Primary bonding busbar: A busbar placed in a convenient and accessible location and bonded, by means of the telecommunications bonding conductor, to the buildings service equipment (power) ground.

9. Secondary bonding busbar: A common point of connection for telecommunications system and equipment bonding to ground and located in the distributor room.
 10. Telecommunications bonding backbone (TBB): A conductor that interconnects the telecommunications main grounding busbar (PBB) to the telecommunications grounding busbar(s) (SBB).
 11. Telecommunications bonding conductor (TBC): A conductor that interconnects the telecommunications bonding infrastructure to the building's service equipment (power) ground.
 12. Telecommunications equipment bonding conductor (TEBC): A conductor that connects the telecommunications main grounding busbar (PBB) or telecommunications grounding busbar (SBB) to equipment racks or cabinets.
- B. Reference standards:
1. Comply with standards set forth in 27 00 01 - Common Work Results for Communications: References.

1.3. QUALITY ASSURANCE

- A. Provide 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. Comply with UL 467 for grounding and bonding materials and equipment. Comply with ANSI/TINEIA-607, "Commercial Building Grounding and Bonding Requirements for Telecommunications." Comply with NFPA 70.

1.4. SYSTEM DESCRIPTION

- A. The system shall provide Standards and Code compliant bonding of products to ground for the safety of equipment, personnel and property and for the stable and reliable operation of connected equipment.
1. The system shall be configured to ensure proper operation of equipment. The system shall not result in ground currents that adversely affect the performance of the connected systems using the system.
 2. The system shall derive its main ground connection from the Electrical Grounding Electrode System as defined by the NEC, the same electrode system used to establish the main/common ground for the building electrical system.
 3. The system shall connect to Electrical Grounding Electrode System at a single point. Coordinate and comply with Section 260526 "Grounding and Bonding for Electrical Systems" where applicable.
 4. The system shall be visually verifiable and adequately sized to handle expected currents safely, directing potentially damaging currents away from sensitive network equipment.

PART 2 PRODUCTS

2.1. GENERAL

- A. Products furnished of each Type shall be manufactured by a single manufacturer, bear the same brand name, be the same finish color and texture, and be from the same product model series, except where otherwise indicated.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Chatsworth.
 - 2. Erico Electrical Products.
 - 3. Harger Lightning & Grounding
 - 4. Storm Power Components.
 - 5. Panduit.
 - 6. Thomas and Betts
- C. Bonding and grounding connectors shall be Listed for the application (e.g., above ground, direct buried, bonding to the metal frame of a building).

2.2. GROUNDING BUSBARS

- A. Secondary Bonding Busbar (SBB) / Telecommunications Grounding Busbar:
 - 1. Electro-tin plated $\frac{1}{4}$ " thick copper bar
 - 2. Insulated standoffs
 - 3. Hole pattern type "CC"
 - 4. 4 inches high x 20 inches wide
 - 5. Comply with referenced standards and BICSI requirements.
- B. Rack Bonding Busbar Kits:
 - 1. Optimized for installation on 19-inch racks or cabinets meeting EIA-310-D.
 - 2. Available pre-assembled with mounting screws.
 - 3. Electro-tin plated to inhibit corrosion.
 - 4. Provide quantities of busbars to handle a quantity of two-hole connectors equal to a minimum of one-half of the total rack units (RUs).

2.3. CONDUCTORS, CONNECTORS AND ELECTRODES

- A. Comply with Section 260526 "Grounding and Bonding for Electrical Systems"

PART 3 EXECUTION

3.1. GENERAL

- A. Ground electrical systems and equipment as required by code, utility, local ordinances, and requirements herein, including referenced Standards.

- B. Work shall be installed in accordance with the Contract Documents, manufacturer's recommended installation practices, applicable codes and referenced Standards.
- C. Contractor shall bring to the Owner's attention any existing system elements not compliant with modern grounding and bonding requirements for possible remediation.

3.2. INSTALLATION

A. General:

1. At minimum, bond together telecommunications racks, cabinets, tray, ladder rack, and risers in each telecommunications equipment room (ER) and telecommunications wiring closet/room (TR) to the busbar in the respective room. Bond each TR busbar to the ER busbar. Bond the ER busbar to the grounding electrode system and the electrical grounding system at the main building ground point. Bond additional points where indicated in the drawings and where required by NFPA 70. Provide a common ground with the building's grounding electrode system for the Telecommunications Infrastructure components.
 2. Bond the Main telecommunication service entrances to the electrical service equipment ground using the most direct route possible to minimize conductor length.
 3. Provide copper grounding conductor from main building grounding electrode system at service entrance to ground bus at the Telecommunications Entrance Facility.
 4. Provide copper bus bars on plywood backboard in each ER and TR.
 5. Provide copper grounding conductors, in conduit, from the electric service ground busbar to each ER and TR ground busbar.
 6. Provide minimum #4 AWG bonding jumper (12 inches maximum) with appropriate lugs at each cable tray joint or provide manufactured braided copper grounding jumper.
 7. Provide minimum #4 AWG insulated (green insulation) grounding conductor with appropriate lugs from side of cable trays to each ER and TR ground busbar. Drill and tap side of cable trays (for appropriate size bolt, 1/4 inch by 20 min.), and provide bolted connections making sure that bolts do not extend into wire management part of trays.
 8. Provide isolation for grounding busbars from the structure support with a 2-inch minimum separation using manufacturer's recommended insulating stand-offs and hardware.
- B. Comply with Section 260526 "Grounding and Bonding for Electrical Systems"
 - C. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
 1. Where protecting a grounding electrode conductor (GEC) from physical damage with rigid, non-metallic conduit (RNC) use schedule 80 PVC as the raceway.

2. The structural frame of the building shall not be used as an equipment grounding conductor.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit. Bond straps directly to basic structure, taking care not to penetrate any adjacent parts. Install bonding so vibration is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- E. Secondary Bonding Busbar (SBB):
1. Install SBB (s) on a plywood backboard (wall lining).
 2. SBB shall be as close as practical to the electrical power panel (panel board) and shall be installed to maintain clearances required by applicable electrical codes.
 3. When a panel board is located in the same room or space as the SBB, bond the alternating current equipment ground (ACEG) (when equipped) or the panel board enclosure to the SBB.
 - a. When a panel board for telecommunications equipment is not installed in the same room or space as the SBB, the SBB shall be located near the backbone cabling and associated terminations.
 - b. Connections (bonds) between the communications grounding and bonding system and associated electrical panels shall be completed by a qualified electrician.
 - c. When a panel board for telecommunications equipment is not installed in the same room or space as the SBB, the SBB shall be bonded to the panel board that feeds the space.
 4. When a bonding backbone conductor (BBC) is required, it shall be bonded to the SBB.
 5. TBBs shall be bonded to the SBB with a conductor the same size as the SBB.
 6. BBC and TBB connections and conductors for bonding telecommunications equipment and pathways to the SBB shall utilize exothermic welding, Listed compression two-hole lugs, or two-hole exothermic lugs.
 7. The SBB shall serve telecommunications equipment that is located within the same room or space.
 8. Minimum size of the SBB is as specified. If required, increase the size of the SBB to accommodate the number of necessary bonded connections.
- F. Bonding of Equipment Racks and Cabinets:
1. The welded construction of a welded cabinet or equipment rack may serve as the method of bonding the structural members of the cabinet/rack together.
 2. Bolted cabinets/equipment racks shall incorporate bonding hardware (e.g., bolts, washers, nuts and screws) specifically designed to accomplish integral bonding of the cabinet and rack assembly, frame and support, and tested to meet applicable NRTL requirements.

- a. If the hardware (e.g. bolts, washers, nuts and screws) are not specifically designed for grounding purposes, the paint shall be removed from bonding contact areas.
 3. Detachable metallic parts of equipment cabinets (e.g., frame, door, side panel, top panel) shall be connected to ground.
 - a. When grounding/bonding jumpers are provided, the jumper shall be minimum No. 12 AWG stranded, high strand count, insulated copper conductor with green or green with yellow stripe jacket. The jumper shall have an easily visible quick connect to facilitate detaching/attaching the door or panel.
 4. Larger equipment (e.g., chassis switches) with integral grounding terminals or pads shall be bonded to the rack-mounted busbar with equipment grounding kits.
- G. When secondary protection is provided, connect the secondary protector grounding conductor to the nearest PBB or SBB using the shortest grounding conductor practical.
- H. Comply with manufacturers' grounding and bonding requirements when installing equipment.

3.3. LABELING

- A. Comply with Section 270553 "Identification for Communications".
- B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed. The labels or text shall be green. Label Text: "GROUND SYSTEM - If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.4. FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. Inspect, test and adjust components, assemblies, and equipment installations, including connections. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test continuity of each conductor. Test completed grounding system at service disconnect enclosure grounding terminal/bar, and at each location where a maximum ground-resistance level is specified or as required to verify integrity of grounding electrode system. Make tests at ground rods before any conductors are connected.
 4. Measure and report measured ground resistances that exceed 3 ohms. If resistance to ground exceeds specified values, notify Design Professional promptly and include recommendations to reduce ground resistance. After review and comment by Design Professional, take appropriate action to reduce resistance to specified values, by

driving additional ground rods or installing additional ground plates or chemically treating adjacent soil, or providing chemical ground rods or combinations thereof. Then retest to demonstrate compliance.

5. Installed components will be considered defective if it does not pass tests and inspections. Correct malfunctioning work on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new work and retest. Prepare test and inspection reports. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 270526.00

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SECTION 270528.00 - PATHWAYS FOR COMMUNICATIONS

PART 1 GENERAL

1.1. SUBMITTALS

A. Product Data:

1. Raceway.
2. Innerduct.
3. Spillways/waterfalls.
4. Floor boxes.
5. Device boxes.
6. Cable spillways.
7. Discrete cable supports.

B. Shop Drawings:

1. Coordinated floor plan drawings depicting the size(s), locations, and dimensions of the following:
 - a. Primary pathways.
 - b. Conduit sleeves (e.g., thru-the-wall, thru-the-floor, and thru-the-bulkhead).
 - c. Roof penetrations.
 - d. Conduits: Trade-size 2 inches and larger.
 - e. Raceway: Featuring a cross-sectional area of 4 square inches.
 - f. Vertical and horizontal working clearances around tray and ladder rack.
2. Conduit Interconnect Diagrams: for each totally-enclosed pathway system.

C. Closeout Submittals:

1. Accurate up-to-date as-built versions of shop drawings.

1.2. REFERENCES

A. Definitions:

1. Hybrid Pathway System: A pathway system built from a varied mixture of boxes, raceway, cable tray and discrete cable supports. Fundamentally a pathway system that is not a totally-closed pathway system. A hybrid pathway system supports cables in the horizontal at increments not exceeding 60 inches.
2. Pathway: A collection of products that when used together achieve a complete means for the conveyance of cable(s) from one location to another. A pathway system protects and supports cables to various degrees depending upon the application and products used. The pathway system most frequently terminates into an enclosure, boxes or other apparatus where cables are terminated, and associated devices are mounted.

3. Primary Pathway: A cabling pathway typically located in a corridor, public area, or dedicated vertical cable chase and used to enclose and/or support large quantities of compatible-signal cables from one or more systems to the general vicinity of where cables are terminated. Cables carried by a primary pathway transfer to secondary pathways.
 4. Raceway: An enclosed pathway component used for the routing of cables. The raceway envelops the cables that pass through it to protect them from physical damage, and at times from heat, humidity, corrosion and water intrusion. A raceway may feature a continuous outer shell, or in select cases (such as surface raceway) may feature a removable outer shell that facilitates installation and removal of cables. Raceway frequently terminates directly into boxes or enclosures used for the purpose of mounting devices and termination of the cables.
 5. Secondary Pathways: Pathways typically branching from a primary pathway and routing to a space(s) where a cable is terminated. A secondary pathway typically accommodates sixteen (16) cables or less. A secondary pathway carries cables from a single system that together can be run in tight parallel proximity to one another without any negative impact on adjacent cables or cause distortion or induce consequential interference on the signals they carry.
 6. Totally Enclosed Pathway System: A pathway system that is built from a mixture of boxes and raceway that when assembled are closed on all sides. Fundamentally it is a pathway system where the cables within the system are not visible and not accessible except when a component of the system, or a device mounted to it is removed. A totally enclosed pathway system supports cables run horizontally and continuously.
- B. Reference standards:
1. Comply with standards set forth in 27 00 01 - Common Work Results for Communications: References.

1.3. SPECIAL REQUIREMENTS

- A. Contract Division of Work and issuance of separate contracts notwithstanding, the entity(s) performing work of this Section shall have the responsibility to provide complete, working and code compliant pathway systems for the systems specified in this Division and for the additional systems so specified in the Contract Documents. Such systems shall be constructed in compliance with the Contract Documents.
- B. Provide complete, working and code compliant pathway systems for Division 27 and Division 28 Systems (where applicable), and as otherwise identified in the Contract Documents. Note that the Drawings may not fully detail the required complete pathway system and components.
- C. Should Work of this Section be performed by a party that is different from the party responsible for providing components (e.g., cabling) that utilize the pathway systems, the pathway provider shall:

1. Review specifications of this Division and Division 28 Systems (where applicable) and the related Drawings to gain a complete understanding of the specific systems that will utilize the pathways.

1.4. SYSTEM DESCRIPTION

A. General:

1. Each communications pathway system shall consist of products to support, protect, enclose, manage and secure the cables that are part of the communication system they serve.
2. Pathway systems shall be supplied and installed to meet the unique requirements of individual communications systems.
3. Separate pathway systems shall be provided for individual communication systems.
 - a. Individual communication systems shall have unique and dedicated conveyances.
 - b. Cables from individual communication systems shall be run in separate conveyances (e.g., data system cables shall be run in separate conveyances from sound system cables).
4. Separate pathway conveyances shall be provided for cables that carry incompatible signal types (e.g., analog microphone level and speaker level cables shall be run in separate conveyances).
5. Pathway systems shall include penetrations through walls, floors, ceilings, roofs, bulkheads and other physical barriers that are necessary to route cable between adjacent spaces.
6. Pathway penetrations shall be prepped, installed, sealed and fire stopped in a code compliant manner.
7. Pathways through expansion joints shall include expansion and deflection joint fittings with bonding straps.
8. Pathways shall be assembled from components that are listed by a recognized safety testing laboratory.
9. The cable fill capacity of each pathway segment shall meet or exceed the capacity necessary to accommodate cables initially installed. Additional capacity shall be provided as identified in the Contract Documents. The sizes and quantities of conveyances shown on the Drawings shall be interpreted as minimums. Larger sizes, or additional quantities, shall be provided as required or further identified herein.
10. Pathway systems shall be provided with sufficient support to carry the weight of the system, plus a full capacity of cables, with a safety factor of greater than or equal to 5. In addition, each individual above-the-floor vertical hanging support shall feature an installed static weight support capacity of not less than 200 lbs. (e.g., hanging all-thread, multi-anchor mounting flange and support cable).
11. Pathway systems shall include matching cover plates over junction and pull boxes.

B. Pathway Systems for Data Systems:

1. Totally enclosed raceway system.
 2. Minimum permissible conduit size: %-inch.
- C. Pathway Systems for Communications Systems:
1. Totally enclosed raceway system .
 2. Minimum permissible conduit size: %-inch.
- D. Pathway Systems for Security Systems:
1. Totally enclosed raceway system . Minimum permissible conduit size: %-inch.

PART 2 PRODUCTS

2.1. GENERAL

- A. Products furnished of each Type shall be manufactured by a single manufacturer, bear the same brand name, be the same finish color and texture, and be from the same product model series, except where otherwise indicated.

2.2. RACEWAY

- A. Conduit:
1. Comply with Division 26 specifications including 26 05 33 — Raceways and Boxes for Electrical Systems.

2.3. DISCRETE CABLE SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into work include:
1. Erico CableCat™ Series.
 2. Panduit J-Pro™ Series.
 3. Cooper/B-Line BCH Series.
- B. Product Requirements:
1. UL 2043 Listed and NEC compliant for use in plenum air returns.
 2. J-Hook style design.
 3. No sharp edges that could come in contact with supported cables during or after installation.
 4. Linear bearing surface for cable:
 - a. For use with backbone cables: Greater than or equal to 1-3/4 inches.
 - b. For use in primary pathways: Greater than or equal to 1-3/4 inches.
 - c. For use in secondary pathway: Greater than or equal to 1-3/8 inches.
 - d. For use with individual cables less than 0.400-inch diameter: Greater than or equal to 7/8 inch.

2.4. FITTINGS

- A. Comply with Division 26 specifications including 26 05 33 — Raceways and Boxes for Electrical Systems.

2.5. PENETRATIONS

- A. All penetrations through walls, floors, and ceilings shall be sleeved.
 - 1. Reference Firestopping for Communications specification for fire rated sleeve assemblies.
 - 2. All sleeves shall be metallic and shall have bushings at both ends.

2.6. BOXES

- A. Standard Wall and Ceiling Device Boxes:
 - 1. Comply with Division 26 specifications including 26 05 33 — Raceways and Boxes for Electrical Systems.
- B. Exterior Surface Mount Outlet Style Boxes:
 - 1. Comply with Division 26 specifications including 26 05 33 — Raceways and Boxes for Electrical Systems.
- C. Junction Boxes and Pull Boxes:
 - 1. Comply with Division 26 specifications including 26 05 33 — Raceways and Boxes for Electrical Systems.
- D. Specialty Wall/Ceiling Boxes:
 - 1. Manufacturers: Subject to compliance with requirements, provide the Basis of Design product listed, or Designer approved comparable product from one of the following manufacturers:
 - a. ESR, Inc.
 - b. Legrand/Wiremold.
 - c. Hubbell Inc.
 - d. Chief.
 - 2. Characteristics:
 - a. Sized to accommodate equipment to be housed within.
 - b. Recessed within wall or ceiling cavity.
 - c. Integrated hardwired receptacles.
 - d. Integral thermostatic controlled fan.
 - 3. Provide quantities and types as shown on the floorplans and system drawings.

2.7. ACCESSORIES

- A. Pull Strings:
 - 1. Construction: nylon.

2. Designed and rated by the manufacturer for use as a pull-rope.
- B. Fiber Optic Innerduct:
1. Manufacturers: Subject to compliance with requirements, provide the Basis of Design product listed, or Designer approved comparable product from:
 - a. Armco.
 - b. Endot.
 - c. Opti-Com.
 - d. Pyramid.
 2. NEMA TC 5, UL listed, corrugated, specifically designed for optical fiber cable pathways.
 - a. Color: Orange.
 - b. 1-inch minimum inside diameter.
 - c. 600 pounds minimum pulling strength.
 - d. Factory installed pull rope.
 - e. UL Listed and NEC approved for the environment in which it is installed.
 - f. Basis of Design:
 - 1) Riser Rated Environments: Carlon DF4X1 C****.
 - 2) Plenum Rated Environments: Carlon CF4X1 C-****.
- C. Cable Waterfalls (Spillways) — for Conduit:
1. Manufacturers: Subject to compliance with requirements, available manufactures offering products that may be incorporated into Work include, but are not limited to, the following:
 - a. Bejed, Inc.
 - b. LincTek, Inc.
 - c. Cooper/B-Line.
 - d. Chatsworth.
 - e. Cable Management Corp.
 - f. Panduit
 2. Product Requirements:
 - a. Available in 2 inches and 4 inches diameter for direct attachment to conduit stubs and sleeves.
 - b. Integral clamp for securing to EMT conduit.
 - c. Maintains proper bending radii for cabling entering the conduit served.
 - d. Self-fastening tie down system.
 - e. UL Listed and NEC approved for the environment in which it is installed.
- D. Supports:
1. General:

- a. Supports, support hardware, and fasteners shall be manufacturer protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic.
 - b. Products used outdoors shall be hot-dip galvanized.
2. Material Types:
- a. Raceway Supports:
 - 1) Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
 - b. Fasteners:
 - 1) Types, materials, and construction features as follows:
 - a) Expansion anchors: Carbon steel wedge or sleeve type.
 - b) Toggle bolts: All-steel springhead type.
 - c) Powder-driven threaded studs anchors: Heat-treated steel, designed specifically for the intended service.
 - d) Solid concrete anchors: Drop-in zinc plated steel tubular expansion shield with solid, cone-shaped expander plug.
 - c. Cable supports for vertical conduit:
 - 1) Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits.
 - 2) Provide with plugs with the number and size of conductor gripping holes as required to suit each individual application.
 - 3) Body construction: Malleable-iron casting with hot-dip galvanized finish.
 - d. Threaded Rod Stock (All-Thread Rod):
 - 1) Available in 1/4-inch, 3/8-inch, 1/2-inch, and 5/8-inch sizes.
 - 2) Utilize 1/2 "for ladder/tray installations under 24" and 5/8" for 24" or larger.
 - a) Rod lengths over 6' will require a "Rod Stiffener" installation for h" and 5/8" rods.
 - e. Slotted Metal Angle and U-channel Systems:
 - 1) 16-gauge steel U-shaped channel;
 - 2) Available in a variety of sizes including: 1-5/8 inches square, 1-1/4 inches square and 13/16-inch square.
 - 3) Available with pre-punched and un-punched versions.
 - 4) Available with holes on top or sides of channel.
 - 5) Available with a wide-variety of fittings for field construction of structural support assemblies.
- E. Bushing, Knockout Closures and Locknuts:
1. Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.

- F. Pipe Curb Assemblies:
1. Manufacturers: Subject to compliance with requirements, available manufactures offering products that may be incorporated into the Work include, but are not limited to:
 - a. The Pate Company, PCC-series.
 2. Product Requirements:
 - a. Designed to seal around pipes penetrating through conventional or metal roofs.
 - b. Prevents the ingress of water into the building under all weather conditions.
 - c. Models available to accommodate all standard sizes or pipe from 1/2 inch to 10 inches O.D.
 - d. Stainless steel pipe fasteners.
 - e. Provide with manufacturer recommended accessories and options necessary to seal and prevent water infiltration.

PART 3 EXECUTION

3.1. COORDINATION

- A. Review and coordinate the size requirements of pathways with the suppliers and installers of cabling and devices. Pathway segments shall accommodate the quantity and type of cables that will be installed. Upsize pathway segments from any default and minimum size(s) identified so as to accommodate the cables that will be installed, including any future expansion capacities, as identified in the Contract Documents.
- B. Review the specific routes and composite length of planned pathway routes with parties responsible for supplying or installing cables as distance limitations will apply differently for different cables and applications.
- C. Coordinate the location and routing of pathways with work of this Division, the work of other trades, the work of the Owner, and existing site conditions (where applicable) to ensure adequate headroom, post installation access to and working clearances around the pathways. Review and verify HVAC, Fire Suppression, Electrical Power, Lighting and other Drawings for design coordination. Provide routes accordingly.
- D. Proactively participate with other trades in the creation of coordination drawings that depict primary and major secondary pathways. Emphasis shall be placed on ensuring that pathways are accessible for initial cable installation and readily accessible for reuse in accommodating future cable moves, additions and changes.
- E. Coordinate the colors and types of surface raceway with the color of surface raceway provided as work of both Division 26 and Division 28. Colors of raceways shall match, except where expressly reviewed and approved by the Architect/Designer.

- F. Ensure that pathways, as installed, are adequately sized for the cables to be installed and any future expansion capacities as identified in the Contract Documents.

3.2. GENERAL

- A. Provide specified pull wires in all cabling pathways.
- B. Ground and bond all systems in accordance with all applicable codes and referenced standards.
- C. All installation material and practices shall fully comply with all applicable codes and referenced standards.
- D. Coordinate work with the building structural systems and electrical installation.
- E. All work shall fully comply with these Specifications and related Drawings and all manufacturers' recommended installation practices.

3.3. PATHWAY SIZING

- A. Raceways shall be sized so that they are the larger of the following:
 - 1. Minimum size indicated within the Contract Documents.
 - 2. In accordance with the National Electric Code.
 - 3. As recommended by the product manufacturer.
- B. Discrete cable supports shall be sized so that they are the larger of the following:
 - 1. Minimum size indicated within the Contract Documents.
 - 2. In accordance with the National Electric Code.
 - 3. As recommended by the product manufacturer.

3.4. RACEWAY USAGE

- A. Rigid Steel (GRC) Conduit:
 - 1. Above grade, outside the building envelope, in exposed areas.
 - 2. Above grade, inside the building envelope, within high moisture areas.
 - 3. As a transitional component of a below grade conduit path where the conduit needs to pass through a poured-in-place concrete slab.
 - 4. As a sleeve through poured-in-place concrete slabs.
 - 5. Where specifically indicated on the Drawings.
- B. Intermediate Metallic Tubing (IMC) Conduit:
 - 1. Where specifically indicated on the Drawings.
- C. Electric Metallic Tubing (EMT) Conduit:
 - 1. Within the building envelope concealed within walls and ceilings.
 - 2. Above grade, inside the building envelope, where no other type of raceway is identified to be used.

3. Where specifically indicated on the Drawings.
- D. Flexible Metal Conduit (FMC):
1. Inside the building envelope as a component of a secondary pathway system where flexibility is necessary for constructability to meet specified objectives and where length of the segment does not exceed 6 feet.
 2. Inside the building envelope as the transitional segment of a raceway system and interconnection to permanently-cabled systems-furniture is necessary and where the length of the FMC segment does not exceed 12 feet.
 3. Where specifically indicated on the Drawings.
- E. Liquid-Tight Flexible Metal Conduit (LFMC):
1. Above grade, outside the building envelope, between junction (or pull) boxes and connected devices (e.g., cameras) and where cables to/from the devices would otherwise be visually exposed or exposed to the elements.
 2. Above grade, outside the building envelope, between junction (or pull) boxes and connected devices requiring regular movement where cables to/from the device would otherwise be visually exposed or exposed to the elements.
 3. Above grade, inside the building envelope, between junction (or pull) boxes and connected devices (e.g., cameras) and where cables to/from the connected devices would otherwise be exposed to water or sustained periods of high moisture.
 4. Above grade, outside the building envelope, between junction (or pull) boxes and connected devices requiring regular movement where cables to/from the device would otherwise be exposed to water or sustained periods of high moisture.
 5. Where specifically indicated on the Drawings.
- F. Polyvinylchloride (PVC) Conduit:
- a. Below grade, where conductive conduit is not otherwise required.
 - b. Where specifically indicated on the Drawings.
- G. Electrical Nonmetallic Tubing:
1. Where specifically indicated on the Drawings.
- H. Non-metallic:
1. Non-metallic raceway shall be used only where specifically indicated to be used in the Contract Documents.
 2. Non-metallic raceway shall only be used where specifically approved for use by the Designer.
- I. Conduit Sleeves:
1. In accessible but concealed ceiling cavities, wherever a cable needs to pass through a wall, floor, ceiling, bulkhead (or similar building obstruction) to get from one space to another.

2. In unfinished areas, high to the ceiling, where a cable not installed in raceway, needs to pass through a wall, floor, ceiling, bulkhead (or similar building obstruction) to get from one space to another.
3. Wherever one or more conduits must pass through a poured-in-place formed concrete structure.

J. Wireway:

1. Where specifically indicated on the Drawings.

K. Communications Poles:

1. Where specifically indicated on the Drawings.

3.5. DISCRETE CABLE SUPPORT USAGE

- A. Discrete cable supports shall be used to support cable that is not installed within raceway, cable tray or ladder rack.
- B. Discrete cable supports shall be supported from the building structure, in a manner that is code compliant.
- C. Discrete cable supports shall be anchored using accessories and hardware that is manufactured or recommended by the support manufacturer.
- D. Discrete cable supports shall be spaced at horizontal increments not exceeding 60 inches on center. Additional supports shall be installed to limit cable sag to less than 9 vertical inches.

3.6. BOX USAGE

A. Boxes:

1. Boxes shall be used at device and equipment locations. Raceway shall terminate into an approved box, except where indicated.
2. Standard wall and ceiling boxes shall be used in walls and ceilings except where specialty boxes are indicated.
3. Boxes designed expressly for use within floors shall be used within floors. The type of box used shall be appropriate for the floor construction.
4. The size and type of boxes used shall accommodate the quantity and type of cable, raceway and devices the box must accommodate.
5. Junction boxes and pull boxes shall be sized to comply with the NEC, but not less than the sizes indicated in the Contract Documents.
6. Custom size and special-order boxes shall be provided where custom sizes and special order boxes are required to meet the project requirements.

3.7. INSTALLATION

A. General:

1. Install in accordance with local codes. Adhere to clearance and fire protection regulations.
 2. Install above-grade pathways parallel to and perpendicular to building elements.
 3. Install pathways plumb and level except where changes in elevation are specifically necessary for constructability.
 4. Document the exact routing of concealed pathways on as-built drawings.
- B. Bonding and Grounding:
1. Conductive components of the pathway systems shall be bonded to ground in accordance with the NFPA and the NEC.
 2. Additional grounding and bonding shall be provided as set forth in the Contract Documents.
- C. Rustproof Fasteners and Hardware:
1. Install pathway components and associated mounted devices with stainless steel nuts, bolts, screws and washers when installed on the exterior of the building, when installed within unconditioned building spaces, and when the pathway serves exterior devices or devices in areas prone to sustained humidity levels in excess of 60-percent.
- D. Conduit:
1. Install conduit in a concealed manner except where approved by the Designer in advance.
 2. Install conduit terminations into boxes and enclosures using fittings featuring locknuts and insulating throat liners.
 3. Install insulating bushings on the exposed ends of conduit stubs and sleeves.
 4. Install insulating bushings on the exposed threaded portion of conduits and conduit fittings that terminate conduit to a box or equipment enclosure.
 5. Support conduits by using pipe straps or trapeze hangers. Space supports not more than 8 feet on center. Secure supports by means of toggle bolts, inserts or expansion bolts.
 6. Space wall brackets supporting conduits not more than 4 feet 6 inches on center. Secure supports by means of toggle bolts, inserts or expansion bolts.
 7. Support raceway components directly from structural building systems, not from ceiling suspensions systems. Provide supplemental supports for junction or pull boxes.
 8. Conceal conduit raceways under floors, in walls, above ceilings and in furred spaces within finished building areas.
 9. Support single conduits 1-1/2 inches and larger by means of rod and cast ring hangers. Support multiple runs in similar manner or use a common trapeze hanger system.
 10. Provide two-hole sheet metal pipe straps for surface mounted conduit supports on walls up to a height of 8 feet above the finished floor.
 11. Pinch type hangers similar to minerallac shall only be used at heights greater than 8 feet.

12. Protect conduits during construction with temporary plugs or caps. Securely cap conduits until pull string, or cable is installed.
13. Do not install conduit horizontally in concrete slabs on grade.
14. Provide expansion/deflection fittings where raceway crosses the building expansion joints.
 - a. Utilize manufacturer recommendations for installation
 - b. Provide external bonding jumpers to bond metallic conduits across joint.
15. Conduit Routing:
 - a. If specific routing information appears on the Drawings, route and maintain conduits as shown. Should interference or a conflict arise, consult the Designer before proceeding with the Work.
 - b. If specific routing information does not appear on the Drawings, Determine the best route for the conduit in accordance with code, accessibility and other project guidelines.
16. Conduit bends:
 - a. Bends shall be made so that the conduit will not be flattened or kinked and so that the internal diameter of the conduit is not reduced.
 - b. The radius of the curve of the inner edge of any bend shall not be less than indicated by the National Electrical Code and TINEIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces.
 - c. All conduit bends or fabricated elbows shall have a bend radius equal or greater than 4 times the trade size.
 - d. When it is necessary to make field bends, use tools manufactured for conduit bending.
 - 1) Heating of metallic conduit to facilitate bending is not permitted.
 - e. Constructing an outside entrance to a building from buried conduit to penetrate above the ceiling line will allow an exception for a 4 inches LB fitting at one end to allow placement of the conduit flat to the building outside wall.
17. Do not cut, burn, or drill any structural member to pass through or mount any pathway product without first obtaining approval in writing from the building architect and structural engineer.
18. Install above-ceiling conduits a minimum of 7 inches above ceiling tiles to permit ceiling tile removal.
19. Install conduits at least 6 inches away from insulated pipes, steam lines or any other hot pipes which they pass. Where the lines are not insulated, the clearances shall be increased until the temperature of the conduit, with no live conductors enclosed, does not rise above the ambient temperature of the installation area.
20. Install flashing and counter flashing or pitch pockets for waterproofing of raceways, outlets and fittings that must penetrate the roof.
21. Install oversized sleeves in forms for new concrete walls, floor slabs, and partitions to allow for the passage of raceways.

22. Waterproof sleeved raceways shall be provided below grade and in areas prone to high moisture and condensation.
 23. Outside Plant Conduits
 - a. All conduits shall drain into open bottom hand holes.
 - b. Minimum depth is 24-30"
 - c. Conduits may slope from middle of run
- E. Pull Boxes:
1. Install each pull box indicated on the Drawings.
 - a. As additionally required by Code.
 2. Install additional pull boxes outside the building envelope:
 - a. Every 500 running feet of below-grade raceway.
 - b. Every 180 degrees of raceway bend.
 - c. Every 100 feet of above-grade raceway. (less than 2")
 - d. Every 200 feet of above-grade raceway (2" and larger)
 - e. As additionally required by Code.
 3. Install pull boxes in areas that will be accessible after installation. Accessible areas include spaces above removable tile ceilings and behind access doors that are installed expressly for this purpose. Do not install pull-boxes in locations that will not be accessible after construction is complete and is not accessible after permanently installed furniture or fixtures are installed.
 4. Size boxes in accordance with the NEC. Use larger boxes where so specified.
 5. Support boxes rigidly.
 6. Land conduits on the boxes such that conduits enter and exit across from each other on opposite sides of the box so as to facilitate straight line pulling of cable through the box.
 7. Do not use pull boxes in lieu of conduit bends, except as necessary by design or to meet constructability constraints.
 8. When directional transition of the cables is necessary through a box, land conduits on the box so that they permit the largest possible bending radius for those cables that will pass through the box.
- F. Pull Stings:
1. Install a usable pull string in every pathway prior to the installation of cables. The string shall be installed after pathway installation and prior to such time as the cable installer desires to install cable within the pathway. The string shall be used as an aid to the installation of cables.
 - a. Install a replacement pull string in each pathway as part of the cable installation process to facilitate installation of additional cable(s). Tie the pull-string off and tag for "Future Use."
- G. Innerduct:

1. Install innerduct within and along pathways that will be used to accommodate fiber optic cables.
 - a. Plenum rated innerduct shall be used in pathways that are not 100-percent conduit.
 - b. Exception: Innerduct is not required in those pathways that will contain exclusively armored-type fiber optic cables.
- H. Spillways:
 1. Install cable spillways where cable(s) will exit a conduit sleeve, cable tray, or wireway and where they would otherwise be unsupported for more than 6 inches.
- I. Telecommunication Poles:
 1. Mount straight and anchor to building structure above the ceiling line.
 2. Provide mounting hardware, entrance end fitting, and ceiling trim plate.
 3. Utilize cutouts or add-on compartments for jack frames.
 4. Isolated pathway from electrical circuits with separate internal raceway.
- J. Discrete Cable Supports:
 1. Install supports in areas that will be readily accessible after installation (e.g., above accessible suspended ceilings; up within the building structure in unfinished areas).
 2. Do not install supports in any location that is not readily accessible and cannot be reached by the hand of an individual standing flat footed on the ground, a ladder or scaffolding. Do not install in areas where an individual has to strain to reach or where a pole will be required to access.
 3. Install separate discrete cable support pathways for cables from each system. Where the allowed capacity of an individual support will be exceeded, install multiple parallel pathways.
 4. Install separate discrete cable support pathways for cables from the same system that carry signals that could negatively interfere with one another. Array supports vertically using an appropriate spacing not less than 6 inches for every 6 dB of nominal voltage differential between the cables.
 5. Attach supports directly to vertical building surfaces, or from overhead structural members using threaded rod and other approved attachment methods. Support of cables by use of suspended ceiling wires shall not be permitted.
 6. Install supports plumb and square.
 7. Install horizontal runs of cables supports level. Change elevation only where necessary for coordination with other trades and pathways of other systems.
 8. Mount the bottom of supports approximately 12 inches above the top of suspended ceilings.
 9. Install cable supports at intervals not exceeding 5 cable feet.
 10. Install supports so that they will not interfere with the removal or installation of ceiling tiles.

11. Provide support in close proximity of device conduit pathway termination for service loop.
- K. Device Boxes:
1. New-work and old-work device boxes shall be installed flush with or slightly recessed below the finished surface. Do not recess boxes more than is permitted by code, nor more than .078 inches (2mm). Old-work boxes require advanced craftsmanship and construction techniques to achieve specification compliance for communications Work.
 2. The installed elevation of boxes shall generally be as indicated on the drawings. Elevations shall be adjusted in the field to ensure a clean appearance resulting from coordination of the new box elevations to match the existing box elevations. Where the specified box elevations and existing condition box elevations differ by more than 4 inches, seek the direction of the Designer prior to installation.
 3. Device boxes and associated cover plates shall not span different types of wall finishes either vertically or horizontally. Horizontal and vertical position of boxes shall be adjusted at time of installation to ensure that this condition does not exist after finish is completed.
 4. Boxes in masonry shall be installed so that the specified over plates will cover the mortar joints and cut openings completely.
 5. Device boxes shall be installed so that they are securely and rigidly attached to structure. Gypsum board and similar non-structural board shall not be used for box support.
 6. Devices boxes shall not rely on raceway as a means of support. Boxes shall be fully supported by surrounding building structure.
 - a. Provide sufficient support for ceiling device boxes to support weight of installed products.
 - b. Provide tile support bridge for device box in accessible ceiling.
 7. Device boxes shall be installed plumb and level.
 8. Boxes shall be shimmed as necessary to insure level and plumb installation.
 9. Install gaskets on boxes installed outside and in wet or damp locations (e.g., tunnels, crawlspaces, pits).
 10. Device boxes shall be protected from plaster, drywall mud, mortar, and other construction debris.
 11. Floor boxes shall be installed flush and true with the finished floor, or otherwise in accordance with the manufacturer's instructions.
 12. Boxes shall be cleaned of debris after installation.
 13. Boxes shall be cleaned of debris thoroughly prior to installation of cover plates;
 14. Install blank cover plates on each unused device box.
 15. Knock out requirements exceeding manufacturers standard sizes shall be accommodated with punch of correct size.

L. Sleeves and Penetrations:

1. Sleeves through poured-in-place concrete surfaces shall be set in place prior to the concrete pour and protected from concrete ingress.
2. Sleeves through floors shall be installed to prevent the passage of water between the sleeve and the floor.
3. Install cable-protecting insulating bushings on each end of each sleeve.
4. Extend through-the-wall sleeves a minimum of 2 inches beyond the wall surface. Extend the sleeve a greater distance where necessary to permit proper installation of cable protecting bushings and any associated cable waterfalls.
5. Extend through-the-floor sleeves to a consistent elevation of 4 inches to 6 inches above finished floors, except where otherwise noted on the Drawings.
6. Fill the voids between sleeve and building surface with approved fire stop material sufficient to maintain the fire-rating of the building surface.
7. Firestop or plug all penetrations, conduits and sleeves to prevent the movement of air between spaces.

M. Conduit Stubs:

1. Install cable-protecting insulating bushings on each conduit stub.

N. Supports:

1. Fabricated Support Devices:
 - a. Conform to the manufacturer's recommendations for selection and installation of supports.
 - b. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 - c. Support parallel runs of horizontal raceways together on trapeze-type hangers.
 - d. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners shall be used in lieu of hangers for 1-1/2 inches and smaller raceways above suspended ceilings only.
 - e. For hanger rods with spring steel fasteners, use 1/4-inch diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
 - f. Support exposed and concealed raceway within 1 foot of box and access fittings. In horizontal runs, support at the box and access fittings shall be omitted where box or access fittings are independently supported, and raceway terminals are not made with chase nipples or threadless box connectors.
 - g. In vertical runs, arrange supports so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on the ends of the raceway.
2. Miscellaneous supports:

- a. Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, pull boxes, junction boxes, and other devices.
 - b. Support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.
3. Fastening:
- a. Fasten pathway products and its supporting hardware securely to the building structure in accordance with the following:
 - 1) Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts shall be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
 - 2) When installing fasteners in concrete or CMU structures, do not cut reinforcing bars.
 - 3) Ensure that the load applied to any fasteners does not exceed 25-percent of the proof test load. Use vibration-and shock-resistant fasteners for attachments to concrete slabs.
 - b. Raceway supports: Hanger spacing shall be as required for adequate support of the raceway, but in no case shall there be less than one hanger per 5 feet of raceway length.
- O. Pathway Evacuation:
1. Prior to the installation of cable:
 - a. Clean and vacuum boxes, raceway, cable tray, and discrete cable supports.
 - b. Remove solids or other hindrances that could impede its full utilization or that could damage cable during or after installation.
 - c. Remove liquids. Blow out until raceway is dry, sufficiently that the installed cables will not be subjected to contact with them.
 2. Where existing raceways are reused, remove liquid from the raceway.
- P. Water Proofing:
1. Protect raceways from moisture infiltration in areas where moisture penetration is probable (e.g., outdoors, natatoriums, wash bays).
 2. Provide watertight fittings where one or more cables exit the pathway in areas where moisture penetration is probable.
 3. Seal below-grade conduit joints to prevent moisture infiltration.

4. Seal joints of conduits in high-moisture areas to prevent moisture infiltration.
 5. Pressure or vacuum test below-grade conduits before and after concealing the conduits to ensure resistance to moisture ingress.
- Q. Repair and Patching:
1. Holes and other penetrations into building surfaces or structure that are created to facilitate pathway installation but that are not ultimately used shall be filled, repaired, and restored to their original strength, appearance and integrity.
 2. Damage to building or property that occurs during the course of pathway installation shall be repaired and restored to its original condition prior to damage.
- R. Cover Plates
1. Provide cover plates over the openings of junction boxes, pull boxes and cast boxes.

END OF SECTION 270528.00

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SECTION 270543.00 - UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS

PART 1 GENERAL

1.1. SUBMITTALS

- A. Product Data:
 - 1. Bill of Materials (BOM).
 - 2. Product Datasheets.
- B. Shop Drawings:
 - 1. Site Plans, coordinated: depicting the planned pathways and routing of pathways.
 - 2. Floor Plans, coordinated: depicting the planned pathways and routing of pathways.
 - 3. Labeling Schema.
 - 4. Traffic Control Plan:
 - a. Proposed work schedule and traffic control details.
- C. Closeout Submittal:
 - 1. Product Datasheets.
 - 2. As-Built Drawings:
 - a. Site Plans.
 - b. Floor Plans.
 - c. Labeling Schema.
 - d. Detail drawing of each splice, termination and/or pull point layout (to scale) showing rack/wall space available for use.

1.2. REFERENCES

- A. Definitions:
 - 1. OSP (Outside Plant): Communications spaces, pathways, cabling, and termination hardware required to connect two or more buildings or structures and includes work through the building or structure penetration to the point of termination.
- B. Reference Standards:
 - 1. Comply with standards set forth in 27 00 01 - Common Work Results for Communications: References.

1.3. SYSTEM DESCRIPTION

- A. The underground ducts and raceways system shall be a system of conduits, boxes, hand holes and other raceways and accessories between communications rooms, entrance points and facilities of building(s), structures on a campus, towers, poles, maintenance holes, hand holes, and telecommunications pedestals or cabinets as part of a complete pathways system

- infrastructure. The underground ducts and raceways infrastructure shall meet the requirements of the authority having jurisdiction (AHJ) and applicable codes.
- B. Locate, identify, and avoid all existing utilities utilizing the marking service required by State Law and information from the Owner where new facilities or excavation is required.
1. Provide all necessary traffic control (vehicular and pedestrian), hazard protection, construction site barriers/warning tape, trench wall supports, and any other safety provisions customary to provide a safe working environment where new work is required.
- C. Pathway System includes the following items and all necessary related activities necessary to provide a fully functional system.
1. System components shall be located and/or provided as indicated on the Drawings.
 2. Provide all indicated entrances into specified Buildings and as detailed on the Drawings.
 - a. Provide necessary penetrations through the facility walls and restore the wall to the same condition as prior to cutting.
 - b. Provide all required Conduits and Boxes to construct the entrance pathway as indicated on the Drawings.
 - 1) Conduit utilized on an exterior wall above grade shall be Galvanized Rigid Conduit (GRC).
 - a) This shall include sleeves extending into the facility.
 - b) The GRC conduit shall continue to the first below grade Hand Hole.
 - 2) Transition boxes used on an exterior wall above grade shall be NEMA 3R rated.
 - 3) Conduit utilized in the interior of a building to extend to an Entrance Facility or termination/transition space shall be GRC.
 - 4) Conduit utilized to stub up into a termination/transition space from or below the slab of the building shall be GRC.
 - c. Provide all necessary hardware to secure and/or protect the entrance pathway.
 3. Provide underground conduit pathway system as shown on the Drawings.
 - a. Provide all necessary Hand Holes including the minimum requirements shown on the Drawings.
 - 1) Provide gravel base in bottom of open bottom hand holes.
 - 2) Provide 6" a re-bar reinforced concrete apron, at least 12" deep, around each hand hole installed in a sidewalk, paved area, roadway (paved or unpaved).
 - 3) Provide enclosure covers with a minimum Tier 15 rating.
 - a) All covers shall indicate a label of "Communications" and Owner Name and telephone number (coordinate with Owner).
 - b) Field verify lid/cover construction requirements or provide all Tier 22 covers.

- c) Bolt the lid to the enclosure.
 - b. Provide all conduits between Hand Holes/ Maintenance Holes/ Entrances and any other points as shown on the Drawings.
 - 1) Quantities and trade sizes shall be as indicated on the Drawings.
 - a) Unless otherwise noted, underground conduits shall be 4" schedule 40 PVC or HDPE.
 - b) (Note: Directional drilling installations shall utilize SDR 11)
 - c) Provide steel casings or concrete encasement around all conduits installed under public roadways to extend at least 5 feet beyond the paved surface on each side of the roadway or 2' beyond the right-of-way of a public roadway, whichever is farther.
 - 4. Accessories
 - a. Provide a #6 locate conductor inside the Primary Pathway conduit along each underground pathway segment; leave 5' coiled at each end.
 - 1) Alternate constructions such as locatable textile inner-duct are acceptable.
 - b. Provide a ¼" nylon pull rope in each conduit segment with 5' minimum slack at each end; coil slack and anchor to enclosure side.
- D. Communications
- 1. All work schedules on site shall be communicated to the Owner and Site Manager at least 2 days in advance unless otherwise noted.
 - 2. At all times during work hours the lead technician shall:
 - a. Carry a cellular telephone equipped with voice mail and local telephone number.
 - b. Provide the access numbers for the device to the Owner, Site Manager, and Consultant.
- E. Restoration:
- 1. Completely restore all areas to how they existed before construction.
 - 2. Provide erosion control, including bailed hay and sediment control fencing, as specified in the referenced standards.
 - 3. Where trenching has been performed, restoration shall include additional trench fill after settlement of original fill has completely subsided and reseeding as necessary for complete restoration. Provide area safety as specified throughout restoration.

PART 2 PRODUCTS

2.1. GENERAL

- A. Products furnished of each Type shall be manufactured by a single manufacturer, bear the same brand name, be the same finish color and texture, and be from the same product model series, except where otherwise indicated.

2.2. PATHWAYS AND SPACES

- A. Refer to Division 26 specifications, including 26 05 33 — Raceways and Boxes for Electrical Systems and 26 05 43 — Underground Ducts and Raceways for Electrical Systems for requirements.
- B. Hand Holes:
 - 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. Strongwell (Quazite).
 - b. Oldcastle Precast.
 - c. Pence".
 - 2. General: Underground enclosures and associated components shall be provided by a single manufacturer, including coupling, lids/covers, adapters, fittings, brackets, hangers and other accessories recommended by the manufacturer and/or necessary for a complete and functional system, as indicated.
 - 3. Underground Enclosures and Covers:
 - a. Manufactured of high strength polymer concrete material consisting of an aggregate mix bound together with a polymer resin.
 - b. Materials shall be non-conductive, non-corrosive, and unaffected by moisture, freezing, subsoil chemicals and UV light.
 - c. Hardware shall be corrosion resistant stainless steel.
 - d. Equip enclosures with adequate provisions for knockouts, cable racking and pulling irons for proper duct and cable installation per code, standards, and practice.
 - e. Minimum design load: 22,500 lbs. over 10-inch by 20-inch plate.
 - f. Minimum test load: 33,750 lbs. over 10-inch by 20-inch plate.
 - g. Size:
 - 1) Sufficient to allow figure-eight coiling of cable slack without violating the bend radius restrictions of the cable.
 - 2) Sufficient to accommodate splice closures.
 - h. Basis of Design: Strongwell (Quazite) PG2436BA30 (24-inch by 36-inch by 30inch deep box) and PG3636BA30 (36-inch by 36-inch by 30-inch deep box).
 - i. Lids/Covers:
 - 1) Covers shall be labeled "Communications" and Owner Name and telephone number (coordinate with Owner).
 - 2) Field verify lid/cover construction requirements or provide the highest-grade cover (i.e., Grade 3) available.
 - 3) Support crossbars shall be provided from the manufacturer to meet load characteristics.
 - 4) Test loads for ANSI/SCTE 77-2007

APPLICATION	LOADING REQUIREMENTS			
Light Duty Pedestrian Traffic Only	Vertical	Test Load	13.3kN	3000 pounds
TIER 5 Sidewalk applications with a safety factor for occasional non-deliberate vehicular traffic	Vertical	Design Load	22.2 kN	5000 pounds
	Lateral	Design Load	28.7 kPa	600 pounds/sq.ft.
TIER 8 Sidewalk applications with a safety factor for non- deliberate vehicular traffic	Vertical	Design Load	35.6 kN	8000 pounds
	Lateral	Design Load	28.7 kPa	600 pounds/sq.ft.
TIER 15 Driveway, parking lot, and offroadway applications subject to occasional non-deliberate heavy vehicular traffic	Vertical	Design Load	66.7 kN	15000 pounds
	Lateral	Design Load	38.3 kPa	800 pounds/sq.ft.
TIER 22 Driveway, parking lot, and off-roadway applications subject to occasional non- deliberate heavy vehicular traffic	Vertical	Design Load	100.1 kN	22500 pounds
	Lateral	Design Load	38.3 kPa	800 pounds/sq.ft.
AASHTO H-20 Deliberate vehicular traffic application.	Certified precast concrete, cast iron, or AASHTO-recognized materials.			
Table I – Test Loads				

- 5) Three grades of lids/covers are acceptable dependent on the location of placement.
 - a) Grade 2, Tier 15, Light Traffic and Mowers: Covers shall have a minimum design load of 15,000 lbs. and a minimum test load of 22,500 lbs. Basis of Design shall be Strongwell (Quazite) PG2436HA12.
 - b) Grade 3, Tier 22, Traffic Areas and Parking Lots: Covers shall have a minimum design load of 22,500 lbs. and a minimum test load of 33,750 lbs. Basis of Design shall be Strongwell (Quazite) PG2436HH12.
 - c) Covers located in Roadways shall have a AASHTO H-20 rating.

C. Conduit:

1. Rigid steel conduit:
 - a. Threaded rigid steel conduit shall be manufactured from mild steel, zinc galvanized both inside and outside including threads. It shall be constructed in accordance with ANSI C80.1 , Federal Specification WW-C-581; UL listed.
2. Non-metallic raceways,

- a. Polyvinylchloride (PVC):
 - 1) PVC conduit shall be virgin C300 type, Schedule 40 or 80 (90^o C) constructed in accordance with NEMA TC2 and Federal Specifications W-C1094A.
- b. Schedule 40 HDPE duct is acceptable for buried ducts but is not permitted indoors or for use with standard conduit fittings.
 - 1) Conduit shall be a nonmetallic flexible raceway manufactured from High Density Polyethylene (HDPE) for use in underground applications. It shall be a smooth-walled interior and exterior configuration with wall construction of SDR 13.5. (Note: Directional drilling installations shall utilize SDR 11) Each conduit shall have a one-half inch pre-lubricated, woven, 1 1301b. minimum polyester tape made from low friction, high abrasion resistant yarns placed within the conduit and secured at each end. Tape shall be printed with sequential footage markings for accurate measurements. Each conduit shall be black with (3) unique colored stripes, to be specified in the part number to replace the "XX" or as specified on the drawings. (i.e. 3D=3 buff stripes, 3E=3 gray stripes, 3F=3 green strips, 3G=3 lilac stripes)
 - a) Standard of quality shall be Carlon 4" smooth-walled HDPE conduit, part 6C9N7AXXC

D. Pull rope:

1. Jacketed, unidirectional aramid fiber, custom woven flat pull rope.
2. Required within each conduit, innerduct or cell.
3. Manufactured using a process that encapsulates the aramid fiber and bonds an exterior waterproof tape to the aramid fibers.

E. Cable lubricant:

1. Use a non-hardening, non-toxic, non-corrosive, non-sensitizing, lubricating compound during installation of cabling to reduce friction. Do not use liquid detergent.

F. Duct Plugs:

1. Removable.
2. Forms a watertight seal.

2.3. SOURCE QUALITY CONTROL

- A. System components shall be tested and listed by one of more United States NRTL.

PART 3 EXECUTION

3.1. GENERAL

- A. Secure applicable permits for work specified in this Section.

- B. Refer to the Drawings for types and quantities of pathways and backbone cabling requirements. Review and coordinate pathways prior to installation.
 - 1. Coordinate to identify quantities and sizes of backbone cables that the pathway system is required to support.
 - 2. Coordinate to resolve deviations, defects or other problems with pathways prior to installation. Allow adequate time for corrections so as to avoid delays to the Project completion date.
 - 3. Provide additional or supplemental TINEIA-569-C, or most current version, compliant pathways and cable support where required. Provide additional sleeves through walls/floors/ceilings, as necessary to route cables within buildings.
 - 4. Locate, identify, and avoid existing utilities utilizing the marking service required by State Law and information from the Owner where new facilities or excavation is required.
 - 5. Coordinate installation of pathway products with work of other trades and other Divisions.
 - a. Provide necessary traffic control (vehicular and pedestrian), hazard protection, construction site barriers, signage, supports, fencing, and any other customary provisions.
 - 6. Coordinate with the Owner and utility company(s) prior to beginning the Work.
 - a. Locate, identify, and avoid existing utilities (public and private), including but not limited to electric, water, sewer, gas, and telecommunications.
 - b. Repair damage occurring to existing underground utilities as a result of the Project.
- C. Installation practices followed shall use the latest available machinery, equipment, and tools. Installation techniques used on the Project shall result in the ease of maintenance and ready access to components.
- D. Right of Way
 - 1. Right-of-way will be secured by the Owner. Provide work specified within the requirements of the right-of-way agreement.

3.2. EXISTING UTILITIES

- A. Comply with the "call before you dig" damage prevention program (Utility Marking Service) prior to excavation.
- B. Locate, identify, and avoid existing utilities (public and private), including but not limited to electric, water, sewer, gas, and telecommunications.
- C. Identify underground utilities by marking on the ground with color coded paint in accordance with the most current version of the American Public Works Association Uniform Utility Color Code.
 - 1. Electric — red

2. Gas/oil — yellow
 3. Communications/CATV — orange
 4. Water — blue
 5. Sewer — green
 6. Limits of exposed excavation — white
 7. Temporary survey marking — pink
- D. Where the actual location is uncertain, identify obstacles located along the proposed construction area by means of test holes.
- E. Create test holes either directly above or to the side of the assumed location of any obstacle. After obstacle is located, take exact measurements and create a profile drawing identifying the obstacle's exact location.
- F. Repair damage occurring to existing underground utilities as a result of this Project.

3.3. INSTALLATION

- A. Provide conduit pathway system(s) as indicated on the Drawings.
1. Provide hand holes, including the minimum requirements shown on the Drawings.
 - a. Hand holes shall meet applicable code requirements, including the most current version of the National Electrical Safety Code (NESC).
 - b. Provide pea gravel base to a minimum depth of 6 inches in the bottom of open bottom hand holes.
 - c. Provide rebar reinforced concrete apron, at least 12 inches deep, around each hand hole installed in a sidewalk, paved area and roadway (paved or unpaved).
 - 1) The Concrete apron shall be compliant with the Contract Documents, including applicable and/or referenced Standards.
 - 2) A fiber expansion joint shall be placed between the apron and the box and between the apron and the surfacing material outside.
 - d. Field verify lid/cover construction requirements.
 - 1) Provide a suitable rated cover as specified.
 - 2) Covers located in Roadways shall have a AASHTO H-20 rating.
 - e. Covers shall be labeled as indicated.
 - f. Bolt the cover to the enclosure.
 2. Provide conduit pathways between Hand Holes and any other points shown on the Drawings.
 - a. Quantities and trade sizes of pathways shall be as indicated on the Drawings.
 - 1) Unless otherwise noted, underground conduits shall be 4-inch, Schedule 40 PVC.
 - 2) Conduits shall be installed at a nominal depth of 30 inches (\pm 6 inches) below grade and as indicated in the Contract Documents.
 - 3) Where minimum depth is unattainable, cover duct system with concrete.

- b. Provide galvanized steel casings around conduits installed under public roadways, including paved street or highways, railroads, river or stream crossing to extend at least 5 feet beyond each side, or 2 feet beyond the right-of-way of a public roadway, whichever is farther.
 - 1) Exception: Private drives located on Owner's property shall not require casings where conduits are installed at a minimum depth of 6 feet below the drive or encased in concrete to eliminate Live Load impact.
 - 2) After installation of underground duct system, fill casing with fine sand (blown in under pressure) and seal both ends with a 3-inch concrete wall.
- c. No single continuous conduit run shall exceed 600 feet between pull points.
 - 1) Provide additional maintenance holes, hand holes, or vaults as required to comply with this requirement.
- d. No more than a total of 180 degrees of bends shall be in any conduit segment between two maintenance holes, hand holes, or vaults. Avoid back-to-back 90degree bends.
- e. Provide additional maintenance holes, hand holes, or vaults as required to comply with this requirement.
 - 1) Where bends are required, manufactured bends shall be used whenever possible. Bends made manually shall not reduce the internal diameter of the conduit. Bends shall be sweeps with a minimum radius of six times the internal diameter for conduits up to 2 inches and ten times the internal diameter for conduits larger than 2 inch.
- f. Multi-cell duct systems shall be installed to manufacturer's instructions, including 65-foot bend radius on turns.
- g. Minimum bend radii shall be observed (for concrete encasement, compacted fill, or directionally bored). Inside radii of bends and sweeps shall not be less than 40 inches.
- h. Changes in conduit depth shall be accomplished with smooth sweeps of no less than a 10-foot bend radius, or the change shall be considered a 45-degree bend.
- i. Install underground duct system with a drain slope to allow drainage and to prevent the accumulation of water. Provide a drain slope of 0.125 inches per foot extending away from all building structures and between underground enclosures extending from mid-span towards each enclosure.
- j. Hand-trench within 5 feet of each side and across existing underground services.
 - 1) All trenches deeper than 5' shall have side walls shored, sheeted, braced or otherwise supported per OSHA requirements unless the side walls are cut to a slope of 12" horizontal for each 24" vertically.
- k. Clearances: Provide and maintain the following clearances from the system at times:
 - 1) 12 inches of well-tamped earth or 3 inches of concrete between system and any electric power of other conduit.
 - 2) 6 inches when crossing and 12 inches when parallel of well-tamped earth between system and any pipes (e.g., gas, water, oil).
 - 3) 50 inches below the top rail of any railroad crossing.

- 4) 36 inches below the top rail of any street railway crossing.
 - l. Seal conduit ends during construction to prevent intrusion of foreign debris. Provide duct plugs on duct ends at underground enclosures and building penetrations to prevent water and gas infiltration.
 - m. Conduit ends shall be smooth and free from burrs and sharp edges.
 - n. After complete installation of the system, and before the installation of any cabling, pull completely through each innerduct a spherical template having a diameter not less than 75-percent of the inside diameter of the innerduct to ensure absence of obstruction(s).
 - o. Provide plenum-rated tubular innerduct for fiber optic runs within the plenum space of a building unless interlocking armor construction is utilized for cables.
3. Entrance Facilities and Entrance Points
- a. Cable entrance points for each building shall be as indicated on the Drawings.
 - b. Provide penetrations through the facility walls and restore the wall to the same condition as prior to cutting. Wall and penetrations shall be water-tight and weather-tight.
 - c. Provide conduits and boxes as required to construct the entrance pathway as indicated on the Drawings.
 - 1) Conduit utilized on an exterior wall above grade shall be Galvanized Rigid Conduit (GRC), including sleeves extending into the building. The GRC conduit shall continue to the first below grade Hand Hole.
 - 2) Conduits shall slope upward at least 1% to the facility from the last pull box/vault.
 - 3) Conduit utilized in the interior ceiling cavity of a building to extend to a termination/transition space shall be EMT.
 - 4) Conduit utilized to stub up from or below the slab of the building shall be Schedule 40 PVC.
 - d. Provide transition point(s) between cable entrance points and the termination point of the cable(s), as required by Code and/or the Drawings.
 - 1) Transition points shall be secured in a 24-inch by 24-inch by 6-inch (minimum) screw-secured covered box. Provide provisions for padlocks.
 - 2) Provide telecommunications backboards at each interior entrance point where a transition box is required.
 - e. Transition boxes used on an exterior wall above grade shall be NEMA 3R rated.
 - f. Provide hardware to secure and protect the entrance pathway.
 - g. Fiber optic cables requiring splicing at transition points shall be fusion spliced. Splices shall be protected by splice trays within a splice enclosure.
 - h. Provide additional cable support, as required, from the entrance points at each building and continuing to the termination point of the cable.
 - i. Entrance Facilities allowing cable entrance to a ducted ceiling space may use open cable supports to support the cable (minimum 5-foot spacing between supports) to a termination point within 50 feet. Prior to installation, verify and comply with the AHJ and Code requirements.
 - 1) Exception: Indoor/Outdoor plenum rated loose tube fiber optic cable(s).

- 2) If the termination point is in excess of 50 feet, a closed metallic conduit shall be continuous from the Entrance Point to the termination point, or an adequately sized splice point must be provided in a serviceable area to splice properly rated indoor cable(s) to the unlisted OSP cable(s).
 - j. Entrance Points allowing cable entrance to a plenum (air return) ceiling space shall use closed metallic conduits to support the cable to a termination or splice point.
 - 1) Exception: Indoor/Outdoor plenum rated loose tube fiber optic cable.
 - 2) If it is impractical to provide a closed metallic conduit continuous from the Entrance Point to the termination point, an adequate splice point shall be installed in a serviceable area to splice properly rated indoor cable(s) to the unlisted OSP cable(s).
 - k. Entrance Point(s) stubbing up into a Communications Room (e.g., Equipment Room (ER), Telecommunications Room (TR), and Entrance Facility (EF)) shall extend 4 to 6 inches above the finished floor, shall be approximately 3 inches from the nearest wall, and shall be bushed. Cap for protection during construction. Provide sleeves for building penetrations. Patch and firestop around the sleeve and provide the appropriate bushings on each end. Split bushings are not acceptable or permissible. Firestop the interior of the sleeve after cabling is installed.
- B. Accessories:
1. Provide a No. 6 locate conductor inside a duct along each pathway; leave 10 feet coiled at each end.
 - a. Place outside the innerduct system in the primary pathway.
 2. Provide a 1/4-inch nylon pull rope in each conduit segment with 5-foot minimum slack at each end; coil slack and anchor to enclosure side. Provide pull rope in all innerducts.
 3. Provide warning tape above pathway runs.
 - a. Slice into ground below the surface over each pathway and provide a 4-inch wide "Buried Cable Below" warning tape at a 6-inch depth along the underground pathway where the pathway is not covered by pavement or concrete. Provide one per pathway (not one per duct).
 4. Provide plugs in duct(s) entering a building.
 - a. Install plugs in conduits entering a building below grade or below the level of the next/last hand hole.
 - b. Install plugs in unused conduits opening into a ceiling cavity from a transition box. Plug conduits/sleeves with cables installed with a removable barrier.
 5. Documentation: Update site plan to indicate actual field conditions. Document labeling used and record on the site plan.

3.4. GROUNDING AND BONDING

- A. Ground electrical systems and equipment as required by code, utility, local ordinances, AHJ and requirements herein, including referenced Standards.

3.5. IDENTIFICATION

- A. Identify system components and cabling in compliance with required codes and referenced standards.
- B. Label each cable, space, pathway, enclosure and termination.
- C. Below Grade Pathways:
 - 1. Below-Grade Conduit Markers:
 - a. Install underground warning tape 6 inches (152 mm) below grade directly above conduit ducts.
 - b. Install underground warning tape on top of the surface over which concrete is poured (e.g., driveways, sidewalks, slabs) and directly above ducts or buried conduits.
 - c. Select a tape featuring a warning message that most accurately describes the pathway usage below.

3.6. RESTORATION

- A. Restore affected areas to how they existed before construction.
 - 1. Where trenching has been performed, restoration shall include additional trench fill after settlement of original fill has completely subsided and reseeding as necessary for complete restoration.
 - 2. Where existing surface is removed, repair by backfilling with material equal in composition and density to the surrounding areas and replace removed surface such as asphalt pavement and concrete riprap with like material to equivalent condition.
- B. Provide erosion control, including bailed hay and sediment control fencing, as identified in the referenced Standards.

END OF SECTION 270543.00

SECTION 270550.00 - FIRESTOPPING FOR COMMUNICATIONS

PART 1 GENERAL

1.1. SUBMITTALS

- A. Product Data:
1. Bill of Materials (BOM).
 2. Product Datasheets.
 3. Material Safety Data Sheets (MSDS).

1.2. REFERENCES

- A. Definitions:
1. Firestop: A fire-rated material, device, or assembly of parts installed in a penetration of a fire-rated barrier.
 2. Firestop system: A specific construction consisting of the material(s) (firestop penetration seals) that fill the opening in the wall or floor assembly and any items that penetrate the wall or floor, such as cables, cable tray, conduit, ducts, pipes, and any termination devices, such as electrical outlet boxes, along with their means of support.
 3. Firestopping: The process of installing listed, fire-rated materials into penetrations in fire rated barriers to reestablish the fire-resistance rating of the barrier.
 4. Intumescent firestop: A firestopping material that expands under the influence of heat.
- B. Reference Standards:
1. . Comply with standards set forth in 27 00 01 - Common Work Results for Communications: References.
 2. ASTM E 84, "Surface Burning Characteristics of Building Materials."
 3. ASTM E 119, "Fire Tests of Building Construction and Materials."
 4. ASTM E 814, "Fire Tests of Penetration Firestop Systems."
 5. ANSI/UL 263, "Fire Tests of Building Construction and Materials."
 6. ANSI/UL 723, "Surface Burning Characteristics of Building Materials."
 7. ANSI/UL 1479, "Fire Tests of Through Penetration Firestops."
 8. Underwriters Laboratories Inc. (UL) — Fire Resistance Directory.
 9. National Fire Protection Association (NFPA) — NFPA 70: National Electrical Code.
 10. National Fire Protection Association (NFPA) — NFPA 101: Life Safety Code.
 11. TIA-569-B, Annex A, "Firestopping."
 12. The most current published edition of the "Telecommunications Distribution Methods Manual (TDMM)" published by the Building Industry Consulting Services International (BICSI), "Firestopping."

1.3. QUALITY ASSURANCE

- A. Where the local jurisdiction requires additional training, licensing, permits and certifications to perform firestopping, the entity and individuals performing the work shall comply with such requirements.

1.4. SYSTEM DESCRIPTION

- A. All penetrations through floors, ceilings, and walls shall be sleeved. All sleeves through floors and walls shall be fire stopped.
 - 1. The firestopping system shall resist and limit the spread of fire, heat, smoke and gasses through otherwise unprotected openings in rated assemblies, including walls, partitions, floors, ceilings/roof and similar locations, restoring the integrity of the fire rated construction to its original fire rating, in accordance with applicable codes, standards, and as directed by the AHJ.
 - 2. All sleeves into spaces containing pressurized fire suppression systems shall be self-sealing sleeve assemblies.
- B. Where penetration is accessible, firestopping shall be manufacturer installed in a re-usable sleeve assembly or may be removable/ re-usable material(s) inserted within and around a sleeve assembly to provide the required protection.
 - 1. Sleeves shall be mechanically fastened.
 - 2. Provide re-usable (re-enterable) firestopping system(s) and materials in backbone and horizontal cabling pathways to accommodate cabling changes.
- C. Firestopping requirements and locations are not specifically indicated on the Drawings. Review the architectural and other related Drawings to determine fire- and smoke-rated walls and floors, including minimum rating requirements. Provide firestopping Work associated with Division 27 and Division 28 (where applicable) per the requirements of the Contract Documents.
 - 1. At a minimum, firestopping shall equal or exceed the rating of the wall or floor and with a minimum UL classification for 1 -hour fire and cold side temperature ratings.
 - 2. Firestopping systems shall be listed for the specific combination of fire-rated construction, type of penetrating item, annular space requirements, and fire rating, including the following criteria:
 - a. F-Rating: Where applicable, provide products that meet the intent of the F-rating classification for passage of flame per ANSI/UL 1479 or ASTM E814 for through penetrations. Rating shall be equal to or greater than the fire-resistance rating of the assembly in which the firestopping will be installed.
 - b. T-Rating: Where applicable, provide products that meet the intent of the T-rating classification for the transfer of temperature per ANSI/UL 1479 or ASTM E814 for through penetrations. In habitable areas where penetrating items are exposed to potential contact with materials on fire side(s) of rated assembly, T-rating must equal F-rating

- c. L-Rating: Provide products that meet the intent of the L-rating classification for the movement of smoke per ANSI/UL 1479 or ASTM E814 for through penetrations.
 - d. W-Rating: Where applicable, provide products that meet the intent of the W-rating classification for passage of water per ANSI/UL 1479 or ASTM E814 for through penetrations. Shall meet UL Water Leakage Test, W-Rating — Class 1 requirements for systems tested and listed in accordance with ANSI/UL 1479 or ASTM E814.
 - e. Wall Penetrations: Through penetration systems shall be symmetrical, with the same rating from both sides of the wall.
3. Firestopping shall be installed within the interior cavity of conduit sleeves, raceway, cable tray and other cable conveyances where the interior volume of the conveyance is open and exposed in one space while the opposite end of the conveyance is open and exposed within another.
 4. Firestopping shall be installed where preparations for, or installation of equipment (e.g., cabling, devices) cause the fire or smoke rating of a building component or assembly to be reduced as a result of some action taken.
 5. Fire-resistive joint sealants: Provide joint sealants with fire-resistance ratings as determined per ASTM E 119, but not less than that equaling or exceeding the fire resistance rating of the construction in which the joint occurs.
 6. Firestopping products shall be compatible with each other, with the substrates forming openings, and with the items, if any, penetrating the firestopping, under the conditions represented by the Project, based on testing and field performance demonstrated by the firestopping products/system manufacturer.
 7. Firestopping system and products exposed to view, traffic, moisture, and physical contact shall not deteriorate when exposed to these conditions.
 8. Firestopping systems for floor penetrations with annular spaces exceeding 4 inches (100 mm) or more in width and exposed to possible loading and traffic shall be capable of supporting the floor loads involved by installing floor plates or by other means.

PART 2 PRODUCTS

2.1. GENERAL

- A. Products furnished of each Type shall be manufactured by a single manufacturer, bear the same brand name, be the same finish color and texture, and be from the same product model series, except where otherwise indicated.

2.2. MANUFACTURERS

- A. To maintain control and integrity of the firestopping applications, utilize a single manufacturer. Specific UL or approved listing agencies systems applicable to each type of firestop condition shall be supplied by a single manufacturer.
- B. Subject to compliance with requirements, provide products by one of the following:
 - 1. Specified Technologies, Inc. (ST I).
 - 2. 3M Fire Protection Products (3M).
 - 3. Hilti Corporation (Hilti).
 - 4. Unique Fire Stop Products.
 - 5. Nelson Firestop Products.
 - 6. Unifrax Corporation.

2.3. MATERIALS

- A. Firestopping products shall be tested and Listed for specific fire resistance rated construction conditions and shall conform to construction assembly type, penetrating item type, annular space requirements, and fire rating involved for each separate instance.
- B. Component Types — Utilize as required to meet Project requirements
 - 1. Intumescent sealants: Single component intumescent latex formulations containing no water soluble intumescent ingredients.
 - a. Basis of Design shall be Specified Technologies Inc. (STI) SpecSeal Series SSS Intumescent Sealant and SpecSeal Series I-CI Intumescent Sealant.
 - 2. Endothermic sealants: Single component latex formulations that upon cure do not reemulsify during exposure to moisture.
 - a. Basis of Design: Specified Technologies Inc. (STI) SpecSeal Series LC Endothermic Sealant.
 - 3. Firestop devices: Factory-assembled steel collars lined with intumescent material sized to fit specific outside diameter of penetrating item.
 - a. Basis of Design: Specified Technologies Inc. (STI) SpecSeal Series SSC Firestop Collars and SpecSeal LCC Firestop Collars.
 - 4. Wall opening protective materials: Intumescent, non-curing pads or inserts for protection of device boxes to reduce horizontal separation to less than 24 inches (610 mm).
 - a. Basis of Design: Specified Technologies Inc. (STI) SpecSeal Series SSP Firestop Putty Pads or SpecSeal Series EP PowerShield Insert Pads.
 - 5. Firestop putty: Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds.
 - a. Basis of Design: Specified Technologies Inc. (STI) SpecSeal Series SSP Putty.
 - 6. Intumescent wrap strips: Single component intumescent elastomeric strips faced on both sides.
 - a. Basis of Design: Specified Technologies Inc. (STI) SpecSeal Series SSW Wrap Strip.

7. Firestop pillows: Re-enterable, non-curing, mineral fiber core encapsulated with an intumescent coating on all six sides contained in a flame-retardant poly bag.
 - a. Basis of Design: Specified Technologies Inc. (STI) SpecSeal Series SSB Pillows.
 8. Mortar: Portland cement based dry-mix product formulated for mixing with water at Project site to form a non-shrinking, water-resistant, homogenous mortar:
 - a. Basis of Design: Specified Technologies Inc. (STI) SpecSeal Series SSM Firestop Mortar.
 9. Silicone sealants: Moisture curing, single component, silicone elastomeric sealant for horizontal surfaces (pourable or non-sag) or vertical surface (non-sag).
 - a. Basis of Design: Specified Technologies Inc. (STI) SpecSeal SIL300 Silicone Firestop Sealant or SpecSeal SIL300 SL Self-Leveling Silicone Firestop Sealant.
 10. Composite sheet: Intumescent material sandwiched between a galvanized steel sheet and steel wire mesh protected with aluminum foil:
 - a. Basis of Design: Specified Technologies Inc. (STI) SpecSeal CS Composite Sheet.
 11. Firestop plugs: Re-enterable, foam rubber plug impregnated with intumescent material for use in blank openings and cable sleeves.
 - a. Basis of Design: Specified Technologies Inc. (STI) SpecSeal Series FP Firestop Plug.
 12. Intumescent collar devices: Steel collar system with intumescent inserts.
 - a. Basis of Design: Specified Technologies Inc. (STI) SpecSeal Series SSC and LCC.
 13. Horizontal wall penetrations in Gypsum Board
 - a. Fire-rated cable grommet: Molded two-piece grommet made from plenum grade polymer with a foam inner core for sealing individual or small, multi-cable bundle penetrations.
 - 1) Basis of Design: Specified Technologies Inc. (ST I) Ready Firestop Grommet.
- C. Firestop sleeve assembly kit:
1. Sized to accommodate cable quantities indicated in the Contract Documents plus 20 _ percent additional capacity for growth.
 2. Includes steel escutcheon plates and intumescent firestop gaskets sized to fit the specific outside diameter of the sleeve and sandwich the barrier to lock the sleeve in place.
 3. Includes sufficient thickness of intumescent firestop putty to seal the ends of the sleeve to restrict the passage of fire, smoke and superheated gases.
 4. Penetrations 2" and smaller:
 - a. Basis of Design shall be Specified Technologies Inc. (STI) SpecSeal READY SLEEVE and SpecSeal READY SPLIT SLEEVE (for existing cable penetrations).
 5. Penetrations larger than 2" or ganged penetrations:
 - a. Fire rated cable pathways: Gangable device modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill and requiring no additional action in the form of plugs, twisting closure, putty, pillow, or sealant to achieve fire and leakage rating. Shall include cable radius control modules that snap onto the ends of devices.

- 1) Basis of Design: Specified Technologies Inc. (STI) EZ-PATH Fire Rated Pathway with RCM33 for Series 33 or EZRCM44S for Series 44+ radius control modules (RCM). Radius Control Modules are to be used for wall penetrations only.

D. Accessories:

1. Provide components for each firestopping system required to install fill materials and to comply with the system performance requirements. Use only components specified by the firestopping manufacturer and approved by the qualified testing and inspecting agency for the designated fire-resistance-rated systems. Firestopping materials shall be asbestos-free and shall not contain flammable solvents. Accessories include but are not limited to the following:
 - a. Permanent forming, damming, backing materials, including the following:
 - 1) Semi-refractory fiber (mineral wool) insulation.
 - 2) Ceramic fiber.
 - 3) Sealants used in combination with other forming/damming materials to prevent leakage of fill materials in liquid state.
 - 4) Fire-rated form-board.
 - 5) Joint fillers for joint sealants.
 - b. Temporary forming materials.
 - c. Substrate primers.
 - d. Collars.
 - e. Steel sleeves.
 - f. Warning labels.

2.4. COMBUSTIBLES IN PLENUM SPACES

- A. Passive combustibles installed within plenum spaces that are not UL listed for installation within plenum spaces shall be encased within high-temperature plenum insulation, the purpose of which is to prevent flame propagation and smoke development in the plenum areas. Passive combustibles include such items as non-plenum cables, pipe, low-voltage connector housings.
 1. Plenum insulation shall be UL listed for the application.
 2. Basis of Design: UniFrax FyreWrap 0.5.

PART 3 EXECUTION

3.1. GENERAL

- A. Consult and comply with the AHJ concerning local firestopping requirements.

1. Where no NRTL tested firestop application exists, manufacturer's engineering judgment derived from similar listed system designs or other tests shall be submitted to the AHJ for review and approval prior to installation.
 2. It is the sole responsibility of the firestopping provider to install tested and approved systems that comply with applicable codes, standards and/or agencies and authorities having jurisdiction.
- B. Comply with TIA-569-B, Annex A, "Firestopping."
- C. Comply with the most current published edition of the "Telecommunications Distribution Methods Manual (TDMM)" published by the Building Industry Consulting Services International (BICSI), including the "Firestopping" article.
- D. Through-penetration firestop systems and construction gap fire resistive systems shall be supplied and installed with approved methods using materials that have been tested and classified to produce a listed and approved assembly.
- E. Provide products that upon curing do not re-emulsify, dissolve, leach, break down or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during or after construction.
- F. Openings within floors and walls designed to accommodate cabling shall be provided with reenterable products that do not cure or dry.
- G. Damaged or expired materials shall be removed from the site and shall not be used in the Work.
- H. Do not use materials that contain flammable solvents.
- I. Sleeves shall be mechanically fastened to the wall, floor, ceiling or roof assembly.

3.2. DELIVERY, STORAGE AND HANDLING

- A. Deliver firestopping products to the Project site in original, unopened containers or packages with intact and legible manufacturer labels identifying product and manufacturer, date of manufacture, lot number, shelf life, if applicable, qualified testing and inspecting agency's classification marking applicable to Project, curing time, and mixing instructions for multicomponent materials.
1. Coordinate the delivery date of firestopping materials with the scheduled date of installation to minimize the amount of storage time required at the Project site.
 2. Store with a copy of the manufacturer MSDS sheet. Submit a copy of each sheet to the Owner's project manager upon delivery to the site.
- B. Store and handle firestopping materials to prevent deterioration or damage due to moisture, temperature changes, contaminants or other causes. Handle, store and protect products and materials according to the manufacturer's printed recommendations and guidelines.

- C. Do not deliver or install product(s) in conditions that jeopardize the performance of the product.

3.3. INSTALLATION

- A. Install firestopping products in compliance with manufacturer's printed instructions, recommendations and technical information.
- B. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to manufacturer's requirements. Coordinate sizing of sleeves, openings, core drilled holes or cut openings to accommodate through-penetration firestop systems.
- C. Environmental conditions:
 - 1. Install firestopping products when ambient or substrate temperatures are within the requirements recommended by the firestopping manufacturer. Do not install firestopping when ambient or substrate temperatures are outside the limits permitted by the manufacturer or when substrates are wet due to rain, frost, condensation or other causes.
 - 2. Maintain temperatures and environmental conditions within limits recommended or required by manufacturers printed instructions or technical information for any required periods of time before, during and after installation of materials.
- D. Ventilation: Provide ventilation as required by firestopping manufacturer, including mechanical ventilation if required.
- E. Examine substrates and conditions for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of firestopping. Do not proceed with installation until unsatisfactory conditions have been corrected.
- F. Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellants and any other substances that may inhibit optimum adhesion.
- G. Clean openings and joints immediately before installation of firestopping to comply with firestopping manufacturer's printed guidelines and recommendations and the following requirements:
 - 1. Remove foreign materials from surfaces of opening and joint substrates and from penetrating items that could interfere with adhesion of firestopping.
 - 2. Clean opening and joint substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with firestopping. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- H. Provide masking and temporary covering to protect adjacent surfaces and prevent contact with the following:

1. Adjoining surfaces that will remain exposed upon completion of the Work.
 2. Surfaces that would otherwise be permanently stained or damaged by such contact or cleaning methods used to remove smears from firestopping materials.
 3. Remove masking and temporary covering as soon as possible to do so without disturbing firestopping seal with substrates.
- I. Install fire stop materials, including forming, packing, and other accessory materials, to fill openings around services penetrating floors, walls, ceilings and roofs, to provide fire-resistance ratings indicated for the assembly in which the penetration occurs. Comply with installation requirements established by the manufacturer and testing and inspecting agency.
 - J. Install forming/damming materials and other accessories of types required to support fill materials during application and in the position needed to produce the cross-sectional shapes and depths required to achieve fire ratings of designated firestop systems. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
 - K. Install fill materials for through-penetration firestop systems by proven techniques to produce the following results:
 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items.
 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - L. Seal between sleeves and pipes and other through-penetration pathway devices with firestop material. Material shall meet applicable fire ratings required.
 - M. Firestop systems shall not hamper the performance of fire dampers in ductwork or other safety systems.
 - N. Tool non-sag sealants immediately after sealant application and before skinning or curing begins. Form smooth, uniform beads of configuration required to produce fire-resistance rating, as well as to eliminate air pockets, and to ensure contact and adhesion of sealants with sides of joint. Remove excess sealant from surfaces adjacent to the joint. Do not use tooling agents that discolor sealants or adjacent surfaces or that are not approved by the sealant manufacturer.
 - O. Firestopping for discrete cable pathways (J-hooks):
 1. Discrete cable pathways shall terminate at each barrier and resume on the opposite side such that cables pass independently through fire-rated pathway devices.

3.4. FIELD QUALITY CONTROL

- A. Components used in firestop systems shall be the same as the products used in fire qualification tests, must be prepared and installed using established quality control

procedures, and verified periodically by an independent quality auditor at the manufacturer's facility. The final field installation shall be reviewed and validated by the AHJ.

- B. Do not enclose firestopping with other construction until examinations are completed. Area of Work shall be accessible until inspections are completed by the AHJ.
- C. Where deficiencies are found, repair or replace firestopping at no additional expense to the Owner so that Work complies with requirements.

3.5. CLEANING

- A. Clean all surfaces adjacent to sealed openings to be free of excess firestopping materials and soiling as work progresses.
- B. Remove excess fill materials and sealants adjacent to openings and joints as Work progresses. Use methods and cleaning materials approved by manufacturers of firestopping products and products in which openings and joints occur. Return surfaces to the original condition.
- C. During and after the curing period, protect firestopping from contact with contaminating substances and from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion.
 - 1. If damage or deterioration occurs, remove damaged or deteriorated firestopping immediately, and install new materials to produce firestopping complying with specified requirements.

END OF SECTION 270550.00

SECTION 270553.00 - IDENTIFICATION FOR COMMUNICATIONS

PART 1 GENERAL

1.1. SUBMITTALS

- A. Labeling schemas.

1.2. SUMMARY

- A. Section Includes:
 - 1. Labeling of cabling and termination devices.
 - 2. Labeling of equipment.
 - 3. Labeling of Communications Rooms.
- B. Requirements of this Section apply to all Work of this Division and Work Division 28 (where applicable).

1.3. REFERENCES

- A. Definitions:
 - 1. Component Identifier / Component ID: See Device ID
 - 2. Device.ID: The unique identifier given to a specific instance of a product, module and assembly. Identifiers are unique within the context of the system and product in which it is used.
- B. Reference Standards
 - 1. Comply with standards set forth in 27 00 01 - Common Work Results for Communications: References.

1.4. SYSTEM DESCRIPTION

- A. The identification system shall be a coordinated system of permanently affixed labels of specified types that are used to uniquely identify each instance of a product and the space in which it is located. The following items shall be identified:
 - 1. Cables.
 - a. All cables shall have cable ID on the jacket at each end 4-6 inches from termination.
 - 2. Telecommunications cabling cross-connect Blocks, including 66-blocks and 110-blocks.
 - 3. Patch Panels.
 - 4. Faceplates.
 - 5. Individual connection jacks, receptacles and terminals.
 - 6. Remote Equipment enclosures/cabinets not within telecommunications rooms.
 - 7. Equipment racks and cabinets within telecommunications rooms.

8. Telecommunications Backboards.
 9. Rooms containing communications or security products.
 10. Device boxes, junction boxes, pull boxes, floor boxes, wall boxes, ceiling boxes and other forms of boxes used for passage, splicing, or termination of cables.
 11. Equipment power cord plugs.
- B. The labeling schema used for horizontal, and backbone structured cabling systems shall be TINEIA-606-A, or most current version, compliant.
- C. Label Type Schedule

LABEL TYPE SCHEDULE		
APPLICATION	TYPE	NOTES
EQUIPMENT RACK - FRONT	DB	
EQUIPMENT RACK - REAR	DB	
PATCH PANELS - BACKBONE ABLES	CB	
PATCH PANELS - HORIZONTAL CABLES	CB	
FACEPLATES - HORIZONTAL	CB	CLEAR BACK
FACEPLATES - CUSTOM	DE	ENGRAVED; SCREENED
FACEPLATES - MULTISERVICE	CB	CLEAR BACK; ENGRAVED
OUTLETS - HORIZONTAL	CB	
OUTLETS - CUSTOM FACEPLATE	DB	
CABLES - HORIZONTAL	CA	
CABLES - BACKBONE	CA	
AV CABLES	CA	
COMMUNICATIONS BACKBOARDS	DC	
CONNECTING BLOCKS	PI	WITH PLASTIC COVER
FIBER OPTIC PANEL	PI	
ABBREVIATED DEFINITIONS CA=SELF LAMINATING (WRAP-AROUND), CB=SELF LAMINATING DA = LAMACOID, DB=TAPE TYPE, DC=IMPRINTED/ETCHED; DE=ENGRAVED PI=PRINTED INTEGRAL LABEL; RA=LAMACOID SEE SECTION 270553 FOR SPECIFICATIONS OF VARIOUS LABEL TYPES		

PART 2 PRODUCTS

2.1. GENERAL

- A. Products furnished of each Type shall be manufactured by a single manufacturer, bear the same brand name, be the same finish color and texture, and be from the same product model series, except where otherwise indicated.

2.2. MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Brady
 - 2. Brother
 - 3. Casio
 - 4. Hubbell
 - 5. Panduit
 - 6. Hellerman/Tyton
 - 7. Thomas and Betts

2.3. PERFORMANCE

- A. Labels shall be designed to remain permanently affixed under typical environmental conditions for the life of the product identified.
- B. Nomenclature shall be permanent and non-fading under typical environmental conditions.
- C. Adhesive labels shall remain attached to the affixed product in continuous conditions of 90% relative humidity and temperatures of 100-degrees Fahrenheit (38-degrees Celsius).

2.4. CABLE INFRASTRUCTURE LABELS

- A. Type CA:
 - 1. Self-laminating type.
 - 2. Adhesive backed.
 - 3. Opaque solid-color background area, color for nomenclature: White.
 - 4. Clear self-laminating wrap-around cover for protection of nomenclature.
 - 5. Available in a variety of heights and widths to suit the cable being labeled.
 - 6. Printing area of the label available in a wide variety of sizes to accommodate the specific nomenclature to be applied.
 - 7. Overall label width: Minimum 1 inch (25 mm); Maximum 2 inches (50 mm).
 - 8. Opaque printing area length: Minimum 1/2 inch (12 mm); Maximum 1-1/4 times the cable circumference.
 - 9. Self-laminating wrap length: 1-1/2 to 2-1/2 times the cable circumference.
 - 10. Bold computer-generated and commercial printer applied high-contrast project and system specific nomenclature.

B. Type CB - Tape Type:

1. Self-laminating type.
2. Adhesive backed.
3. Opaque solid-color background area, color for nomenclature: White.
4. Available in a variety of heights and widths to suit the termination being labeled.
5. Printing area of the label available in a wide variety of sizes to accommodate the specific nomenclature to be applied.
6. Overall label width: Minimum 1 inch (25 mm); Maximum 2 inches (50 mm).
7. Opaque printing area length: Minimum 1/2 inch (12 mm); Maximum 1-1/4 times the cable circumference.
8. Bold computer-generated and commercial printer applied high-contrast project and system specific nomenclature.

C. Type PI - Tape Type:

1. Integral card type.
2. Opaque solid-color background area, color for nomenclature: White.
3. Heights and widths to suit the termination being labeled.
4. Printing area of the label to accommodate the specific nomenclature to be applied.
5. Bold computer-generated and commercial printer applied high-contrast project and system specific nomenclature.
6. Provide with clear plastic covers to protect label.

2.5. DEVICE LABELS

A. Type DB - Tape Type:

1. Tape-type construction.
2. Material: Polyester.
3. Working temperature range: -40 to 248 degrees Fahrenheit (-40 to 120 degrees Celsius)
4. Opaque solid-color background over which nomenclature is applied.
5. Self-adhesive backing for adhesion to labeled item.
6. Designed for thermal-transfer based machine imprinting of nomenclature.
7. Available in a wide-variety of manufacturer sizes.
8. Available with a wide-variety of background colors.
9. Available with a variety of different nomenclature colors.

2.6. CABLE LABEL HEATSHRINK

- A. Should any condition arise in which cable labels are used that are neither self-laminating nor permanent, then properly sized clear heat-shrink shall be applied over the label to make it permanent.

PART 3 EXECUTION

3.1. INSTALLATION

A. General:

1. Label each instance of each product.
2. Label each connector of each product.
3. Install labels so that they are legible after installation.
4. Install labels so they are parallel to the dominant visual lines of the product identified.
5. Install labels of the appropriate size for the application.
6. Maintain consistency in label sizes that are used for labeling similar applications.
7. Install secondary labels on the rear of products that are mounted within racks, within equipment enclosures/cabinets, within furniture or casework, and in any application where the rear of the product is accessed for termination, installation, service, operation or adjustment.
8. Coordinate "final" room numbers or identifiers with the Owner prior to performing work; all labeling shall perform to operational room identifiers. If actual room numbers differ from architectural room numbers both shall be included on the as-built floorplans.
9. Campus environments with multiple buildings shall add a building identifier to the labeling in each building.

B. Cables:

1. General:

- a. Uniquely identify each cable so that no two cables serving a single system utilize the same identifier.
- b. Cables that terminate within different architectural spaces shall include both the source and destination space identifiers on the label in addition to a unique cable identifier
- c. Install a primary label near the end of cable.
- d. Install a secondary label (with identical nomenclature as the primary label) near the ends of the cable at such point that the label is viewable and readable when the cable is in its final dressed position.
- e. Utilize specified labeling schemas. Substitute schema may be considered if submitted to, reviewed and returned by the Designer without exceptions.

2. Horizontal Cables:

- a. Label in accordance with referenced standards.
- b. Horizontal labeling schema:

- 1) "Communication Room Identifier"—"Outlet Room Number"—"Rack, Patch Panel and Patch Panel Port Number."

3. Backbone Cables:

- a. Label in accordance with referenced standards.
 - b. In addition to labels at each end, apply a label at each junction/pull point to identify the cable.
 - c. Cabling labeling schema:
 - 1) Service designation and number: CB = Copper Backbone, FB = Fiber
 - 2) Backbone, VB = Video Backbone (e.g., CB.OI, FB.OI, FB.02, VB.OI) 2) Interconnected Communication Room designations (e.g., ER01—TR04)
 - 3) Composite Examples:
 - a) Example: CB.01-ER01-TR02.
 - b) Example: CB.01-ER01-TR03.
 4. Patch Cables:
 - a. Label with the same unique identifier at each end.
 5. Multi-Cable Assemblies and Tethers:
 - a. Label the overall assembly, sleeve, or jacket (as applicable) at both ends.
 - b. Label each individual cable member at both ends.
 - c. If the cable assembly features connectors on the end of any cable member, affix labels also on the connector. Use user-friendly nomenclature that identifies the use of the connector and the port to which it mates.
 - d. See illustrations at the end of this Section.
- C. Faceplates and Outlets:
1. Faceplates — General:
 - a. Label each faceplate with a Device.ID label.
 - 1) Exception: Faceplates used exclusively for Horizontal cables do not need to feature a Device.ID label.
 - 2) Exception: Blank faceplates are not required to have a Device.ID label, except where noted.
 - b. Use labels with a clear background or a background color that matches the plate. On custom fabricated faceplates, label shall be integral to the plate by means of engraving or screening or other approved means.
 - c. See illustrations at the end of this Section.
 2. Faceplates — with Horizontal Cables:
 - a. Label modular outlet frame(s) with a label identifying origination and destination rooms of the horizontal cable(s) present at the faceplate. When non-modular faceplates are used, affix the label to the plate.
 3. Outlets/Connectors — General:
 - a. Label each outlet.
 4. Outlets/Connectors — Horizontal Cables:
 - a. Identify the specific patch panel and port to which the opposite end of the cable is connected.

5. Use .35" tape with 9 pt Arial font.
- D. Cross-Connect Blocks:
1. 110-Style:
 - a. Label the front of the block directly above or below (as indicated by the manufacturer) each position in the block.
 - b. Label connections in numerical order and corresponding to the faceplate outlet schema (horizontal cabling) or the opposite end labeling schema (backbone cabling), dependent upon use.
 - c. Label the upper left corner of each block designating the service of that particular block.
 2. 66-Style:
 - a. Label the front of the block directly above or below (as indicated by the manufacturer) each position in the block.
 - b. Label connections in numerical order and corresponding to the faceplate outlet schema (horizontal cabling) or the opposite end labeling schema (backbone cabling), dependent upon use.
 - c. Label the upper left corner of each block designating the service of that particular block.
- E. Patch Panel:
1. Chassis — General:
 - a. Label each panel chassis with a Device-ID.
 - b. Affix chassis labels aligned with the left or right edge of the product. Locate consistently across chassis in the rack and throughout the project.
 2. Chassis — for Horizontal Cabling:
 - a. In lieu of or in addition to the Device.ID uniquely label the chassis for each panel within each Communication Room in accordance with the following schema:
 - b. "Letter" or "Letter Letter" where letters A-Z or dual letter assemblies AA-ZZ are valid.
 3. Individual Connectors — for Horizontal Cabling:
 - a. Label each connector on each panel in order from Left to Right and Top to Bottom 1 to "X," where "X" is the number of connector spaces on the panel.
 - b. In addition, the connector label nomenclature shall clearly identify the room number in which the opposite end of the cable is terminated.
 4. Individual Connectors — Others:
 - a. Label each connector.
 - b. Use color-coded nomenclature acceptable to the Designer.
- F. Patch Bays (e.g., Audio, Video):
1. Label each patch bay with a Device.ID.
 2. Label each connector on the patch bay.
 3. Use color-coded nomenclature acceptable to the Designer.

4. Where the patch bay features an integral labeling strip, label the connectors using the strip following the techniques recommended by the manufacturer.
5. Where the Drawings depict additional means of labeling, provide additional labels with designer reviewed nomenclature.

G. Equipment Racks:

1. Label each equipment rack with a unique identifier.
2. Accurately record the nomenclature on the project as-built documentation.
3. Affix a primary label to the front of the rack.
4. Affix a secondary label to the rear of the rack.
5. Locate labels on the upper-most part of the rack, typically the frame, in an area that is clearly visible if doors are installed and closed.
6. Label each equipment rack to match the designation indicated on the floor plans
7. Labels shall be black text on white background.

H. Terminal Blocks:

1. Label each terminal block.
2. Label every conductor of every terminal block.
3. Label logical groups, pairs, or segments of the terminal block as to the purpose they serve.

3.2. LABEL PROTECTION

- A. Cable Labels: If at any time during the course of the project a condition arises for which cable labels are used that are neither self-laminating nor permanent, then such labels shall be protected with properly sized clear heat-shrink to protect the label and to make it permanent.

3.3. RECORD DRAWINGS

1. Accurately record the labels used for identifying items within the project as-built documentation.

END OF SECTION 270553.00

SECTION 270810.00 - VERIFICATION TESTING OF STRUCTURED CABLING

PART 1 GENERAL

1.1. SUBMITTALS

A. Product Data:

1. Bill of Materials (BOM):
 - a. Make, Model, Serial Number.
 - b. Description of the test instrument.
 - c. Tests for which the instrument will be used.
2. Product Datasheets: For each test instrument to be used.
3. Product Calibration Certificate for each test instrument: Certificate shall document the date of calibration and the name of the calibration organization.

B. Closeout Submittal:

1. UTP Cable Test Result Documentation:
 - a. Make, model, serial number and date of last calibration of each piece of test equipment used.
 - b. Summary Test Reports: Digital copy of the summary test results shall be provided that lists the links that have been tested with the summary information as set forth in Part 3.
 - c. Detailed Test Reports: Detailed test results data to be provided in the electronic database for each tested link must contain the information as set forth in Part 3.
 - 1) The database for the completed job including any software tools required to view, inspect, and print any selection of test reports.
2. Fiber Optic Test Result Documentation:
 - a. Make, model, serial number and date of last calibration of each piece of test equipment used.
 - b. Summary Test Reports: Digital copy of the summary test results shall be provided that lists the links that have been tested with the test summary information as set forth in Part 3.
 - 1) Fiber tests from the same cable between the same 2 points shall not vary over .25db from each other.
 - c. Detailed Test Reports: Detailed test results data to be provided in the electronic database for each tested fiber link must contain the information as set forth in Part 3.
 - 1) The database for the completed job including any software tools required to view, inspect, and print any selection of test reports.
3. Coaxial Cabling Test Result Documentation:
 - a. Make, model, serial number and date of last calibration of each piece of test equipment used.

- b. Summary Test Reports: Digital copy of the summary test results shall be provided that list links that have been tested with the summary information as set forth in Part 3.
- c. Detailed Test Reports: Detailed test results data to be provided in the electronic database for each tested link must contain the information as set forth in Part 3.
 - 1) The database for the completed job including any software tools required to view, inspect, and print any selection of test reports.

1.2. REFERENCES

A. Definitions:

- 1. IDC: Insulation displacement connector.
- 2. Margin: Designates the difference between the measured value and the corresponding test limit value. For passing links, 'worst case margin' identifies the smallest margin over the entire frequency range; the point at which the measured performance is "closest" to the test limit.
- 3. NVP: Nominal Velocity of Propagation expresses the speed of the electrical signals along the cabling link in relation to the speed of light in a vacuum. Insulation characteristics and twist rate of the wire pair influence NVP in minor ways. Typically, an 'average' value for NVP is published for four wire-pairs in a cable.
- 4. OLTS: Optical loss test set.
- 5. OTDR: Optical time domain reflectometer.

B. Reference Standards:

- C. Comply with standards set forth in 27 00 01 - Common Work Results for Communications: References.

1.3. COORDINATION

- A. The Owner or the Owners representative shall be invited to witness and review field testing and procedures. The representative shall be notified of the start date of the testing phase a minimum of five (5) business days before testing commences.

1.4. QUALITY ASSURANCE

- A. Individuals performing tests shall have attended and have successfully completed an appropriate training program and have obtained a certificate as proof thereof. Appropriate training programs include but are not limited to installation certification programs furnished by BICSI or the ACP (Association of Cabling Professionals).
- B. Test equipment shall perform in accordance with the manufacturer's published specifications and shall have been calibrated by either the manufacturer or a recognized

independent test equipment calibration organization within the 365-day period prior to its use.

1.5. SYSTEM DESCRIPTION

- A. Outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work.
- B. Perform testing on each cabling link (connector to connector), including copper twisted pair, fiber optic (multi-mode and single-mode) and coaxial cabling.
 - 1. Fiber optic Intra-Building Links shall be tested as Tier 1 .
 - 2. Fiber optic Inter-Building Links shall be tested as Tier 2.
 - 3. All fiber optic links including more than one segment shall be tested as Tier 2 whether involving fusion splicing or mechanical connection.
- C. Testing shall not include any active devices or passive devices within the link other than cable, connectors, and splices.
 - 1. Link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
- D. In addition to the tests identified in this document, contractor shall notify the Owner or Owner's representative of any additional tests that are deemed necessary to guarantee a fully functional system. These tests shall be implemented with additional measurement results recorded at no additional costs.

PART 2 PRODUCTS

2.1. TEST EQUIPMENT REQUIREMENTS

- A. Subject to compliance with requirements, available test equipment manufacturers that may be used for testing include, but are not limited to the following:
 - 1. Fluke Corporation.
 - 2. Ideal
 - 3. Softing
 - 4. Viavi
 - 5. FiberFox
- B. UTP Cable Test Equipment:
 - 1. Category 5e, 6 and 6A (Augmented Category 6) Compliance: Coordinate with the Drawings and related Sections for project requirements.
 - a. The test equipment (tester) shall comply with the accuracy requirements for field testers as defined in referenced standards. The tester, including the appropriate interface adapter, must meet the specified accuracy requirements. The accuracy

requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in referenced standards.

- 1) Level IIe — Category 5e (100MHz)
 - 2) Level III - Category 6 (250 MHz)
 - 3) Level IV - Category 6A (500MHz)
- b. The test plug shall fall within the values specified in referenced standards for NEXT, FEXT and Return Loss.
 - c. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.
 - d. The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.
 - e. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests. Any Fail or Fail* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass*.
 - f. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer must provide documentation as an aid to interpret results marked with asterisks.
2. Measurement Capabilities
- a. Wire Map
 - b. Length
 - c. Propagation Delay
 - d. Delay Skew
 - e. DC Loop Resistance
 - f. DC Resistance Unbalance within a pair
 - g. DC Resistance Unbalance between pairs
 - h. Insertion Loss
 - i. NEXT (Near-End Crosstalk)
 - j. PS NEXT (Power Sum Near-End Crosstalk)
 - k. ACR-N (Attenuation to Crosstalk Ratio Near-End)
 - l. PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End)
 - m. ACR-F (Attenuation to Crosstalk Ratio Far-End)
 - n. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
 - o. Return Loss
 - p. TCL (Transverse Conversion Loss)

- q. ELTCTL (Equal Level Transverse Conversion Transfer Loss)
 - r. Time Domain Reflectometer
 - s. Time Domain Xtalk Analyzer
 - t. PS ANEXT (Power Sum Alien Near-End Crosstalk)
 - u. Average PS ANEXT (Average Power Sum Alien Near-End Crosstalk)
 - v. PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)
 - w. Average PS AACR-F (Average Power Sum Alien Attenuation to Crosstalk Ratio Far-End)
- C. Fiber Optic Cable Test Equipment:
- 1. The test equipment shall be within the calibration period recommended by the manufacturer.
 - 2. Fiber optic test jumpers and adapters shall be of high quality and shall not show excessive wear.
 - 3. Optical Loss Test Set (OLTS):
 - a. An OLTS is comprised of two components: an optical light source and an optical power meter. After making a reference measurement, the source and meter are located at opposite ends of the fiber under test. A source and meter may be contained within the same package to enable bi-directional testing without swapping end test equipment.
 - b. Multimode optical fiber light source:
 - 1) Dual LED light sources with central wavelengths of 850nm (± 30 nm) and 1300nm (± 20 nm).
 - 2) Output power of -20dB minimum.
 - 3) The light source shall meet the launch requirements of referenced standards. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap with a Category 1 light source.
 - c. Singlemode optical fiber light source:
 - 1) Dual laser light sources with central wavelengths of 1310nm (± 20 nm) and 1550nm (± 20 nm).
 - 2) Output power of -1 OdB minimum.
 - d. Power Meter:
 - 1) 850 nm, 1300/1310 nm, and 1550 nm wavelength test capability.
 - 2) Power measurement uncertainty of ± 0.25 dB.
 - 3) Store reference power measurement.
 - 4) Save at least 100 results in internal memory.
 - 5) PC interface (serial or USB).
 - 4. Optical Time Domain Reflectometer (OTDR):
 - a. Internal non-volatile memory and removable memory device with at least 16MB capacity for results storage.
 - b. Serial and USB ports to transfer data to a PC.

- c. Multimode OTDR:
 - 1) Wavelengths of 850nm (\pm 20nm) and 1300nm (\pm 20nm).
 - 2) Event deadzones of 3.7 m maximum at 850 nm and 1300 nm.
 - 3) Attenuation deadzones of 10m maximum at 850nm and 13m maximum at 1300nm.
 - 4) Distance range at least 2,000m.
 - 5) Dynamic range at least 10dB at 850nm and 1300nm.
 - d. Singlemode OTDR:
 - 1) Wavelengths of 1310 nm (\pm 20 nm) and 1550 nm (\pm 20 nm).
 - 2) Event dead zones of 3.5 m maximum at 1310 nm and 1550 nm.
 - 3) Attenuation dead zones of 10 m maximum at 1310 nm and 12 m maximum at 1550 nm.
 - 4) Distance range not less than 10,000 m.
 - 5) Dynamic range at least 10 dB at 1310 nm and 1550 nm
 - 5. Fiber Microscope:
 - a. Magnification of 200X or 400X for endface inspection
 - b. Optional requirements:
 - 1) Video camera systems are preferred.
 - 2) Camera probe tips that permit inspection through adapters are preferred.
 - 3) It is preferable to use test equipment capable of saving and reporting the end face image.
 - 6. Integrated OLTS, OTDR and fiber microscope:
 - a. Test equipment that combines into one instrument an OLTS, an OTDR and a fiber microscope may be used.
- D. Coaxial Cable Test Equipment:
- 1. Capacitance Meter:
 - a. Range: 1 nanofarad to 9,999 microfarads.
 - b. Accuracy: \pm 1.5% or better.
 - 2. DCR Ohms Meter:
 - a. Range: .01 ohms to 40 megaohms.
 - b. Resolution: 2 .1 ohm.
 - c. Accuracy: \pm .4% or better.
 - 3. Cable Loss Meter:
 - a. RF Signal Generation:
 - 1) Range: 1-2000 megahertz.
 - 2) Resolution: 1 megahertz or better.
 - 3) Output level capability: 1dBmV to 220dBmV.
 - b. Spectrum Analysis:
 - 1) Range: 1-2000 megahertz.
 - 2) Resolution: 1 megahertz or better.

- c. Loss Measurement Resolution:
 - 1) 0.1dBmV or better.
- d. Data Storage & Recall:
 - 1) Capable of storing test results from ≥ 100 individual cables.
 - 2) Serial and USB ports to transfer data to a PC.
- 4. Copper Time-Domain Reflectometer (TDR):
 - a. Adjustable Pulse Width Settings.
 - b. Programmable nominal velocity of propagation (NVOP) to match cable under test.
 - c. NVOP Range: .30 to .99, in .01 increments
 - d. Measurement Accuracy: 1% or better.
 - e. Measurement Range: $\geq 30,000$ -feet @ 64% NVOP.

PART 3 EXECUTION

3.1. UTP CABLE TESTING

- A. General:
 - 1. Field test UTP cabling upon completion of the installation.
 - 2. Every cabling link in the installation shall be tested in accordance with the field test specifications defined in referenced standards.
 - 3. The installed twisted-pair horizontal links shall be tested from the MDF/IDF (ER/TR) in the telecommunications room to the telecommunication wall outlet in the work area against the "Permanent Link" performance specification.
 - 4. One hundred percent of the installed cabling links must be tested and must pass the requirements of the standards mentioned above and as further detailed in Part 3. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for links shall be provided in the test results documentation (below).
 - 5. Field-test instruments shall have the latest software and firmware installed.
 - 6. Link test results from the Test Equipment shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.
 - 7. Testing shall be performed on each cabling segment (panel to panel, panel to connector or connector to connector).
 - 8. Testing of the cabling shall be performed using high-quality test cords of the same Category and manufacturer as the cabling under test.
- B. Performance Test Parameters — Category 5e, Category 6 and Category 6A (Augmented Category 6):
 - 1. The field test specifications are defined in referenced standards.

2. The test of each link shall contain the following parameters as detailed below.
 - a. Category 5e: In order to pass the test, measurements at each frequency in the range from 1 MHz through 100 MHz must meet or exceed the limit value determined in the above-mentioned standard.
 - b. Category 6: In order to pass the test, measurements at each frequency in the range from 1 MHz through 250 MHz must meet or exceed the limit value determined in the above-mentioned standard.
 - c. Category 6A (Augmented Category 6): In order to pass the test, measurements at each frequency in the range from 1 MHz through 500 MHz must meet or exceed the limit value determined in the above-mentioned standard.
3. Wire Map:
 - a. The wire map test is intended to verify pin-to-pin termination at each end and check for installation connectivity errors. For each of the 8 conductors in the cabling, the wire map indicates:
 - 1) Continuity to the remote end
 - 2) Shorts between any two or more conductors
 - 3) Reversed pairs
 - 4) Split pairs
 - 5) Transposed pairs
 - 6) Distance to open on shield
 - 7) Any other miss-wiring
 - b. The correct connectivity of telecommunications outlets/connectors is defined in referenced standards. Two color schemes are permitted. The user shall define which scheme is to be used. The field tester shall document which color scheme was used.
4. Length:
 - a. The length of each balanced twisted pair shall be recorded.
 - b. Since physical length is determined from electrical length, the physical length of the link calculated using the pair with the shortest electrical delay shall be reported and used for making the pass or fail determination.
 - c. The pass or fail criteria is based on the maximum length allowed for the Permanent Link as specified in referenced standards plus the nominal velocity of propagation (NVP) uncertainty of 10%. For a Permanent Link, the length measurement can be 325 ft. (99 m) before a fail is reported.
5. Propagation Delay:
 - a. Is the time it takes for a signal to reach the end of the link.
 - b. The measurement shall be made at 10 MHz.
 - c. The propagation delay of each balanced twisted pair shall be recorded.
 - d. Is not to exceed 498 ns.
 - e. This measurement is to be performed for each of the four wire pairs.
 - f. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay. The report shall include the propagation delay value measured as well as the test limit value.
6. Delay Skew

- a. The delay skew of each balanced twisted pair shall be recorded.
 - b. Is not to exceed 44 ns.
 - c. This parameter shows the difference in propagation delay between the four wire pairs. The pair with the shortest propagation delay is the reference pair with a delay skew value of zero.
 - d. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay (the longest propagation delay). The report shall include the delay skew value measured as well as the test limit value.
7. DC Resistance
- a. Often reported as Resistance, is the loop resistance of both conductors in the pair.
 - b. Cat 5e and Cat 6
 - 1) Is not specified in ANSI/TIA-1152 but shall be recorded for all four pairs.
 - c. Cat 6A
 - d. The DC Resistance shall be reported for all four pairs.
 - e. Is not to exceed 21 Ω for all four pairs.
8. DC Resistance Unbalance within a pair
- a. Often reported as Resistance Unbalance, is the difference in resistance of the two wires within the pair.
 - b. Cat 5e and Cat 6
 - 1) Is not specified in ANSI/TIA-1152 for a Permanent Link but shall be recorded for all four pairs. C. Cat 6A
 - 2) The DC Resistance Unbalance within a pair shall be reported for all four pairs.
 - 3) Is not to exceed 200 m Ω or 3%, whichever is the greatest.
9. DC Resistance Unbalance between pairs (Cat 6A)
- a. Is the difference in DC parallel resistance of the conductors of a pair compared to the DC parallel resistance of another pair, given in the formula below?
$$Resistance_Unbalance_{Between_pairs} = \left(\frac{|R_{P1} - R_{P2}|}{R_{P1} + R_{P2}} \right) 100\%$$

Where:
 R_{P1} is the DC parallel resistance of the conductors of a pair.
 R_{P2} is the DC parallel resistance of the conductors of another pair.
 - b. The DC Resistance Unbalance shall be reported for the following pairs
 - 1) 1,2-3,6
 - 2) 1,2-4,5
 - 3) 1,2-7,8
 - 4) 3,6-4,5
 - 5) 3,6-7,8
 - 6) 4,5-7,8
 - c. Is not to exceed 200 m Ω or 7.5%, whichever is the greatest.
10. Insertion Loss (Attenuation):

- a. Insertion Loss is a measure of signal loss in the permanent link or channel. The term "Attenuation" has been used to designate "Insertion Loss." Insertion Loss shall be tested from 1 MHz through the frequency range identified above for the category-rating requirements, in maximum step size of 1 MHz. Measure insertion loss at the same frequency intervals as NEXT Loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk ratio (ACR) parameter.
- b. Minimum test results documentation (summary results): Identify the worst wire pair (1 of 4 possible). The test results for the worst wire pair must show the highest attenuation value measured (worst case), the frequency at which this worst-case value occurs, and the test limit value at this frequency.

11. NEXT Loss:

- a. Pair-to-pair near-end crosstalk loss (abbreviated as NEXT Loss) shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). This parameter is to be measured from 1 through the frequency range identified above for the category-rating requirements. NEXT Loss measures the crosstalk disturbance on a wire pair at the end from which the disturbance signal is transmitted (near-end) on the disturbing pair. The maximum step size for NEXT Loss measurements shall not exceed the maximum step size defined in the Standard as shown in Table 1.
- b. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst case NEXT margin and the wire pair combination that exhibits the worst value of NEXT (worst case). NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

c. Table 1 — Maximum frequency step size

d.

Frequency Range (MHz)	Maximum Step size (MHz)
1 – 31.25	0.15
31.26 - 100	0.25
100 - 250	0.50
250 - 500	1.00

12. PS NEXT Loss:

- a. Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link under-test (a total of eight results). PS NEXT Loss captures the combined near-end crosstalk effect (statistical) on a wire pair when other pairs actively transmit signals. Like NEXT this test parameter must be evaluated

from 1 through the frequency range identified above for the category-rating requirements, and the step size may not exceed the maximum step size defined in the Standard as shown in Table 1.

- b. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PS NEXT. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
13. ACR-N Loss, pair-to-pair:
- a. Attenuation Crosstalk Ratio Near-end is calculated from the pair-to-pair NEXT Loss. It shall be measured for each wire-pair combination from both ends of the link under-test. NEXT Loss measures the crosstalk disturbance on a wire pair at the close end (near-end) from which the transmitter emits the disturbing signal on the disturbing pair. NEXT is measured to compute ACR-N Loss that must be evaluated and reported in the test results. ACR-N measures the relative strength of the near-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire pair combinations. ACR-N is to be measured from 1 through the frequency range identified above for the category-rating requirements, and the maximum step size for NEXT Loss measurements shall not exceed the maximum step size defined in the Standard as shown in Table 1 .
 - b. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ACR-N. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
14. PS ACR-N Loss:
- a. Power Sum Attenuation Crosstalk Ratio Near-end is a calculated parameter that combines the effect of the NEXT disturbance from three wire pairs on the fourth one. This test yields eight wire-pair combinations. Each wire-pair is evaluated from 1 through the frequency range identified above for the category-rating requirements, in frequency increments that do not exceed the maximum step size defined in the Standard as shown in Table 1.
 - b. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
15. ACR-F Loss, pair-to-pair:
- a. Attenuation Crosstalk Ratio Far-end is calculated from the pair-to-pair FEXT Loss. It shall be measured for each wire-pair combination from both ends of the link under-test. FEXT Loss measures the crosstalk disturbance on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair. FEXT is measured to compute ACR-F Loss that must be evaluated and reported in the test results. ACR-F measures the relative strength of the farend crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire pair combinations. ACR-F is to be

- measured from 1 through the frequency range identified above for the category-rating requirements, and the maximum step size for FEXT Loss measurements shall not exceed the maximum step size defined in the Standard as shown in Table 1.
- b. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ACR-F. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
16. PS ACR-F Loss:
- a. Power Sum Attenuation Crosstalk Ratio Far-end is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs on the fourth one. This test yields eight wire-pair combinations. Each wire-pair is evaluated from 1 through the frequency range identified above for the category-rating requirements, in frequency increments that do not exceed the maximum step size defined in the Standard as shown in Table 1.
 - b. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
17. Return Loss:
- a. Return Loss (RL) measures the total energy reflected on each wire pair. Return Loss is to be measured from both ends of the link-under-test for each wire pair. This parameter is also to be measured from 1 through the frequency range identified above for the category-rating requirements, in frequency increments that do not exceed the maximum step size defined in the Standard as shown in Table 1.
 - b. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for Return Loss. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
18. TCL (Transverse Conversion Loss)
- a. Is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the near-end on the same wire pair.
 - b. This parameter is also to be measured from 1 through the frequency range identified above for the category-rating requirements, in frequency increments that do not exceed the maximum step size defined in the Standard as shown in Table 1.
 - c. Both worst case and worst margins shall be reported in both directions for all four pairs.
 - d. Cat 5e and Cat 6

- e. Is not specified in ANSI/TIA-1152 but shall be recorded for all four pairs.
- f. Cat 6A
 - 1) Is not to exceed the Category 6A limits.
- 19. ELTCTL (Equal Level Transverse Conversion Transfer Loss)
 - a. Is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the far end on the same wire pair minus the Insertion Loss of that pair.
 - b. This parameter is also to be measured from 1 through the frequency range identified above for the category-rating requirements, in frequency increments that do not exceed the maximum step size defined in the Standard as shown in Table 1.
 - c. Both worst case and worst margins shall be reported in both directions for all four pairs.
 - d. Cat 5e and Cat 6
 - 1) Is not specified in ANSI/TIA-1152 but shall be recorded for all four pairs.
 - e. Cat 6A
 - 1) Is not to exceed the Category 6A limits.
- C. UTP Cable Test Result Documentation:
 - 1. The test results/measurements shall be transferred into a database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee must be made that the measurement results are transferred unaltered, i.e., "as saved in the tested' at the end of each test and that these results cannot be modified at a later time.
 - 2. The database for the completed job shall be stored and delivered electronically including the software tools required to view, inspect, and print any selection of test reports.
 - 3. An electronic copy of the summary test results shall be provided that lists the links that have been tested with the following summary information:
 - a. The identification of the link in accordance with the naming convention defined in the overall system documentation.
 - b. The overall Pass/Fail evaluation of the link-under-test including the NEXT Headroom (overall worst case) number.
 - c. The date and time the test results were saved in the memory of the tester.
 - 4. General Information to be provided in the electronic data base with the test results information for each link:
 - a. The identification of the customer site as specified by the end-user.
 - b. The identification of the link in accordance with the naming convention defined in the overall system documentation.
 - c. The overall Pass/Fail evaluation of the link-under-test.
 - d. The name of the standard selected to execute the stored test results.
 - e. The cable type and the value of NVP used for length calculations.
 - f. The date and time the test results were saved in the memory of the tester. .

- g. The brand name, model and serial number of the tester.
 - h. The identification of the tester interface.
 - i. The revision of the tester software and the revision of the test standards database in the tester.
 - j. The test results information must contain information on each of the required test parameters that are listed and detailed above.
5. In-Link (In-Channel) Test Results Data. The detailed test results data to be provided in the electronic database must contain the following information:
- a. For each of the frequency-dependent test parameters, the value measured at every frequency during the test is stored. The database program must be able to process the stored results to display and print a color graph of the measured parameters. Software must also provide a summary numeric format in which some critical information is provided numerically as defined by the summary results (minimum numeric test results documentation) as outlined above for each of the test parameters.
 - 1) Length: Identify the wire-pair with the shortest electrical length, the value of the length rounded to the nearest 0.1 m and the test limit value.
 - 2) Propagation delay: Identify the pair with the shortest propagation delay, the value measured in nanoseconds (ns) and the test limit value.
 - 3) Delay Skew: Identify the pair with the largest value for delay skew, the value calculated in nanoseconds (ns) and the test limit value.
 - 4) Insertion Loss (Attenuation): Minimum test results documentation as identified above for the worst pair.
 - 5) Return Loss: Minimum test results documentation as identified above for the worst pair as measured from each end of the link.
 - 6) NEXT, ACR-F: Minimum test results documentation as identified above for the worst pair combination as measured from each end of the link.
 - 7) PS NEXT and PS ACR-F: Minimum test results documentation as identified above for the worst pair as measured from each end of the link.

3.2. OPTICAL FIBER CABLE TESTING

A. General

- 1. Testing Tiers requirements are as described below, unless indicated otherwise or otherwise required by the Owner.
- 2. Every fiber optic cabling link in the installation shall be tested in accordance with the field test specifications defined in referenced standards
- 3. One hundred percent of the installed cabling links must be tested and must pass the requirements as specified within this document. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for links shall be provided in the test results documentation (below).

4. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests.
 5. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter.
 - a. Loss shall not exceed calculated link loss.
 6. Tests shall be documented, including OLTS dual wavelength attenuation measurements for multimode and singlemode links and channels and OTDR traces and event tables for multimode and singlemode links and channels.
 7. Tests performed on optical fiber cabling that use a laser or LED in a test set shall be carried out with safety precautions in accordance with ANSI ZI 36.2.
 8. Field-test instruments shall have the latest software and firmware installed.
 9. Link and channel test results from the OLTS and OTDR shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.
 10. Fiber end faces shall be inspected at 200X or 400X magnification. 200X magnification is suitable for inspecting multimode and singlemode fibers. 400X magnification may be used for detailed examination of singlemode fibers. Scratched, pitted or dirty connectors shall be diagnosed and corrected.
 - a. End face images shall be recorded in the memory of the test instrument for subsequent uploading to a PC and reporting.
 11. Testing shall be performed on each cabling segment (connector to connector).
 12. Testing shall be performed on each cabling channel (equipment to equipment) that is planned for use per the owner's instructions.
 13. Testing of the cabling shall be performed using high-quality test cords of the same fiber type as the cabling under test. The test cords for OLTS testing shall be between 1 m and 5 m in length. The test cords for OTDR testing shall be approximately 100 m for the launch cable and at least 25 m for the receive cable.
- B. Performance Test Parameters:
1. Three tiers of certification are available that vary in thoroughness of infrastructure analysis.
 - a. Tier 1: optical loss testing
 - b. Tier 2: optical loss and OTDR testing
 - c. Tier 3: optical loss and OTDR testing and magnified endface inspection
 2. Optical loss testing (Tiers 1, 2 and 3):
 - a. Backbone link:
 - 1) Multimode backbone links shall be tested at 850 nm and 1300 nm in accordance with ANSI/EINTIA-526-14A, Method B, One Reference Jumper or the equivalent method.
 - 2) Singlemode backbone links shall be tested at 1310 nm and 1550 nm in accordance with ANSI/TINEIA-526-7, Method A.I , One Reference Jumper or the equivalent method.

- 3) Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
 - 4) Use the One Reference Jumper Method specified by ANSI/TINEIA-52614A, Method B and ANSI/TIA/EIA-526-7, Method A.I or the equivalent method. Follow the procedures established by these standards or application notes to accurately conduct performance testing.
 - 5) Fiber tests from the same cable between the same 2 points shall not vary over .25db from each other.
3. OTDR Testing (Tiers 2 and 3):
 - a. Fiber links shall be tested at the appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
 - 1) Multimode: 850nm and 1300nm
 - 2) Singlemode: 1310nm and 1550nm
 - b. Each fiber link and channel shall be tested in both directions.
 - c. A launch cable shall be installed between the OTDR and the first link connection.
 - d. A receive cable shall be installed after the last link connection.
 4. Magnified Endface Inspection (Tier 3):
 - a. Fibers shall be inspected at 200X or 400X magnification. 200X magnification is suitable for inspecting multimode and singlemode fibers. 400X magnification may be used for detailed examination of singlemode fibers.
 - b. Scratched, pitted or dirty connectors shall be diagnosed and corrected.
 - c. The end face images shall be saved and included in the test documentation package.
 5. Length Measurement:
 - a. The length of each fiber shall be recorded.
 - b. It is preferable that the optical length be measured using an OLTS or OTDR.
 6. Polarity Testing:
 - a. Paired duplex fibers in multi-fiber cables shall be tested to verify polarity in accordance with Clause E.5.3 of ANSI/TIA-568-C.O. The polarity of the paired duplex fibers shall be verified using an OLTS.
- C. Fiber Optic Cable Test Result Documentation:
1. The OLTS and OTDR test result information for each link shall be recorded in the memory of the field tester upon completion of the test.
 2. The test result records saved by the tester shall be transferred into a database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee shall be made that these results are transferred to the PC unaltered (i.e., as saved in the tester at the end of each test). The popular 'csv' format (comma separated value format) does not provide adequate protection and shall not be acceptable unless specified by the end user.

3. The database for the completed job shall be stored and delivered on CD-ROM. This CDROM shall include the software tools required to view, inspect, and print any selection of test reports.
4. Circuit IDs reported by the test instrument shall match the specified label ID.
5. Summary Test Reports: A copy of the test results shall be provided listing links that have been tested, including the following summary information.
 - a. The identification of the link in accordance with the naming convention defined in the overall system documentation.
 - b. The overall Pass/Fail evaluation of the link-under-test
 - c. The date and time the test results were saved in the memory of the tester.
6. General Information to be provided in the electronic data base containing the test result information for each link:
 - a. The identification of the customer site as identified by the end-user.
 - b. The operator responsible for testing.
 - c. The overall Pass/Fail evaluation of the link-under-test.
 - d. The name of the standard selected to execute the stored test results.
 - e. The value of the NVP of the cable installed (used for length calculations).
 - f. The date and time the test results were saved in the memory of the tester.
 - g. The brand name, model and serial number of the tester.
 - h. The tester software version and the revision of the test standards database in the tester.
7. Detailed Test Reports: Detailed test results data to be provided in the electronic database for each tested optical fiber must contain the following information.
 - a. The identification of the link/fiber in accordance with the naming convention defined in the overall system documentation.
 - b. Tier 1:
 - 1) The insertion loss (attenuation) measured at each wavelength, the test limit calculated for the corresponding wavelength and the margin (difference between the measured attenuation and the test limit value).
 - 2) The link length shall be reported for each optical fiber for which the test limit was calculated based on the formulas above.
 - c. Tier 2:
 - 1) Tier 1 test results.
 - 2) The overall OTDR loss (attenuation) and length.
 - 3) The OTDR event loss at each wavelength and event location.
 - 4) The OTDR trace at each wavelength.
 - d. Tier 3:
 - 1) Tier 1 and 2 test results.
 - 2) A picture of the magnified connector endface.
 - 3) The pass status based upon visual inspection.

3.3. COAXIAL CABLE TESTING

- A. Test every cable individually. The following tests shall be conducted, and the results recorded and submitted:
1. Visual Inspections:
 - a. Conduct a visual inspection of the center conductor at each end of each cable. Verify that the center conductor does not have any visible nicks.
 2. Mechanical retention of connectors:
 - a. Verify F-Connectors each can withstand at least 35 pounds of direct pulling force for 2-seconds.
 - b. Verify hardline connectors shall be verified to withstand at least 100 pounds of direct pulling force for 2-seconds.
 - c. Verify that other connector types used withstand 90% of their manufacturer rated retention strength for 2-seconds.
 3. Cable measurements:
 - a. Length of cable. Determine length through the use of physical cable markings and through the use of a TDR calibrated for the cable under test.
 - b. DC Loop Resistance: Short the center conductor and shield at the station outlet end of the cable using a premade thread on O-ohm shunt. Measure and record the loop resistance of the cable at the opposite end of the cable.
 - c. DC Resistance to Ground. Measure and record the DCR between each cable conductor (center and shield) and the nearest telecommunications grounding bus bar. This measurement shall occur after the telecommunications grounding system has been tested.
 - d. Attenuation by Frequency: Sweep the cable from 1 MHz to 1 GHz and record the attenuation results. Quantify the results in table-form in at least the following frequencies: 1, 5, 10, 50 megahertz, and 100 to 2000 megahertz in 50 megahertz increments.
 - e. Cable capacitance. With no load connected at one end of the cable connect a capacitance meter to the opposite end. Measure and record the total center conductor- to-shield capacitance.
- B. Conduct, coordinate and supply cable test data to parties supplying or installing products that will connect to and use the coaxial cabling. Timing is critical as these parties may need to perform calculations based on test values prior to procurement and installation of certain products.

3.4. ACCEPTANCE OF TEST RESULTS

- A. A representative of the end-user may at their discretion select a random sample of five percent of the installed links. The representative (or his authorized delegate) shall test these randomly selected links, and the results shall be stored in accordance with this Section. The results obtained shall be compared to the data provided by the installation contractor. If

- more than two percent of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the end-user representative shall repeat 100-percent testing at no cost to the Owner.
- B. Installed cabling links and channels shall be field-tested and pass the test requirements and analysis as described in this Section. Any link or channel that fails these requirements shall be diagnosed and corrected. Any corrective action shall be documented and followed with a new test to prove that the corrected link or channel meets performance requirements. The final and passing result of the tests for links and channels shall be provided in the test results documentation in accordance with this Section.
 - C. Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with Contract Documents and to the satisfaction of the Owner.

END OF SECTION 270810.00

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SECTION 271110.00 - WALL LININGS FOR COMMUNICATION ROOMS

PART 1 GENERAL

1.1. DEFINITIONS

- A. Communications Backboard: Finished plywood surface (wall lining) installed over a finished wall and used for the purpose of wall attachment/mounting of a wide-variety of communications and electronic security products.

1.2. SYSTEM DESCRIPTION

- A. Wall lining shall be installed around the entire perimeter of each communication room, except where otherwise detailed on the Drawings.
 - 1. Wall lining materials shall be installed behind wall-mounted Communications, Audio Visual and Security products, except as otherwise approved in advance by the Designer.
 - 2. Wall linings shall provide a solid reusable and fire-retardant surface for mounting of active and passive electronic products.
 - 3. Linings shall be attached to and supported by a wall structure in such manner as to be capable of fully supporting the load of products attached to it.
 - 4. Linings shall be applied over the standard painted drywall, brick and/or block wall materials as may be present within the space.
 - 5. Linings shall be installed in addition to and shall not take the place of standard wall-finish materials.

PART 2 PRODUCTS

2.1. MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated in the Work include, but are not limited to:
 - 1. Georgia-Pacific.
 - 2. Weyerhaeuser.
 - 3. Sherwin-Williams.
 - 4. PPG Industries, Inc.
 - 5. Benjamin Moore.
 - 6. Hy-Tech Thermal Solutions.
 - 7. Hilti Corporation.
 - 8. Red Head.

2.2. WALL LININGS

A. Plywood:

1. ¾" AC-grade fire-rated plywood.
2. 4-foot wide x 8-foot tall x 3/4-inch thick.

2.3. FINISHES:

A. Paint:

1. Color: White.
2. Self-priming design.
3. 30-Year manufacturer warranty.
4. ASTM E-84/UL 723 Class A-B fire-retardant.

2.4. HARDWARE:

A. Anchoring Hardware:

1. Material: Steel.
2. Finish: Rust preventative permanent outer coating.
3. Lag-type hex-head bolts for attachment to wood framed walls.
4. Lag-type hex-head bolts with expandable metal anchors for attachment to CMU construction.
5. Machine-thread hex-head bolts and expandable machine threaded concrete anchors for attachment to concrete walls.
6. Molly bolt or similar type all-metal machine threaded permanent anchor assembly for anchoring to metal stud framing.
7. Steel washers and lock washers between bolt head and wall lining.

PART 3 EXECUTION

3.1. INSTALLATION

A. Wall Linings:

1. Install plywood directly over and against the finished wall surfaces, without use of standoffs, and without leaving a gap between the plywood and wall.
2. Line the entire interior surface of each communication room, starting each wall with a full-size sheet at the left edge of each wall and progressing to the right, unless otherwise detailed on the drawings.
3. Utilize full standard-size sheets. Where the sheets need to be cut down to fit within the available mounting space, cut a single sheet down to fit the opening. Do not use multiple partial-size sheets where a full-size sheet, or where a single sheet cut down from a full-size sheet shall suffice.

4. Mount sheet with the highest-grade side (e.g., A-side) outward facing into the space.
 5. Attach sheets securely to the walls using horizontally arrayed columns of (at least) three bolts (top, middle, and bottom). Spacing of bolt columns shall be such as to secure the backboard directly to wall studs or other structural wall members. Each full-size sheet shall be supported by not less than two (2) columns of bolts. Horizontal spacing between bolts used for a single sheet shall not exceed 24 inches. The minimum number of bolts per sheet shall not be less than one (1) bolt for every 5.33sq/ft of plywood surface area, but not less than four (4) bolts.
 6. Set mounting hardware flush and smooth with the finished surface of the plywood.
 7. Install plywood plumb and level.
 8. Install the bottom of edge of the plywood beginning at 1/2 inch above the baseboard or 6 inches above the finished floor (whichever is lower).
 9. Where plywood must mount over devices such as AC switches, outlets, fire-alarm devices and the like, the backboard shall be cut to permit the entire device to be revealed plus an additional margin of 1/4 inch on each side of the device. Openings shall be plumb and level.
- B. Painting:
1. Prior to painting, mask fire-retardant labels on plywood such that the paint does not obscure the rating upon removal.
 2. Paint the front and rear surfaces of the wall linings using fire-retardant paint.
 3. Paint the edges of lining, including edges of the lining that abut other segments of the lining or another surface.
 4. Paint the edges of the lining that result from cutouts around obstacles.
 5. Paint the hardware used to secure the lining to the wall. Use the same color used to paint the lining.
 6. Apply minimum of two coats of fire-retardant paint. Apply additional coats as recommended by the paint manufacturer to achieve specified fire-retardant rating.

END OF SECTION 271110.00

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SECTION 271116.00 - CABINETS, RACKS, FRAMES AND ENCLOSURES

PART 1 GENERAL

1.1. SUBMITTALS

A. Product Data:

1. Product Datasheets.
2. Bill of Materials (BOM):
 - a. At the top of each BOM list, identify the following:
 - 1) Rack Device.ID.
 - 2) Name and number of the space where the rack is located.
 - 3) Name of the systems the rack supports.
 - 4) Rack type.
 - b. Enumerate the quantity, brand, model and description of the rack and each option and accessory being furnished with the rack (e.g., sides, casters and fans).

B. Shop Drawings:

1. Enlarged plans of the spaces housing equipment racks.
 - a. Plans shall call out the Type and Device ID of the rack.

C. Closeout Submittals:

1. Product data.
2. As-built drawings:
 - a. Enlarged plan depicting the as-installed locations of the racks.

1.2. REFERENCES

A. Definitions:

1. Where the term "equipment rack" or "rack" is used, in either the singular or plural form, it refers generically to products that are designed for and normally used to house and/or mount 19-inch, 23-inch and 25-inch EIA standard rack mounted equipment. Racks come in multiple forms, sizes, finishes and styles.
2. Where asterisks (*) are used in part numbers, they represent alphanumeric variables. These variables typically represent that portion of a model or product number that must be established when ordering product based upon the size, color, accessories and other information specified.

B. Reference Standard:

1. Comply with standards set forth in 27 00 01 - Common Work Results for Communications: References.

1.3. COORDINATION

- A. Review and coordinate the sizes, quantity, and location of racks/cabinets/enclosures to ensure they will adequately support the work of this Division and Division 28 Systems (where applicable).
 - 1. Coordinate requirements of all systems to provide a coordinated and usable installation.

1.4. SYSTEM DESCRIPTION

- A. Furnish and install all Equipment Racks, accessories and products identified in this section, and as shown on the Drawings, and as additionally required to support the installation of systems and equipment specified in other related sections.
 - 1. Mount securely as specified and shown.
- B. Provide all rack hardware and accessories as specified.
 - 1. Provide in quantities as shown on the Drawings, as specified, and as needed to provide a complete and working system.
- C. Provide Rack Bus Bar (RBB) on each Rack.

PART 2 PRODUCTS

2.1. GENERAL

- A. Products furnished of each Type shall be manufactured by a single manufacturer, bear the same brand name, be the same finish color and texture, and be from the same product model series, except where otherwise indicated.
- B. Accessories furnished for equipment racks shall be as manufactured from the same manufacturer as the rack served, except where otherwise indicated.
- C. Black shall be the default color for racks. Provide alternate colors where specified.
- D. Racks that are located adjacent to one another shall be matching size, color, fit and finish except where otherwise indicated.
- E. Rack sizes. Unless another size of rack is identified in a schedule or indicated on the Drawings, provide the largest RU rack size option available of the Type specified, if another RU size is not defined as the default size.
- F. Additional rack accessories:
 - 1. Refer to the Drawings for additional requirements for rack assemblies.
 - 2. Provide additional manufacturer recommended accessories for installation of products specified.
- G. Rack Side Panels:

1. Where equipment racks utilize accessory side panels, and where such racks are detailed on the Drawings to be ganged together, only one set of side panels is required per model group that is installed adjacent.
 - a. Where more than one depth of enclosed cabinet is utilized in a row, side panels shall be provided between the different depths.

2.2. SUBSTITUTION LIMITATIONS

- A. Approved qualifying manufacturer status notwithstanding, substitute equipment racks may not differ in exterior physical dimensions as compared to the specified equipment racks by more than $\pm 3/4$ inch in any dimension, without pre-bid model-specific review and approval. Substitute racks with dimensions that differ greater than this shall not be considered after award of the Contract.

2.3. EQUIPMENT RACKS

- A. Floor Mounted Types:
 1. Manufacturers: Subject to compliance with the requirements, provide the basis of design product or a comparable product by one of the following manufacturers:
 - a. Legrand AV / Middle Atlantic.
 - b. Lowell Manufacturing.
 - c. Atlas IED.
 - d. Basis-of-Design for communications:
 - 1) APC NetShelter 2 AR201
 - e. Basis-of Design for AV equipment:
 - 1) Legrand ERK series
 2. General Requirements: All products of this type shall meet or exceed the following requirements unless otherwise noted:
 - a. Construction: Steel, fully welded. 16-gauge, with 1/8-inch corner braces.
 - b. Field configurable reversible swing.
 - c. Designed to enable two units to be mounted together side-by-side.
 - d. Finish: Durable textured powder coat.
 - e. UL Listed.
 - f. Rack mounting width: 19-inch EIA horizontal rack rail spacing.

2.4. RACK ACCESSORIES

- A. Manufacturers: Subject to compliance with the requirements, provide the basis of design product or a comparable product by one of the following manufacturers:
 1. Legrand AV / Middle Atlantic.
 2. Atlas IED.
 3. Lowell Manufacturing.
 4. Hubbell.

5. Hoffman.
 6. X-Mark.
 7. Chatsworth.
 8. Ortronics/Legrand.
 9. Great Lakes Case & Cabinet.
 10. Panduit
- B. Storage Drawer:
1. Construction: Steel.
 - a. Greater than or equal to 20-gauge drawer bottom.
 - b. Greater than or equal to 18-gauge face.
 - c. Greater than or equal to 16-gauge top and sides.
 2. Finish: Black powder coat.
 3. Available in the following standard vertical RU sizes: 1, 2, 3, and 4.
 4. Depth, usable: 13.43 inches.
 5. Depth, overall: 15.00 inches.
 6. Height, overall: 1.75 to 7.00 inches, RU dependent.
 7. Width, usable: 15.09 inches.
 8. Width, overall: 19.00 inches.
 9. Weight capacity: Greater than or equal to 501bs.
 10. Integral horizontal support rail system on one (1) RU size designed to enable rear support by attachment to the rear rack rails of equipment rack.
 11. Ball-bearing drawer slides.
 12. Cable entry hole/slot in rear of drawer.
 13. Key lock option where designated.
 14. Latch option where designated.
 15. Quantity: 1
- C. Filler Panels:
1. General:
 - a. Panel mix: Provide mixture of vent and blank-type filler panels as required to ensure satisfactory air-flow and heat dissipation.
 - b. Sizes: Provide filler panels in sizes not exceeding two (2) RU, except where shown on the Drawings.
 - c. Quantity: Provide filler panels to occupy all unused mounting spaces of the front rack rail of Communications racks.
 2. Vent-Type:
 - a. Construction: 16-gauge steel.
 - b. Finish: Flat black powder coat.
 - c. Ventilation: Vertical vent slots.
 - d. Flanged upper and lower horizontal edges for rigidity.

- e. Size: Available sizes from one (1) to two (2) RI-J.
- 3. Blank-Type:
 - a. Construction: 16-gauge steel.
 - b. Finish: Flat black powder coat.
 - c. Ventilation: None, solid face.
 - d. Flanged upper and lower edges for rigidity.
 - e. Sizes: Available sizes from one (1) to six (6) RI-J.
- D. Rack Mount Shelves, for Voice/Data/Network racks:
 - 1. Universal Type:
 - a. Construction: 16-gauge steel.
 - b. Finish: Flat black powder coat.
 - c. Ventilated shelf (2 to 4 RU only).
 - d. Height: Available in standard sizes from 1 to 4 RI-J.
 - e. Quantity: As indicated on the Drawings.
- E. Rack Mount Shelves, for Audio, Video, Security and other system racks:
 - 1. Construction: 16-gauge steel.
 - 2. Finish: Flat black powder coat.
 - 3. Ventilated shelf (2 to 4 RU only).
 - 4. Height: Available in standard sizes from 1 to 4 RI-J.
 - 5. Usable Depth:
 - a. 1 RU: 10.7 inches.
 - b. 2 to 4RU: 15 inches.
 - 6. Quantity: As indicated on the Drawings.
- F. Rack Mounting Screws:
 - 1. Truss-type screw head.
 - 2. Black finish.
 - 3. Matching size and color nylon protective washer.
 - 4. For Racks with #10-32 threaded rack rails.
 - a. #10-32 thread.
 - 5. For Racks with #12-24 threaded rack rails.
 - a. Quantity: Four (4) Phillips-drive screw/per RU/per rack.
 - 6. For Racks with 6MM cage-nut rack rails.
 - a. Quantity: Four (4) Phillips-drive screw/per RU/per rack.
- G. Thermostatic Fan Control:
 - 1. UL Listed.
 - 2. 120VAC Input voltage.
 - 3. Temperature probe with 48 to 60 inches of cable.
 - 4. Fan Receptacles: Four (4) separate AC fan receptacles.

5. Regulates the speed of up to four rack ventilation fans based upon temperature range.
 6. Minimum of four (4) temperature/fan speed ranges:
 - a. Fan off: Less than 80 degrees Fahrenheit.
 - b. Fan low: 80 to 90 degrees Fahrenheit.
 - c. Fan medium: 90 to 100 degrees Fahrenheit.
 - d. Fan high: Greater than or equal to 100 degrees Fahrenheit.
 7. Quantity: One (1) per enclosed equipment rack; additional units where indicated.
- H. Grounding Busbar:
1. Solid bare copper.
 2. Cross sectional area: 0.375 square inches minimum (typically 0.25 inches thick by 1.5 inches wide).
 3. Length: Equivalent to the vertical RU of the rack served.
 4. Drilled and tapped #10 holes for ground cable connections.
 5. Screws: Supplied with #10 copper machine-threaded screws, one (1) per RI-J.
 6. Quantity: One (1) per equipment rack; additional units where indicated.

2.5. CABLE MANAGEMENT

- A. Lacing Strips:
1. Horizontally Mounted:
 - a. Designed for mounting to rear rack rails.
 - b. Solid or perforated bar construction, designed for dressing and supporting wires that route horizontally between sides of rack and from sides of racks to mounted equipment.
 - c. Available in various shapes and sizes to accommodate a wide variety of cable types, bundle sizes, and rack equipment configurations.
 - d. Quantity: Minimum one (1) per each RU of cable termination panels.
 2. Vertically Mounted:
 - a. Available in various lengths to match the number of RUS of the rack served.
 - b. Perforated strip designed to accommodate types of wire ties, including hook-and-loop type.
 - c. Quantity: Two (2) per rack, additional units where indicated.
- B. Wire Management Panels:
1. Manufacturers: Subject to compliance with the requirements, provide the basis of design product or a comparable product by one of the following manufacturers:
 - a. Legrand AV / Middle Atlantic
 - b. Hubbell.
 - c. Leviton.
 - d. Ortronics/Legrand.
 - e. Panduit.

2. Type A: Cable management panels shall be of this type unless specifically noted otherwise on the Drawings.
 - a. Rack mountable design.
 - b. Front and rear mounted horizontal metal slotted rings.
3. Type B:
 - a. Rack mountable design.
 - b. Front mounted horizontal and vertical metal slotted rings.
 - c. Must be used with horizontal lacing bars.
 - d. Shall not be used with vertically mounted cable managers that may interfere with side rings.

PART 3 EXECUTION

3.1. COORDINATION

- A. Coordinate with each party providing product that will be housed within the racks. Review rack configurations to ensure they complement the systems being provided.
- B. Coordinate the delivery and installation to meet the workflow and schedules of parties reliant upon the product for their portion of the Work.

3.2. INSTALLATION

- A. Equipment Racks:
 1. General:
 - a. Secure fixed-position, non-portable racks using removable threaded fasteners to prevent from moving or tipping.
 - b. Secure racks without casters to the floor allowing a 36-inch minimum clearance between the rearmost part of the rack and the nearest obstruction. See the Drawings for additional and more stringent requirements.
 - c. Install doors, side panels and other accessories specified.
 - d. Install bushings or grommets at cable entry and exit points to protect cables.
 - e. Clean, prep and paint visible conduits using oil-based paint that matches the color of the rack.
 - f. Comply with rack manufacturers' printed instructions and guidelines for rack installation.
 - g. Security:
 - 1) Two copies of each key shall be provided, labeled to indicate purpose.
 - 2) Colo Cabinets:
 - a) Coordinate with Owner's representative for keying requirements within each space. Unless otherwise requested, each compartment

within a telecom space shall be keyed differently. Provide four (4) sets of keys for Colo cabinets.

2. Wall Mounted Types:
 - a. Mount rack plumb and level.
 - b. Install blocking in wall as recommended by the manufacturer of sufficient loading capacity to carry the rated load capacity of the rack.
 - c. Orient the rack so that the rack can be opened fully for equipment installation and service.
 - d. Coordinate placement of the rack and required pathway provision with the pathway provider to ensure proper placement.
- B. Rack Accessories:
 1. Grounding Bus Bar:
 - a. Install grounding bus bars in the rear of racks.
 - b. Coordinate location with equipment being housed within the rack and for full adjustability of the rack rails.
 2. Filler Panels:
 - a. Install filler panels within each equipment rack.
 - b. The size, location and ratio of blank—to-vent filler panels shall be as required to assure proper ventilation of equipment.
 - c. Mount the filler panels using approved mounting hardware, ensuring that unused spaces within the equipment rack are covered.
 3. Ventilation Products:
 - a. Furnish and install ventilation products as specified and indicated on the Drawings. Test operation of ventilation products and adjust as necessary.
 4. Cable Management Products:
 - a. Install horizontal and vertical cable lacing bars in locations to optimize support and grouping of cables within the equipment racks.
 - b. Mount bars using hardware recommended by the product manufacturer. Mount securely.

3.3. GROUNDING AND BONDING

- A. Install a grounding busbar in each equipment rack and bond to equipment rack.

3.4. IDENTIFICATION

- A. Label each rack.

END OF SECTION 271116.00

SECTION 271126.00 - RACK MOUNTED POWER PROTECTION AND POWER STRIPS

PART 1 GENERAL

1.1. SUBMITTALS

- A. Product Data:
 - 1. Bill of Materials.
 - 2. Product Datasheets.
- B. Shop Drawings:
 - 1. Power Distribution Diagram(s):
 - a. Depict the power products and the AC power distribution configuration for each rack:
 - 1) Identify the Device.ID for each rack.
 - 2) Include a rack layout depicting the location of power products within the rack.
 - 3) Depict UPSs, PDUs, sequencers, receptacle strips, remote power modules, modular power strips and other distribution products.
 - 4) Identify the interconnectivity between sequencers and the products the sequencer controls.
 - 5) Identify the power up and power down sequence.
- C. Closeout Submittal:
 - 1. Product Data:
 - a. Bill of Materials.
 - b. Product Datasheets.
 - 2. As-Built Drawings:
 - a. Power Distribution Block Diagram(s).

1.2. SYSTEM DESCRIPTION

- A. General:
 - 1. Equipment racks, furniture and enclosures that house communications and security (where applicable) equipment shall be equipped with a functional local AC power distribution system for delivery of power from the building power system to the product(s) they house.
 - 2. Each distribution system shall be sufficient to support the powered products.
 - 3. Each distribution system shall feature sufficient connectivity to accommodate each powered product, plus an additional 20-percent spare receptacle count usable for future use. Each designated "spare" outlet shall be accessible and usable without the removal or movement of existing cables, plugs or other product.

4. Selected distribution systems shall feature one or more locally installed uninterruptible power supplies for maintaining power to connected equipment in the event there is a loss of incoming building power.
 - a. UPS units shall be provided with SNMP and web-based communications options to monitor and control the UPS from a network management station or any PC running Microsoft Internet Explorer. Coordinate with the Owner and provide network connectivity to the UPS.
 5. Communications backboards, countertops/work-surfaces and other locations where insufficient building power receptacles are present shall be equipped with local power distribution equipment with sufficient outputs to serve the locally installed equipment.
- B. Provide UPS and power distribution equipment as shown on the detail drawings and as required to protect and power communications and security equipment.
- C. Following is a baseline of requirements for the Project, unless additional quantities are indicated.
1. Equipment Racks for Horizontal Cable and/or Network Switches:
 - a. Each rack shall be equipped with a full-time un-switched power distribution system.
 - b. Each rack used for Network Switches equipment shall be equipped with a minimum of one (1) independent full-length vertical power strip.
 - c. Each Communications System rack shall be equipped with a minimum of (1) Type-A 3kVA UPS.
 - d. Each Audio Visual System shall be equipped with a minimum of (1) Type-A 1.5kVA UPS.

PART 2 PRODUCTS

2.1. GENERAL

- A. Products furnished of each Type shall be manufactured by a single manufacturer, bear the same brand name, be the same finish color and texture, and be from the same product model series, except where otherwise indicated.

2.2. UNINTERRUPTIBLE POWER SUPPLIES (UPS)

- A. Manufacturer: Subject to compliance with requirements, provide products from one (1) of the following manufacturers:
1. Middle Atlantic
 2. APC.
 3. Eaton.
- B. Type A - 120V:

1. General Requirements: All products of this type shall meet or exceed the following requirements unless otherwise noted:
 - a. True on-line double conversion.
 - b. Furnish with power management software.
 - c. 120VAC input and output.
 - d. Transient voltage surge suppression.
 - e. EMI/RFI Filters.
 - f. 19-inch EIA rack mounting hardware.
 - g. Six (6) NEMA 5-15/20R receptacles.
 - h. Provide optional web card for SNMP and web-based management.
 - i. Basis of Design: Liebert GXT Series.
2. 3kVA Size:
 - a. (3000VA/2700W)
 - b. One (1) NEMA L5-30R output receptacle.
 - c. 10' cord with NEMA L5-30p plug.
3. 1.5kVA Size:
 - a. (1500VA/1000W)
 - b. One (1) NEMA L5-30R output receptacle.
 - c. 10' cord with NEMA L5-30p plug.

2.3. VERTICALLY MOUNTED RECEPTACLE STRIPS

- A. Manufacturers: Subject to compliance with requirements, provide products from one (1) of the following manufacturers:
 1. Middle Atlantic Products.
 2. Hammond Manufacturing.
 3. Chatsworth Products.
 4. Leviton.
 5. Lowell Manufacturing.
- B. Type VB:
 1. 20 Amp capacity.
 2. 120VAC input.
 3. NEMA 5-20R receptacles.
 4. Largest size available for height of rack to be installed in.
 5. 9-foot power cord with NEMA 5-20P plug.
 6. Manufacturer accessory mounting brackets.

PART 3 EXECUTION

3.1. INSTALLATION

- A. Surge Suppression

1. Where independent outboard surge suppression products are used, connect the surge suppression products to incoming branch power first, then derive power for downstream power distribution products from the surge suppression device.
- B. Uninterruptible Power Supplies (UPS):
1. Connect UPS units to un-switched AC building power.
 2. Rackmount power supply(s) and the accessory batteries that are designed for rack mounting.
- C. Vertical Receptacle Strips:
1. In racks, mount vertical receptacle strips inside and in the rear of the rack in an accessible location that does not interfere with the mounting of the equipment served or with future mounting of equipment.
 2. When UPS products are present, derive power for the strips from the output receptacle(s) of the UPS.
 3. Mount receptacle strips securely.
 4. Mount strips using the accessories and hardware recommended by the manufacturer.

END OF SECTION 271126.00

SECTION 271323.00 - FIBER OPTIC BACKBONE CABLING

PART 1 GENERAL

1.1. SUBMITTALS

- A. Product Data:
 - 1. Bill of Materials (BOM).
 - 2. Product Datasheets.
- B. Shop Drawings:
 - 1. Backbone System Diagram.
 - 2. Labeling Schema.
- C. Closeout Submittals:
 - 1. Product Datasheets.
 - 2. As-Built Drawings:
- D. Labeling Schema.
- E. Backbone System Diagram.
 - 1. Field Quality Control / Test Results.

1.2. REFERENCES

- A. Definitions:
 - 1. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- B. Reference Standards:
 - 1. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651 and NFPA 70 for the following types:
 - a. Plenum Rated, Nonconductive: Type OFNP, complying with UL 910.
 - b. Riser Rated, Nonconductive: Type OFNR or OFNP, complying with UL 1666.
 - c. Plenum Rated, Conductive: Type OFCP or OFNP, complying with UL 910.
 - d. Riser Rated, Conductive: Type OFCR or OFNR, OFCP or OFNP, complying with UL 1666.
 - 2. Comply with standards set forth in 27 00 01 - Common Work Results for Communications: References.

1.3. COORDINATION

- A. Review and coordinate the sizes, quantity, routing and spacing of pathways to ensure they will adequately support the work of this Section.

1. Confirm that cables to be installed shall not exceed maximum fill capacities of raceways and shall meet the minimum requirements of Local, State and Federal laws and requirements.
- B. Coordinate layout and installation of communications cabling with Owner's telecommunications, WAN and LAN equipment and service suppliers.

1.4. QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate marking of applicable testing agency.
- B. Prior to bid, Contractor shall be listed and shall maintain participation as part of the cabling and connectivity manufacturers' certified contractor programs. Provide documentation as outlined in Submittals.

1.5. DELIVERY, STORAGE AND HANDLING

- A. Store materials in conditions endorsed by the product manufacturer.
- B. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- C. Do not deliver or install product(s) in conditions that jeopardize the performance or manufacturer life expectancy and service life of the product.

1.6. WARRANTY

- A. The cable manufacturer and the connectivity products manufacturer shall have a partnership agreement established in order to provide the required warranty.
- B. Required warranty: The standards compliant cable system shall include a minimum 25 year extended product warranty and performance/applications assurance program.

1.7. SYSTEM DESCRIPTION

- A. The fiber optic backbone cabling system shall be a system of interconnections between communications rooms, main terminal spaces and entrance facilities as part of a complete communications cabling system infrastructure. The cabling system consists of cables, crossconnect enclosures, and terminations used for backbone-to-backbone cross-connection.
- B. Provide fiber optic backbone cabling system compliant with referenced standards.
- C. Cabling

1. Refer to the Drawings for types and quantities of backbone cables.
 2. Provide total connectivity for complete and permanent installed communications links.
 3. Backbone cabling cross-connects shall be located within communications rooms, entrance facilities and other locations as designated.
- D. Unless pre-approved by the Designer, provide a single, uniform and complete connectivity solution for this Section:
1. Cabling and connectivity for this Section, and related structured cabling Sections (used to form a unified Structured Cabling System), shall be provided by a single manufacturer or a two-manufacturer formal relationship.

PART 2 PRODUCTS

2.1. GENERAL

2.2. Products furnished of each Type shall be manufactured by a single manufacturer, bear the same brand name, be the same finish color and texture, and be from the same product model series, except where otherwise indicated.

2.3. FIBER OPTIC CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Belden.
 2. CommScope, Inc. (CommScope).
 3. Corning
 4. General Cable Technologies Corporation (General Cable).
 5. Leviton
 6. Superior Essex.
- B. General:
1. General Performance: Comply with referenced transmission standards when testing.
 2. System cables shall be code compliant and UL/NEC rated for the location, manner, and environmental conditions in which the cables are installed.
 - a. Cables that are installed in an air handling space and not installed in a totally enclosed pathway system shall be UL plenum rated.
 - b. Cables used for below grade applications, and cables used in pathways that may reasonably end up with standing water within them, shall be manufacturer rated

for continuous contact with water without performance degradation or compromise in warranty.

- c. Cables used for direct burial, aerial, or other applications shall be manufacturer rated for the application.

- 1) Also see "Inter-Building Cabling" Section for cable alternate construction.

- 3. Fiber optic backbone cables on this Project shall utilize industry standard jacket color coding to identify fiber grade.

C. Cable Construction

- 1. Any fiber optic cable not of interlocking armored construction will be installed in a properly rated (plenum) inner-duct.
- 2. All fiber optic cable will be properly constructed for the environmental conditions and to meet all applicable codes.
- 3. Jacket:
 - a. Utilize industry standard color coding for multimode and singlemode fiber optic cable jacket colors.
 - b. Cable cordage jacket, fiber, unit and group color shall be according to referenced standards.
 - c. Imprinted with fiber count, fiber type and aggregate length at regular intervals not to exceed 40 inches (1000 mm).
- 4. The following basic construction types are recognized on this Project:
 - a. Tight buffer armored premise distribution cable
 - 1) Plenum (OFNP) rated construction unless otherwise specifically noted.
 - 2) Used in indoor pathways primarily as backbone cable.
 - 3) Fiber counts can range from 4 to 72 strands
 - 4) Hybrid SMIMM strand mix is acceptable.
 - 5) This cable construction will never be used in an outdoor or harsh environment.
 - 6) OD shall range .49"-.59"

D. Optical Properties

- 1. Description: Singlemode, OS2.
 - a. Comply with ICEA S-83-596 for mechanical properties.
 - b. Comply with referenced standards for crush resistance and impact resistance.
 - c. Meet or exceed referenced standards for Singlemode optical characteristics:
 - 1) Dual window of 1310 nm and 1550 nm.
 - 2) Guaranteed Gigabit Ethernet (GbE) Distance: 10,000 m at 1310 nm.
 - 3) Guaranteed 10 Gigabit Ethernet (10 GbE) Distance: 5,000 m at 1310 nm; 30,000 m at 1550 nm.
 - 4) Maximum attenuation: .7 dB/km at 1310 nm; .7 dB/km at 1550 nm.

2.4. FIBER OPTIC CABLE TERMINATIONS AND HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CommScope, Inc. (CommScope).
 - 2. Corning.
 - 3. Hubbell Premise Wiring (Hubbell).
 - 4. Leviton.
 - 5. Ortronics.
 - 6. Panduit.
 - 7. 3M.

- B. General Requirements for Cable Connecting Hardware:
 - 1. Cables shall be terminated with connecting hardware of same optical performance or higher.
 - 2. Provide one single manufacturer for fiber optic cable termination hardware.
 - 3. Cable hardware (i.e., connectivity) shall be part of the manufacturer's enterprise solution.

- C. Rack Mounted Fiber Optic Panel Enclosure: Modular enclosures housing multiple adapter plates, splice trays and MTP cassette modules:
 - 1. Steel: black powder coated finish.
 - 2. Front metal door or smoked polycarbonate door, removable.
 - 3. Rear metal cover/door, removable.
 - 4. Rear tray capacity for splice trays.
 - 5. Slack management spools included.
 - 6. Accepts standard fiber optic adapter plates and cassettes.
 - 7. EIA standard 19 inches rack rails.
 - 8. Available in IRI-J (1.75 inches), 2RU (3.50 inches) or 3RU (5.25 inches) sizes.
 - a. 1 RU: Capacity for up to (3) adapter plates; up to (3) splice trays.
 - b. 2RU: Capacity for up to (6) adapter plates; up to (6) splice trays.
 - c. 3RU: Capacity for up to (9) adapter plates; up to (12) splice trays.

 - d. Include slide mounting kit for access, as required.
 - e. Include additional fiber management rings, as required. f. Include Cable clamp kits.

- D. Wall Mounted Fiber Optic Panel Enclosure: Modular enclosures housing multiple adapter plates and splice trays:
 - 1. Steel: black powder coated finish.
 - 2. Wall mountable panel.
 - 3. Split metal door with lock on service side and lock on customer side.
 - 4. Slack management spools included.
 - 5. Accepts standard fiber optic adapter plates and splice trays, as required.

6. Available capacities: four (4) adapter plates / six (6) splice trays, twelve (12) adapter plates / six (6) splice trays.
- E. Fiber Optic Adapter Plates: Modular adapter plates for multiple fibers and connector types fitting within rack mounted and wall mounted fiber optic panel enclosures:
 1. Singlemode:
 - a. Individual couplers installed.
 - b. Mounts within fiber optic panel enclosures.
 - c. Six (6) duplex LC adapters with ceramic sleeves accommodating six (12) singlemode fibers.
 - d. Color code SM couplers blue; utilize industry standard color coding.
 - e. Coordinate with fiber optic panel enclosure.
 - f. Provide adequate panels to terminate all fiber strands on rear of adapter plates.
- F. Fusion Splice Tray: Splice trays mounting within fiber optic panel enclosures:
 1. Each splice tray shall be of fusion type.
 2. Splices shall be enclosed in a splice tray mounted in a splice module housing or splice enclosure.
 3. Provide mounting hardware kits, holders and sleeves as required.
- G. Cable Connectors: Connectors for terminating fiber optic cable strands:
 1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TINEIA-604-2, TINEIA-604-3-A and TINEIA-604-12. Comply with TINEIA-568-C.
 2. SC Pigtail, Singlemode (Fusion Splice):
 - a. Each LC connector shall be pre-terminated on a 900 micron singlemode fiber optic strand with 1 m (minimum) length.
 - b. The connector ferrule shall be ceramic.
 - c. The connection shall provide 0.25 dB typical insertion loss or less.

2.5. SOURCE QUALITY CONTROL

- A. System components shall be tested and listed by one or more United States NRTL.

PART 3 EXECUTION

3.1. GENERAL

- A. Review and coordinate cabling pathways prior to pathway and cabling installation.
 1. Coordinate to resolve deviations, defects or other problems with pathways prior to installation. Allow adequate time for corrections so as to avoid delays to the Project completion date.

2. Provide additional or supplemental pathways and cable support where required. Provide additional sleeves through walls/floors/ceilings, as necessary to route cables within buildings.
- B. Project Conditions
1. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 2. Do not deliver or install product(s) in conditions that jeopardize the performance or manufacturer life expectancy and service life of the product.
 3. Delivery, Storage and Handling
 - a. Store materials in conditions endorsed by the product manufacturer.
- C. Compliance
1. Comply with NECA 1.
 2. Comply with referenced standards.
 3. Monitor cable pull tensions, and comply with BICSI ITSIMM, Chapter "Pulling Cable."
 4. Comply with BICSI ITSIMM, Chapter "Cable Termination Practices."
 5. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications."
 - a. Comply with referenced standards, for pull-box sizing and length of conduit and number of bends between pull points.
 - b. Do not exceed the required fill capacity of raceways.

3.2. ENTRANCE FACILITIES

- A. Coordinate backbone cabling with the protectors and demarcation point provided by the communications service providers.

3.3. INSTALLATION OF CABLES

- A. Install cables within approved pathways. Install cables that are not otherwise required to be installed within raceway in such manner as to conceal them from view. Conceal conductors and cables in accessible ceilings, walls and floors.
- B. Provide the appropriate cable rated for the environmental conditions in which the cable is to be installed.
- C. Fiber optic cable shall be installed in a protective barrier (innerduct) with the appropriate rating for the environmental conditions.
1. Any fiber optic cable not of interlocking armored construction shall be installed in a properly rated (plenum) inner-duct.
 2. Exception: Fiber optic cabling with plenum rated interlocking armor jacket shall not require innerduct.

- D. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
- E. Do not splice cable between terminations or junction points. Cable runs shall be continuous.
- F. Maintain complete protection of cabling. Cabling shall not be left hanging or coiled where it potentially obstructs the Work of other trades.
- G. Cable routing shall follow building structure lines (parallel and perpendicular).
- H. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
- I. I. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
- J. Open-Cable Installation:
 - 1. Install cabling with horizontal and vertical cable guides in communications spaces with terminating hardware and interconnection equipment.
 - 2. Suspend cable not in a raceway, a minimum of 8 inches (200 mm) above ceilings by discrete cable supports not more than 60 inches (1524 mm) apart. Bridle rings are not permitted.
 - 3. Cable shall not be run through structural members or in contact with conduits, pipes, ducts or other similar or potentially damaging items.
- K. Provide conduit sleeves for penetrations.
 - 1. Provide conduit sleeves for cables where cables pass through walls, floors and ceilings.
 - 2. Patch and firestop around sleeves.
 - 3. Firestop the interior of the sleeves after cable installation.
 - 4. Provide the appropriate bushings on each end. Split bushings shall not be used.
 - 5. Provide waterproof sealant for penetrations in humidity controlled areas.
- L. Comply with requirements in Section 270502 "Basic Materials and Methods for Communications."
 - 1. Bundle cables within racks, ladder racks, cable trays and in discrete cable supports. Utilize reusable cable bundling hardware. Utilize plenum-rated hardware in plenum spaces.
- M. Separate cabling by service and type (i.e., voice, data, control, coaxial, fiber) prior to terminating.
 - 1. Terminate cabling on specified termination hardware in alpha-numerical order.
 - 2. Neatly dress and securely attach cabling to the backboard and/or cabinet/rack.
 - 3. Provide adequate cable lengths to reach any location on the backboard or within the cabinet/rack.
 - 4. Bundle and support cables of this System separately from the cables of other systems.

5. Where cables from different systems or cables with different signal types are expressly permitted by the Designer to share a common pathway, each of these cable groups shall be kept segregated to the maximum degree physically possible. Cables from different systems shall not be mixed or intertwined.
- N. Provide a minimum service loop of 5 feet at each end and 10 feet at each junction point, unless noted otherwise.
- O. Maintain (do not violate) the minimum bend radius specified by the manufacturer of the cable.
- P. At final termination, excess cable and the service loop shall be supported and stored neatly in the cable tray or ladder rack within the communications rooms.
 1. Proper strain relief shall be applied to cables after installation to lessen the risk of physical damage and to provide proper aesthetic value.
- Q. Cabling within Enclosures:
 1. Bundle, lace, and train cables within enclosures.
 2. Connect to terminal points with no excess and without exceeding manufacturers' limitations on bending radii.
 3. Provide and use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
- R. Cable Termination:
 1. Terminate every conductor; no cable shall contain unterminated elements unless otherwise indicated. Make terminations only at indicated outlets, terminals, crossconnects and patch panels.
 2. Fiber optic cabling shall be terminated using fusion-spliced, factory-polished pigtails.
 3. Fiber optic cables shall utilize factory manufactured break-out kits to protect fiber strands within fiber optic enclosures.
 - a. Provide buffer tubing on fiber strands from the connector to the cable break-out (minimum 6 inches pigtails), and secure to the cable jacket for fiber optic cables that do not have a cladding.
 4. Utilize standard positive identification color coding for multi-strand cables.

3.4. IDENTIFICATION

- A. Label each end of the cable.
- B. Identify system components and cabling in compliance with TINEIA-606-B, or most current version.

3.5. FIELD QUALITY CONTROL

- A. Perform tests and inspections.

1. Visually inspect optical fiber cabling jacket materials for NRTL certification markings.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords and labeling of components.
3. Optical fiber cable tests:
 - a. Test instruments shall meet or exceed applicable requirements in TINEIA-568-C. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- B. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report for the cables as well as a detailed report for each cable tested.
- C. Remove and replace cabling where test results indicate they do not comply with specified requirements. Retest cabling and provide documentation.
- D. End-to-end cabling shall be considered defective if it does not pass tests and inspections.
- E. Prepare and submit test and inspection reports.
- F. The Owner reserves the right to have a representative present during testing procedures. Verification testing of copper and fiber may be performed at or near Project completion by the Consultant for quality assurance.
- G. Upon verification testing, if the Consultant finds the test results do not match the Contractor's results, the Consultant or a third party may at the Owner's request retest the cabling and submit those results to the Owner and deduct the verification testing costs from the Contractor's Contract amount.

END OF SECTION 271323.00

SECTION 271513.00 - COPPER HORIZONTAL CABLING

PART 1 GENERAL

1.1. SUBMITTALS

- A. Product Data:
 - 1. Bill of Materials (BOM).
 - 2. Product Datasheets.
- B. Shop Drawings:
 - 1. Floor Plans
 - 2. Labeling Schema.
- C. Closeout Submittals:
 - 1. Product Datasheets.
 - 2. As-Built Drawings:
 - a. Floorplans
 - b. Labeling Schema.
 - 3. Field Quality Control / Test Results.
 - 4. Cable and connectivity manufacturers' certification of quality and performance.
 - a. Warranty documentation, including cabling and connectivity manufacturers' current product warranty data and certificates of complete connectivity solution provider status for the Contractor.

1.2. REFERENCES

- A. Definitions:
 - 1. Consolidation Point (CP): A location for interconnection between horizontal cables extending from Telecommunications Rooms and horizontal cables extending to the communications outlet/connector. Typically used to feed office furniture or similar reconfigurable areas.
 - 2. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
 - 3. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors. Similar function as CP except the horizontal cables are terminated with RJ45 interfaces at both ends and the cable extends to the workstation as a station attachment cable.
 - 4. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
 - 5. Twisted-Pair: Two individually insulated copper wires physically twisted together to form a balanced pair.

6. Twisted-Pair Cable: A multi-conductor cable comprising two or more copper conductors twisted in a manner designed to cancel electrical interference. Also called balanced twisted-pair cable.

B. Reference Standards:

1. Comply with standards set forth in 27 00 01 - Common Work Results for Communications: References.

1.3. COORDINATION

- A. Review and coordinate the sizes, quantity, routing and spacing of pathways to ensure they will adequately support the work of this Section.
 1. Confirm that cables to be installed will not exceed maximum fill capacities of raceways and shall meet the minimum requirements of Local, State and Federal laws and requirements.
 2. Confirm that cables to be installed within the pathways will not exceed the maximum standards-based distance limitations (90 meters (295 feet)) for horizontal cabling.
- B. Coordinate communications outlet/connector locations with the location of power receptacles at each work area. Coordinate so that power receptacles are immediately adjacent and same height.
- C. Coordinate layout and installation of communications cabling with telecommunications and LAN equipment and service suppliers.

1.4. QUALITY ASSURANCE

- A. Prior to bid, Contractor shall be listed and shall maintain participation as part of the cabling and connectivity manufacturers' certified contractor programs. Provide documentation as outlined in Submittals.

1.5. DELIVERY, STORAGE AND HANDLING

- A. Store materials in conditions endorsed by the product manufacturer.
- B. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- C. Do not deliver or install product(s) in conditions that jeopardize the performance or manufacturer life expectancy and service life of the product.

1.6. WARRANTY

- A. Additional requirements: Cabling and connectivity products manufacturers, including patch cords, shall have in place an agreement recognizing each other for execution of the warranty

as specified. Performance and applications warranties shall be channel rated, including patch cords.

- B. The cable manufacturer and the connectivity products manufacturer shall be the same manufacturer or shall have a partnership agreement established in order to provide the required warranty.
- C. Required warranty: The standards compliant cable system shall include a minimum 25 year extended product warranty and performance/applications assurance program.

1.7. SYSTEM DESCRIPTION

- A. Horizontal cabling and connecting hardware provide the means of transporting signals between the communications outlet/connector and the horizontal cross-connect located in the communications room or enclosure. The cabling and associated connecting hardware are called a "permanent link," a term that is used in the testing protocols.
- B. Provide standards compliant 4-pair twisted pair horizontal cabling system.
 - 1. Provide Category 6A (Augmented Category 6) compliant horizontal cabling system for all data cabling.
- C. Cabling
 - 1. Refer to the Drawings for types and quantities of horizontal cables.
 - 2. Provide total connectivity for complete and permanent installed communications links.
 - 3. The copper horizontal cabling system shall include provisions for voice/telephone, data/network, video surveillance, audio-visual, access control, building automation, control data and intrusion detection systems.
 - a. Cables may be color-coded by system. Reference the Drawings for requirements, and coordinate with the Owner for final verification.
- D. Unless pre-approved by the Designer, provide a single, uniform and complete connectivity solution for this Section:
 - 1. Cabling and connectivity for this Section, and related structured cabling Sections (used to form a unified Structured Cabling System), shall be provided by a single manufacturer or a two-manufacturer formal relationship.

PART 2 PRODUCTS

2.1. GENERAL

- A. Products furnished of each Type shall be manufactured by a single manufacturer, bear the same brand name, be the same finish color and texture, and be from the same product model series, except where otherwise indicated.

2.2. CABLING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Belden.
 2. CommScope, Inc. (CommScope).
 3. General Cable Technologies Corporation (General Cable).
 4. Leviton
 5. Superior Essex.
- B. General:
1. General Performance: Comply with referenced transmission standards when testing.
 - a. Twisted pair cable is required to have the appropriate Category classification. Compliance with these electrical characteristics shall be third party verified by the manufacturer.
 2. System cables shall be code compliant and ULINEC rated for the location, manner, and environmental conditions in which the cables are installed.
 - a. Cables that are installed in an air handling space and not installed in a totally enclosed pathway system shall be UL plenum rated.
 - b. Cables used for below grade applications, and cables used in pathways that may reasonably end up with standing water within them, shall be manufacturer rated for continuous contact with water without performance degradation or compromise in warranty.
 - c. Cables in conduit to a floor box in a slab on grade application shall be rated for both above and below grade application or transition to OSP rated 4 pair cables using an appropriate standards rated cable transition splice.
 - d. Cables used for direct burial, aerial, or other applications shall be manufacturer rated for the application.
 3. Cables on this Project may be color-coded. See drawings for color code.
- C. Twisted Pair Cable
1. Description: 100-ohm, Four-pair with a thermoplastic jacket.
 - a. Comply with referenced standards for Category 6.
 - 1) Cable shall have two individually insulated 23 AWG solid copper conductors formed into a twisted pair.
 - 2) Cable shall be constructed of one 4-pair bundle of individually insulated Unshielded Twisted Pairs (UTP).
 - 3) Minimum of 5dB of crosstalk margin beyond the CAT 6 standard for NEXT, PSNEXT, ACR and PSACR.
 - 4) Cable shall include integral cross-web pair separator.
 - 5) Cable shall have footage and unique cable identifier printed on the jacket every 2 feet.
 - 6) Cable shall be UL listed as required by installation location.

- b. Comply with referenced standards for Category 6A (Augmented Category 6).
 - 1) Cable shall have two individually insulated 23 AWG solid copper conductors formed into a twisted pair.
 - 2) Cable must be constructed of one 4-pair bundle of individually insulated Unshielded Twisted Pairs (UTP).
 - 3) Nominal cable OD shall not exceed 0.300 inches.
 - 4) Cable shall have footage and unique cable identifier printed on the jacket every 2 feet.
 - 5) Cable shall be UL listed as required by installation location.

2.3. CABLE TERMINATION HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. CommScope, Inc. (CommScope).
 2. Corning.
 3. Hubbell Premise Wiring (Hubbell).
 4. Leviton.
 5. Ortronics.
 6. Panduit.
 7. 3M.
- B. General Requirements for Cable Connecting Hardware:
 1. Cables shall be terminated with connecting hardware of same category or higher.
 2. Provide one single manufacturer for twisted pair termination hardware used together in a permanent link and whenever a Category certification is required.
 3. Cable hardware (i.e., connectivity) shall be part of the manufacturer's enterprise solution.
 4. Cable hardware shall be component rated with third-party verification for the specified Category-rated component compliance.
- C. Patch Panels
 1. IDC Patch Panel: Pre-configured panels housing multiple-numbered in-line configured IDC terminations for permanent termination of pair groups of installed cables.
 - a. Provide panels in quantities sufficient to terminate each 4 pair UTP cables as indicated on the Drawings.
 - 1) Add one additional panel if spare ports are less than 10.
 - b. Comply with referenced standards for Category 6A (Augmented Category 6).
 - 1) Flat patch panel.
 - 2) UL listed.
 - 3) Black steel with PCB connection between interfaces.
 - 4) Labeling areas on front and rear.
 - 5) Mountable in EIA standard 19-inch rack/cabinet rails.

- 6) 24-ports in 1.75 inches of rack space (1 RU); 48-ports in 3.5 inches of rack space (2RU).
 - 7) RJ45 (8P8C) jack interface on front and 1 10-style IDC connections on rear.
 - 8) Tested and verified to meet TIA component, permanent link and channel requirements.
 - 9) Provide accessory strain relief bars on the rear with hook and loop ties.
- c. Basis-of-Design: Panduit NKFP48Y
- D. Patch Cables
1. Pre-configured patch panel assemblies featuring self-retracting mechanisms to prevent excess cable.
 2. Basis-of-Design: PATCHBOX Plus+ CAT6A.
- E. Retractable patch cables (vehicle bay).
1. Provide two retractable patch cables for the vehicle bay.
 2. Basis-of-Design: Stage Ninja CAT6-25-S reel with VMB-7-S mounting bracket.
- F. Connector Jacks, Jack Assemblies
1. Connector Jacks:
 - a. 100-ohm, balanced, twisted pair connector; four-pair, eight-position modular color-coded receptacle units with integral IDC-type or "tool-less" terminals, component rated.
 - b. Connector jacks shall match or exceed the rating of the terminated cable.
 - c. Performance rating shall be clearly marked on the front of the module.
 - d. Module shall support both T568B & T568A wiring configurations.
 - e. Same module shall be used in faceplate and patch panel.
 - f. Module's contacts shall be gold plated and designed to minimize spark gap erosion.
 - g. Module shall be rear loading.
 - h. Module must mount to the device using a locking latch for quick reliable mounting and easy, tool less removal.
 - i. Module shall use lacing cap/crimp termination method.
 - j. Module shall work with faceplates, surface mount boxes and panels.
 - k. Modules shall be available in multiple standard colors.
 - l. Connector jacks and jack assemblies shall be color coded by system. 1) Color(s): As scheduled in the Contract Documents.
 - m. Basis-of-Design: Panduit CJ6X88TGxx
- G. Faceplates
- H. Faceplates Basis-of-Design: Panduit NK2FWHY.

2.4. SOURCE QUALITY CONTROL

- 2.5. System components shall be tested and listed by one or more United States NRTL.

PART 3 EXECUTION

3.1. GENERAL

- A. Review and coordinate cabling pathways prior to pathway and cabling installation.
 - 1. Coordinate to resolve deviations, defects or other problems with pathways prior to installation. Allow adequate time for corrections so as to avoid delays to the Project completion date.
 - 2. Provide additional or supplemental pathways and cable support where required. Provide additional sleeves through walls/floors/ceilings, as necessary to route cables within buildings.
- B. Project Conditions
 - 1. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Do not deliver or install product(s) in conditions that jeopardize the performance or manufacturer life expectancy and service life of the product.
 - 3. Delivery, Storage and Handling
- C. Store materials in conditions endorsed by the product manufacturer.
- D. Compliance
 - 1. Comply with referenced standards.
 - 2. Provide the appropriate cable rated for the environmental conditions in which the cable is to be installed.
 - a. Install faceplates and inserts furnished under Section 271543 "Faceplates and Connectors" and/or Section 271544 "Custom Faceplates, Panels and Connectors."

3.2. INSTALLATION OF CABLES

- A. Prior to procurement and installation of the horizontal cabling system, coordinate and verify pathways provided and indicated on the Contract Documents.
 - 1. Coordinate and verify to ensure that horizontal cables will not exceed the maximum standards-based distance limitations (90 meters (295 feet)) for horizontal cabling. Any

- discrepancy shall be immediately brought to the attention of the Designer for direction.
2. The maximum allowable total channel distance is 328 feet (100m) between equipment in the communications room and station equipment, including cable service loops, patch cables and station attachment cables.
 3. If proactive steps are not taken prior to procurement or installation, the Contractor shall be responsible for costs associated with providing the horizontal cabling system within industry-standard distance limitation parameters, including, but not limited to, additional required cabling, pathways, rough-in, equipment, communications rooms or enclosures, power and cooling requirements.
- B. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the communications outlet/connector.
- C. Bridged taps and splices shall not be installed as part of the horizontal cabling.
- D. Install cables within approved pathways. Install cables that are not otherwise required to be installed within raceway in such manner as to conceal them from view. Conceal conductors and cables in accessible ceilings, walls and floors.
- E. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
- F. Do not splice cable between terminations or junction points. Cable runs shall be continuous. Wiring shall be free from grounds, shorts, opens and reversals.
- G. Maintain complete protection of cabling. Cabling shall not be left hanging or coiled where it potentially obstructs the Work of other trades.
- H. Cable routing shall follow building structure lines (parallel and perpendicular).
- I. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
- J. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
- K. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in communications spaces with terminating hardware and interconnection equipment.
 2. Suspend cable not in a raceway, a minimum of 8 inches above ceilings by discrete cable supports not more than 60 inches apart. Bridle rings are not permitted.
 3. Cable shall not be run through structural members or in contact with conduits, pipes, ducts or other similar or potentially damaging items.
- L. Provide conduit sleeves for penetrations.
1. Provide conduit sleeves for cables where cables pass through walls, floors and ceilings.

2. Patch and firestop around sleeves.
 3. Firestop the interior of the sleeves after cable installation.
 4. Provide the appropriate bushings on each end. Split bushings shall not be used.
 5. Provide waterproof sealant for penetrations in humidity-controlled areas.
- M. Maintain (do not violate) the minimum bend radius specified by the manufacturer of the cable.
- N. At final termination, excess cable and the service loop shall be supported and stored neatly in the cable tray or ladder rack within the communications room and above the ceiling line at an accessible point at the station end.
- O. Proper strain relief shall be applied to cables after installation to lessen the risk of physical damage and to provide proper aesthetic value.
- P. Cabling within Enclosures:
1. Bundle, lace, and train cables within enclosures.
 2. Connect to terminal points with no excess and without exceeding manufacturers' limitations on bending radii.
 3. Provide and use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
- Q. Comply with requirements in Section 270501 "Basic Materials and Methods for Communications."
1. Communications."
 2. Bundle cables within racks, ladder racks, cable trays and in discrete cable supports. Utilize reusable cable bundling hardware. Utilize plenum-rated hardware in plenum spaces.
- R. Separation from EMI Sources:
1. Outlet requirements where power and communications must be co-located, a voltage barrier shall be provided.
 2. Comply with BICSI TDMM and referenced standards for recommendations for separating unshielded twisted pair (UT P) cable from potential EMI sources, including electrical power lines and equipment.
 3. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5kVA: A minimum of 24 inches.
 4. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating between 2 and 5kVA: A minimum of 6 inches.

- c. Electrical Equipment Rating More Than 5kVA: A minimum of 12 inches.
 5. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5kVA: A minimum of 6 inches.
 6. Separation between Communications Cables and Electrical Motors and Transformers: A minimum of 48 inches.
 7. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.
- S. Separate cabling by service and type (i.e., voice, data, control, coaxial, fiber) prior to terminating.
 1. Color coding of cable and termination devices shall be coordinated and approved prior to procurement and installation.
 2. Terminate cabling on specified termination hardware in alpha-numerical order.
 3. Group connecting hardware for cables into separate logical fields.
 4. Neatly dress and securely attach cabling to the backboard and/or cabinet/rack.
 5. Provide adequate cable lengths to reach any location on the backboard or within the cabinet/rack.
 6. Bundle and support cables of this System separately from the cables of other systems.
 7. Maintain separation between cables carrying different signal types and different signal levels.
 - a. Where cables from different systems or cables with different signal types are expressly permitted by the Designer to share a common pathway, each of these cable groups shall be kept segregated to the maximum degree physically possible. Cables from different systems shall not be mixed or intertwined.
- T. Service loop:
 1. Within communications rooms, provide a minimum service loop of 10 feet and spool the service loop in the ladder rack.
 2. At the outlet/connector, provide a minimum service loop of 2 feet and spool and store within a discrete cable support (J-hook) above the accessible ceiling at the outlet/connector location.
- U. Cable Termination:
 1. Terminate every conductor; no cable shall contain unterminated elements unless otherwise indicated. Make terminations only at indicated outlets, terminals, crossconnects and patch panels.
 2. Utilize standard positive identification color coding for multi-conductor cables.
 3. Provide 110-style IDC termination hardware unless otherwise indicated.

- a. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
4. Cables from the same room/space shall be terminated adjacent on termination hardware. Cables from outlets/connectors shall be terminated in alpha-numeric, sequential order, based on final room numbers.
 - a. If the communications room serves more than one floor, in addition to the requirements identified above, sequentially group the cables, by floor, on separate patch panels.

3.3. IDENTIFICATION

- A. Label cables and other components in compliance with Section 270553 "Identification for Communications" for labeling requirements.
- B. Label each end of the cable.
- C. Identify system components and cabling.

3.4. FIELD QUALITY CONTROL

- A. Comply with Section 270810 "Verification Testing of Structured Cabling".
- B. Perform tests and inspections.
 1. Twisted pair cabling shall be factory tested according to referenced standards.
 2. Visually inspect twisted pair jacket materials for NRTL certification marking. Inspect cabling terminations in communications equipment rooms for compliance with color coding for pin assignments and inspect cabling connections for compliance with referenced standards.
 3. Visually confirm the required Category-rated marking of cables, outlets, cover plates, outlets/connectors, patch panels and other termination hardware.
 4. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords and labeling of components.
 5. Test twisted pair copper cabling for DC loop resistance, shorts, opens, intermittent faults and polarity between conductors.
 - a. Test instruments shall meet or exceed applicable requirements in referenced standards. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 6. UTP Performance Tests:
 - a. Test for each outlet. Perform the following tests according to referenced standards and 270810 "Verification Testing of Structured Cabling."
 - b. Test cables through a Consolidation Point from workstation to patch panel.

7. Final Verification Tests: Perform verification tests for twisted pair systems after the complete communications cabling and workstation outlet/connectors are installed.
 8. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report for the cables as well as a detailed report for each cable tested.
 9. Remove and replace cabling where test results indicate they do not comply with specified requirements. Retest cabling and provide documentation.
 10. End-to-end cabling shall be considered defective if it does not pass tests and inspections.
 11. Prepare and submit test and inspection reports.
- C. The Owner reserves the right to have a representative present during testing procedures. Verification testing of copper and fiber may be performed at or near Project completion by the Consultant for quality assurance.
- D. Upon verification testing, if the Consultant finds the test results do not match the Contractor's results, the Consultant or a third party may at the Owner's request retest the cabling and submit those results to the Owner and deduct the verification testing costs from the Contractor's Contract amount.

END OF SECTION 271513.00

SECTION 271544.00 - CUSTOM FACEPLATES, PANELS AND CONNECTORS

PART 1 GENERAL

1.1. SUBMITTALS

A. Product Data:

1. Datasheet for each distinct device (e.g., connector, switch, lamp assembly) to be used within an assembly.

B. Shop Drawings:

1. Separate Shop Drawing for each assembly:
 - a. Clearly indicate the following:
 - b. Device-ID of the assembly.
 - c. Manufacturer.
 - d. Material.
 - e. Finish and color.
 - f. Dimensions.
 - g. Mounting-hole quantity, size and spacing.
 - h. Nomenclature:
 - 1) Fonts.
 - 2) Font sizes.
 - 3) Colors.
 - 4) Line widths.
 - i. Devices to be used: By manufacturer, model and color.

1.2. REFERENCES

A. Definitions:

1. Devices: Products that are assembled to the front, side, rear, top or bottom of a faceplate or panel. Devices include such items as connectors, switches, lamps, meters, faders, potentiometers and connector modules.
2. Components: Passive or active electronic parts that are part of a faceplate or panel assembly.

1.3. QUALITY ASSURANCE

- A. Faceplate and panel manufacturers shall be in the full-time business of fabricating custom faceplates and panels for the communications industry. Contractor fabricated products shall not be permitted.

PART 2 PRODUCTS

2.1. GENERAL

- A. Custom faceplates and panel assemblies shall be provided wherever pre-manufactured, stock faceplates and panel assemblies are not expressly specified within another Section.
- B. Quantities of assemblies required shall be derived from the Drawings and requirements of other Sections.
- C. Configurations shall be derived from the Drawings, from the requirements of this Section, and from requirements of other Sections of the Contract Documents that rely upon these assemblies.
- D. Assemblies shall satisfy the requirements of the systems that utilize them and shall be appropriate for the Owner's intended use.
 - 1. Where a Drawing detail is not published depicting a specific assembly configuration, follow the guidelines set forth in this Section, in conjunction with Drawing notes and requirements of the system served, guide the layout of the assemblies provided. Contractor provided assemblies shall feature the same fit, finish and level of detail as assemblies that are detailed on the Drawings. Seek the express direction of the Designer.

2.2. FACEPLATES AND PANELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - 1. Panel Crafters (Liberty Wire and Cable).
 - 2. Pro-Co Sound.
 - 3. Rapco.
 - 4. RCI Custom Products.
 - 5. Whirlwind.
 - 6. Wireworks Corporation.
- B. Material:
 - 1. Stainless Steel.
- C. Material Thickness:
 - 1. Stainless Steel: 0.030 inch to 0.045 inch.
- D. Finish:
 - 1. Wall Mounted: Clear Stainless.
 - 2. Ceiling Mounted: Clear Stainless.
 - 3. Floor Box: Clear Stainless.
 - 4. Rack Mounted: Black .
- E. Mounting Holes:

1. Plates of standard and oversized electrical gang sizes shall be provided with countersunk holes appropriate for accommodating trade-standard screw sizes. Holes shall be spaced to mate with the box, substructure and devices.
 2. Provide quantity of holes depicted on details and additionally as necessary to securely attach the faceplate.
- F. Bracing:
1. Supplemental metal bracing shall be provided on the rear of faceplates and panels to ensure that during normal use, the faceplate or panel does not deflect more than 1/32 of an inch when inserting and removing a connector, or when operating a device.
 2. Supplemental metal bracing shall be incorporated onto the rear of faceplates and panels with unsupported spans of 10 inches or more or when the unsupported surface area exceeds 120 square inches.
- G. Nomenclature:
1. Nomenclature includes lettering, lines, borders, arrows, icons and other visual elements that are used to identify and organize device elements.
 2. Nomenclature shall be engraved directly into the surface, except where otherwise indicated on the detail Drawings.
 3. Engraved nomenclature shall be backfilled using enamel paint.
 4. Standard nomenclature colors:
 - a. Clear anodized faceplates and panels: Black.
 - b. Black anodized faceplates and panels: Yellow.
 - c. Clear stainless-steel faceplates and panels: Black.
 - d. Standard colors identified above shall be furnished for faceplates and panels that are not otherwise detailed or scheduled to have different nomenclature colors.
- H. Devices:
1. General:
 - a. Drawings or required by the system, the following manufacturers are approved for use:
 - 1) Neutrik.
 - 2) Switchcraft.
 - 3) Canare.
 - 4) AMP.
 - b. Where specific connector types are listed within this Section, only the listed model(s) are acceptable.
 - c. For consistency in appearance and performance, connectors of a given type shall be from a single manufacturer from a single series and the same model (where applicable).
 2. Default Connector Types:
 - a. Unless otherwise indicated on the Drawings, the following default connector types shall be provided for the usage indicated.

- 1) Audio Signals:
 - a) Balanced audio outputs: XLR, 3-Pin Male.
 - b) Balanced audio inputs: XLR, 3-Pin Female.
 - c) Unbalanced mono audio inputs: 1/4-inch Phone tip-sleeve connector.
 - d) Unbalanced mono audio output: 1/4-inch Phone tip-sleeve connector.
 - e) Unbalanced stereo audio input pairs: (2) RCA phono connectors.
 - f) Unbalanced stereo audio output pairs: (2) RCA phono connectors.
 - g) Speaker level audio: speakON
 - b. Data/Control Signals:
 - 1) AMX Axlink: XLR, 4-Pin Female.
 - 2) Crestron Cresnet: XLR, 4-Pin Female.
 - 3) Ethernut: RJ45, Category 6 rated Jack.
 - 4) Digital Audio (Dante, AVB): RJ-45, Category 6 rated Jack.
 - 5) Serial RS-232: DB-9, Female.
 - 6) Serial RS-422: DB-9, Female.
 - 7) Serial RS-485 (without power): DB-9, Female.
 - 8) Serial RS-485 (with power): XLR, 4-Pin Female.
 - c. Digital Video:
 - 1) HDMI: HDMI Female.
 - 2) SDI, 12G-SDI: Recessed BNC Bulkhead, Jack-to-Jack.
 - 3) Proprietary UT P formats: Ethercon Category 6 Rated Jack.
 - d. Default connector types notwithstanding, the type of connector provided shall be subject to review during the submittal process and prior to the fabrication of any assembly. Review may uncover the need to depart from the default device type or gender.
3. Audio Connectors:
- a. XLR Type:
 - 1) Neutrik D-series.
 - 2) 3-Pins, unless otherwise detailed or noted.
 - 3) Nickel finish, unless otherwise noted.
 - 4) Use male gendered version for signal outputs.
 - 5) Use female gendered version for signal inputs.
 - b. 1/4-inch Tip-Sleeve (TS) and Tip-Ring-Sleeve (TRS) Type, Locking:
 - c. 1/4-inch Phone Tip-Sleeve (TS) and Tip-Ring-Sleeve (TRS) Type:
 - 1) Switchcraft "Little-Jax" Series.
 - 2) Supply with accessory insulating flat washer and SI 029 insulating shoulder washers.
 - d. 3.5mm Mini Phone Tip-Sleeve (TS) and Tip-Ring-Sleeve (TRS) Type:
 - 1) Switchcraft "Tini-Jax" Series.

- 2) Supply with accessory insulating Switchcraft wedged fiber washer and insulating shoulder washer.
- e. RCA - Phono, RCA Solderback:
 - 1) Canare.
 - 2) Provide with accessory 7/16 insulating bushings/washers as follows:
 - a) Provide white insulators to designate "Left" audio channels.
 - b) Provide white insulators to designate "Mono" audio channels.
 - c) Provide red insulators to designate "Right" audio channels.
 - d) Provide black insulators to designate general purpose use.
- f. RCA Phono:
 - 1) Switchcraft.
 - 2) Solder based connections.
 - 3) Supply with accessory insulating flat washer and insulating shoulder washers.
 - a) Provide white insulators to designate "Left" audio channels.
 - b) Provide white insulators to designate "Mono" audio channels
 - c) Provide red insulators to designate "Right" audio channels.
 - d) Provide black insulators to designate general purpose use.
- g. speakON:
 - 1) 4-Conductor.
 - 2) 30A RMS continuous duty current rating.
 - 3) Twist-lock locking action.
 - 4) Indoor Applications
 - a) Chassis color: Black
 - 5) Outdoor Applications
 - a) Chassis color: Silver/Nickel
4. Video Connectors:
 - a. BNC Recessed Bulkhead, Jack-to-Jack:
 - 1) Canare.
 - 2) Integral insulated-from-panel design.
 - b. BNC Non-Recessed Bulkhead, Jack-to-Jack:
 - 1) Canare.
 - 2) Provide with accessory IU 7/16 insulating bushings/washers as follows:
 - a) Yellow for "composite" video signals.
 - b) Red, Green and Blue for component (Y-Pb-Pr) video signals.
 - c) Red, Green and Blue for RGB video signals.
 - d) Red, Green and Blue, White for "RGSB" video signals.
 - e) Red, Green and Blue, White and Yellow for "RGBHV" video signals.
5. RF Connectors:
 - a. F-Type Bulkhead, Jack-to-Jack:

- 1) Canare.
6. Data/Control:
 - a. Ethernet:
 - 1) Category 6 rated RJ-45 modular jack.
 - 2) Keystone form factor.

2.3. FACEPLATE GAP FILLERS

- A. Gap fillers shall be supplied for installation behind faceplates to fill visible gaps that may result after installation.
- B. Thickness: 1/8-inch.
- C. Size: Height and width to exactly match the height and width of the faceplate, or 1/8-inch larger than the faceplate. Fillers of the oversized variety shall feature a bevel to ensure no exposed sharp edges on the assembly.
- D. Material: Anodized aluminum.
- E. Color and finish: To match the faceplate served.

2.4. MOUNTING HARDWARE

- A. Phillips drive countersink oval-head machine screws shall be used to secure faceplates whose mounting-hole spacing is based upon the standard electrical device gang-box mounting hole spacing.
- B. Phillips-drive truss-head machine screws shall be used for securing faceplates and panels that are not sized to mount over a standard electrical gang box size.
- C. Rackmount based panels shall be secured to rack rails using truss-head type machine screws.
- D. Clear nylon washers shall be installed behind screw-heads not designed for countersinking. Washer thickness shall be 1 to 2 mm thick. The diameter of the washer shall match the diameter of the screw.
- E. Colors:
 1. Clear stainless steel and clear anodized aluminum faceplates and panels: Chrome.
 2. Black finish faceplates and panels: Matte or satin Black.
 3. Other faceplate colors: same as faceplate or panel color.

PART 3 EXECUTION

3.1. COORDINATION

- A. Coordinate pathway requirements with the Work of Section 270528 "Pathways for Communications."
 - 1. Coordinate the size of the back boxes and similar devices that are used for faceplate and panel mounting.
 - 2. Coordinate the set-back of boxes behind mounting surface to ensure the faceplate and panels shall be installed flush.
 - 3. Coordinate the proximity of adjacent back boxes to ensure adequate spacing remains for faceplate and panel installation without interference and to achieve an aesthetic alignment.
 - 4. Coordinate the entry-point of raceways into the boxes in such locations as to ensure cable radius minimums will not be violated.
- B. Coordinate the details of individual faceplates and panels with the Work of this Division.
- C. Coordinate labeling nomenclature between assemblies serving each system. Coordinate with the provider of the system(s) that will use them.

3.2. FABRICATION

- A. Faceplate and Panel Milling:
 - 1. Provide openings to accommodate devices to be mounted to a device-box prior to installation.
 - 2. Size openings in accordance with device manufacturers recommended tolerances and in accordance with recognized industry standards.
 - 3. Mill the front and/or reverse side to accommodate mounting and attachment of devices sufficiently to achieve a professional appearance and allow the fully functional use of the devices without compromise.
- B. Device Mounting:
 - 1. Securely, neatly, and professionally attach devices.
 - 2. Mount devices so that they will not loosen during normal use and operation.
 - 3. Connector-type devices shall be secured so that they do not rotate when inserting, locking or removing mating devices.
 - 4. Switch-type devices shall be secured so that they do not rotate or work loose during operation.
 - 5. Use mounting brackets and standoffs for mounting of devices where applicable. Use custom fabricated brackets and standoffs where standard brackets and standoffs are not readily available to suit the application.
 - 6. Devices with through-mounting holes shall be secured using removable machine threaded fasteners. Pop rivets shall not be acceptable.
 - a. Phillips drive flat-head countersink screws shall be used where the device manufacturer provides a countersunk mounting hole. The size of the head shall match the size of the countersink. Screw head shall not stand proud of the countersink and no sharp exposed edges of the screw shall exist.

- b. Philips truss head machine screws shall be used for devices without countersunk mounting holes.
 - c. Thread-lock compound shall be applied to screw threads used to secure devices. Low-strength blue Loctite™ or equivalent shall be used.
 7. Devices designed to be mounted without the use of through-mounting-holes shall be secured using the means expressly recommended by the device manufacturer.
 8. Mount devices parallel to the dominant edge of the faceplate or panel.
 9. Install devices so that there is no movement during use other than that which is intended by the manufacturer for the functional use of the device.
- C. Assembly Wiring:
 1. Wiring shall be neatly and professionally attached to devices and components. Employ strain relief techniques on pigtails to ensure no mechanical strain at the point of electrical connection.
 2. Different color wires shall be used to aid in identification of circuits.
 3. Legible permanent labels shall be attached to cables and conductors to aid in identification of purpose and circuit. Color codes and identification shall be accurately recorded on as-built documentation.

3.3. INSTALLATION

- A. General:
 1. Verify rough-in installation before device and faceplate installation:
 - a. Verify that wall boxes are installed plumb and level prior to installation of devices or the mounting of faceplates. Install within one-tenth (1/10) of a degree level and plumb.
 - b. Verify that the leading exposed edge of the rough-in does not stand proud of (i.e., protrude out beyond) the finished surface over which it is mounted.
 - c. If the rough-in is sufficiently out of tolerance as to prevent level, plumb and flush mounting of the faceplate, coordinate the rework of the rough-in with the responsible installer.
 - d. When these guidelines are disregarded, and faceplates are installed over rough-in that is out of level and not plumb, the cost to remove and reinstall a faceplate assembly is the responsibility of the faceplate assembly installer.
 2. Ensure that each cable landing on a faceplate assembly is labeled and recorded on the as-built drawings prior to termination and mounting.
- B. Mounting:
 1. Install faceplates plumb and level. Drill and tap backboxes in the field as required.
 2. Securely attach faceplates to approved box or sub-structure. Mounting to drywall, wood and masonry shall not be acceptable.
 3. Install faceplates so they are flush with the surface behind (e.g., wall, ceiling, surface mount box, floor box).

4. Securely attach faceplates using machine threaded fasteners.
- C. Gap Fillers:
1. Supply and install gap fillers behind faceplates to cover any resulting visible gaps between the rear faceplate surface and the surface over which it mounts.
 2. Provide gap fillers that match the size of the faceplate. Provide custom-sized gap fillers where standard gap fillers are not available.
 3. Where oversized gap fillers are permitted, install them so that a uniform reveal around the faceplate is achieved.
 4. Adhere gap fillers to the rear of faceplate to ensure the filler remains correctly aligned when the faceplate is removed. Use of visible fasteners that exist for the sole purpose of affixing the gap filler shall not be acceptable.
- D. Box Drilling and Tapping:
1. Faceplates that mount over SC-type or similar junction, pull and device boxes shall be mounted using machine-thread fasteners.
 2. Mounting holes shall be drilled and tapped in the box, after the box has been installed, to match the level and plumb orientation of the faceplate or panel assembly. The holes shall be positioned so that the assembly is centered over the box. The holes shall be positioned such that the faceplate is plumb and level when secured.
 3. Faceplate mounting holes shall be drilled and tapped in accordance with the Unified Thread Standard (UTS), using an appropriately selected UNC or UNF-class thread. The thread and tap-drill size used shall ensure that the box achieves two or more full threads at a minimum thread depth of 75%.

3.4. INDENTIFICATION

- A. The specific nomenclature and graphics used on assemblies is subject to the review and modification by the Designer.

3.5. CLEANING

- A. Faceplates and Panels:
1. Clean and vacuum boxes prior to termination of cables to devices and again immediately prior to mounting.
 2. Wipe down using cleaning products and methods recommended by the manufacturer.
- B. Connectors:
1. Vacuum out connectors and clean the contacts of each.
 2. Clear connector before use. Clean again after the connectors are subjected to environmental contamination.

3.6. PROTECTION

- A. Protect products from physical damage during Work of the Project.

- B. Protect connectors from environmental contaminants during the construction period.
- C. Replace any product damaged during the course of the Project.

END OF SECTION 271544.00

SECTION 271600.00 - COMMUNICATIONS CORDS, DEVICES AND ADAPTERS

PART 1 GENERAL

1.1. SUBMITTALS

- A. Product Data.
 - 1. Bill of Materials (BOM).
 - 2. Product Datasheets.
- B. Closeout Submittals:
 - 1. Product Datasheets.
 - 2. As-Built Drawings:
 - a. Labeling Schema utilized for cable assemblies.
 - b. Cable color code utilized for patching.
 - 3. Cable and connectivity manufacturers' certification of quality and performance.
 - a. Warranty documentation, including cabling and connectivity manufacturers' current product warranty data and certificates of complete connectivity solution provider status for the Contractor.

1.2. REFERENCES

- A. Definitions:
 - 1. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.
 - 2. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
 - 3. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
- B. Reference Standards:
 - 1. Comply with standards set forth in 27 00 01 - Common Work Results for Communications: References.

1.3. COORDINATION

- A. Review and coordinate the quantity, lengths, colors and rating of patch cords with the Project requirements and the Owner prior to procurement and installation.

1.4. QUALITY ASSURANCE

- A. Prior to bid, Contractor shall be listed and shall maintain participation as part of the cabling and connectivity manufacturers' certified contractor programs. Provide documentation as outlined in Submittals.

1.5. DELIVERY, STORAGE AND HANDLING

- A. Store materials in conditions endorsed by the product manufacturer.
- B. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- C. Do not deliver or install product(s) in conditions that jeopardize the performance or manufacturer life expectancy and service life of the product.

1.6. WARRANTY

- A. Cabling and connectivity products manufacturers, including patch cords, shall have in place an agreement recognizing each other for complete execution of the warranty as specified. Performance and applications warranties shall be channel rated, including patch cables.
 - 1. Comply with warranty requirements of related Sections. The cable manufacturer and the connectivity products manufacturer shall have a partnership agreement established in order to provide the required warranty.

1.7. SYSTEM DESCRIPTION

- A. General:
 - 1. Provide cables, cords, devices and adapters as quantified and described.
 - a. Provide cable assemblies with electrical properties to match the designed infrastructure and specified in related Sections.
 - 1) 4 pair cable assemblies shall be compliant to the Category specified for the 4-pair UT P horizontal cabling system.
 - 2) Cables may be color-coded by system.
 - 2. Provide adapters and devices as quantified and described.
 - a. Work shall comply with the Contract Documents and the manufacturers' printed recommended installation practices.
 - 3. System cables and device shall be ULINEC rated for the location, manner, and environmental conditions in which the cables are installed.
 - 4. Provide one single manufacturer for twisted-pair termination hardware and patch cable assemblies used together in a permanent link and whenever a Category Certification is required.
- B. Provide the following cable assemblies (cords), devices, and adapters:
 - 1. Copper Patch Cables:

- a. Length as required for the Equipment Room/Telecommunications Room end.
 - b. Confirm required cable color coding.
 - c. Provide rack patch cable in minimum standard lengths to patch directly from patch cable to switch
 - d. Provide a quantity of one (1) for each horizontal cable installed.
 - e. Includes provisions for voice/telephone, data/network, video surveillance, audio-visual, access control, control data and intrusion detection systems.
2. Copper Workstation and Device Cables:
 - a. Length as required for workstation and device locations.
 - b. Confirm required cable color coding.
 - c. Provide a quantity of one (1) for each horizontal cable installed.
 - 1) Includes provisions for, but not limited to, voice/telephone, data/network, wireless access point, video surveillance, audio-visual, access control, control data and intrusion detection systems.
3. Fiber Optic Patch Cables:
 - a. Length as required for switch-to-switch and switch-to-patch panel connections.
 - b. Labeled with same unique identifier at both ends of the assembly.
 - c. Provide a quantity of one (1) pairs for each pair of backbone fiber optic cable strands installed. Provide quantities of patch cables required for switch-to-switch requirements.
 4. System cables shall be ULINEC rated for the location, manner, and environmental conditions in which the cables are installed. Plenum rated patch cables shall be provided for above-ceiling applications.

PART 2 PRODUCTS

2.1. COPPER PATCH CABLE ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Leviton Mfg. Company, Inc. (Leviton).
 2. Ortronics; a subsidiary of Legrand (Ortronics).
 3. Panduit Corp. (Panduit).
 4. CommScope, Inc. (CommScope).
 5. Hubbell Premise Wiring (Hubbell).
- B. Category 6 Copper Patch Cables:
 1. Comply with referenced standards for Category 6.
 2. Independently tested and verified.
 3. UTP Cable Assemblies.
 4. Confirm cable lengths with the Owner.
 5. Confirm cable color coding with the Owner.

C. Category 6A Copper Patch Cables:

1. Comply with referenced standards for Category 6A.
2. Independently tested and verified.
3. UTP Cable Assemblies.
4. Tested and verified to meet TIA component, permanent link and channel requirements.
5. Confirm cable lengths with the Owner.
6. Confirm cable color coding with the Owner.

2.2. FIBER OPTIC PATCH CABLE ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CommScope, Inc. (CommScope)
2. Hubbell Premise Wiring (Hubbell).
3. Leviton Mfg. Company, Inc. (Leviton).
4. Ortronics; a subsidiary of Legrand (Ortronics).
5. Panduit Corp. (Panduit).

B. Patch Cords: Factory-made, dual-fiber cables.

1. Coordinate with the Owner for termination types to match equipment.
2. Coordinate with the Owner and installed equipment locations for lengths required.
3. Provide patch cords to match specified optical fiber performance.

2.3. CLOCKS

- A. The clock shall be a Sapling SAP Series IP clock. It shall be an analog clock with a black hour hand, a black minute hand, and a red second hand. The clock shall receive time data from an NTP or SNTP server or a Sapling SMA Series Master Clock. Time data shall be transmitted and received by the clock via Sapling's IP communication protocol, which shall be delivered to the clock through a CAT5, CAT5e, CAT6, or CAT6A cable. The clock settings shall be adjustable through a Web Interface that can be accessed by a web browser, such as Internet Explorer. Settings for the clock shall include Daylight Saving Time, Network Settings, and a list of up to 10 NTP sources. The clock shall have a microprocessor-based movement that shall require fewer than 5 minutes to perform a correction of the hand positions. The clock will be powered using Power-over-Ethernet (PoE). The clock shall have a smooth surface ABS case or metal case which can be attached to a standard-sized gang box. The round ABS versions of the case shall be designed such that they will fit within Sapling's wood or aluminum round clock housings. The ABS clock case shall be produced in round cases with diameters of 9, 12, or 16 inches, or square cases with widths of 9 or 12 inches. The dial is to be made of durable polystyrene material. The crystal is to be made of shatterproof, side molded polycarbonate. The clock shall be UL and cUL listed.

- B. Basis of Design is Sapling SAP-4BS-19R-M or equivalent.

PART 3 EXECUTION

3.1. INSTALLATION OF CABLES

- A. Maintain complete protection of cabling. Cabling shall not be left hanging or coiled where it potentially obstructs the Work of other trades.
- B. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
- C. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter.

3.2. IDENTIFICATION

- A. Label each end of each cable, as described within this Section.
- B. Apply all labels straight and legible.

END OF SECTION 271600.00

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SECTION 274100.00 – AUDIO VIDEO SYSTEMS

PART 1 GENERAL

1.1. WORK INCLUDES

- A. Work in this section includes, but is not limited to, furnishing and installing a fully integrated Audio-Visual presentation system in each Classroom and all other areas as indicated on the Drawings.

1.2. DESCRIPTION

- A. Each space should have an integrated audio and video system. The Roll Call Room will have three displays. The Multi-Purpose and Conference Room will have four displays.
- B. An Av over IP switching system will be deployed in each area with each having their own dedicated network switch.
- C. A control system and digital signal processor shall be used to change inputs and volume in each room as well as route audio and provide acoustic echo cancellation during conferencing.

1.3. RELATED SECTIONS

- A. Section 27 05 00 – Communications Common Work Results
- B. Section 27 05 26 – Grounding and Bonding for Communications
- C. Section 27 05 28 – Pathways for Communications

1.4. PRODUCTS INCLUDE

- A. Products include, but are not limited to,
 - 1. Monitors and mounting hardware
 - 2. AV over IP encoders and decoders
 - 3. Control System
 - 4. Digital Signal Processor
 - 5. Conference Cameras and Microphones
 - 6. Network switch
 - 7. Amplifiers and Speakers

1.5. CONTRACTOR QUALIFICATIONS

- A. The Contractor shall currently maintain a locally run business for a minimum of three years and shall be an authorized distributor and service center for the supplied equipment having full warranty privileges.

- B. The Contractor shall maintain at his facility the necessary spare parts in the proper proportions as recommended by the equipment manufacturer to maintain and service the equipment being supplied. These facilities and inventory shall be made available for inspection by the Engineer.
- C. The Contractor shall maintain current applicable certifications for the systems being provided, including but not limited to Certified Technology Specialist (CTS and CTS-D) as provided by InfoComm, as well as certification by the specific manufacturer's where available, for the installation and servicing of all manufacturer's equipment being supplied and/or installed. The Contractor shall also have an employee with Dante Level 3 certification as well as a programming certification from the Control system of choice. Please include these certificates at the back of your proposal.
- D. The Contractor shall have a minimum of three installations of like magnitude and complexity within the last three years. Please include a short synopsis of the project including client contact information at the back of your proposal.

1.6. RECORD DRAWINGS

- A. As-built documentation for all variations of the systems provided under the scope of the Specification shall be provided to the Engineer for review and approval, upon approval of the Engineer, incorporate the drawings into the O&M manual provided to the Owner.
- B. As-built documentation as defined elsewhere in these Specifications shall contain, at a minimum:
 - 1. Locations of all the systems provided, including, but not limited to any indications of variations,
 - 2. Riser(s) with all details of the individual installations, including, but not limited to,
 - a. Device or component manufacturer and model numbers,
 - b. Specific I/O points on the devices or equipment.
 - c. Type of cable(s), and any cable ID installed.
 - d. Nature of signal being transmitted, such as HDMI, RF or IR Control.
 - e. Any other pertinent details of the interconnection to assist in the ongoing maintenance and upkeep of the system.
 - f. Note: Where the systems provided repeat in layout, a single riser may be provided. However, any deviation of the installation, such as varying quantity of speakers, shall require a separate and unique riser for each deviation. Each riser required shall be provided with a unique title so as to make it easily identifiable when being referenced. Should such deviations exist, the plans indicating the location of each of the systems shall clearly indicate which riser is applicable to each individual occurrence of the system.
 - 3. A complete list of all equipment with Manufacturer, Model Number, Serial Number, and location of the equipment shall be compiled and turned over to the Owner representative prior to final acceptance of the project.

4. Listing of all user-serviceable parts, including, but not limited to, Manufacturer and Model number of part(s)

PART 2 PRODUCTS

2.1. PRODUCT SUBSTITUTIONS

- A. As indicated elsewhere in these documents, the products specified in these Construction Documents shall be furnished as indicated. The substitution of materials or products considered to be functionally equivalent, where not previously approved in writing by the Engineer, shall be unacceptable. Any deviation from the use of materials or products shall be handled in accordance with terms and conditions established elsewhere in the documents.

2.2. PRODUCTS

- A. All products shall be new, UL listed and comply with all applicable Federal, State and Local regulations.
- B. Display monitors (Roll Call 85-86", Multipurpose 85-86", and Conference Room 75")
 1. Type "T" Refer to Drawings for quantities.
 - a. Brightness 450nits +
 - b. Resolution: 4K UHD
 - c. Touchscreen: No
 - d. HDMI Inputs: (3)
 - e. External Control: RS232, RJ45, Wi-Fi
 - f. Built-in Speakers: Yes
 - g. CPU: Yes, internal Processor
 - h. Operating System: Android 13
 - i. Audio Out: Yes
 - j. Manufacturers:
 - k. LG-86UH5 / 75UH5 (basis of design)
 - 1) Equals by Planar, Sony, Panasonic, or Samsung
 2. Mounting hardware
 - a. Sized as required for weight of display.
 - b. Continuously vertically adjustable minimum 15.75"
 - c. Compatible with standard VESA brackets
 - d. Finish: Manufacturer's standard powder coated black
 - e. Manufacturers:
 - 1) Basis-of-Design: Standard displays
 - a) 86" Chief XSM1U,
 - b) 75" Chief LSM1U.
 - c) 55" MSM1U

- 2) Basis of Design: Displays with equipment behind
 - a) Chief AS3LD
3. AV over IP encoders and decoders
 - a. See one-line diagram for quantities.
 - b. 4K60 4:4:4: Video encoding and decoding
 - c. HDMI loop through
 - d. RS-232 over IP and CEC over IP
 - e. Compatible with standard IP networks
 - f. Manufactures
 - 1) Visionary 5 Series (Basis of design)
 - 2) Equals by Crestron, Extron, and AMX (SVSI)
4. Digital Signal Processor
 - a. See one line diagram for quantity.
 - b. 8x8 Dante support
 - c. 8ch Acoustic Echo Cancellation
 - d. AES67 support
 - e. VOIP support
 - f. Manufactures
 - 1) QSC Core Nano (Basis of design)
 - 2) Equals by Crestron, Biamp, and Symetrix
5. Network Switch
 - a. See one line for quantities.
 - b. Fully Managed Switch
 - c. 30-48 ports
 - d. POE budget of 300w or greater if needed.
 - e. Switching capacity of 56Gbps
 - f. Forwarding rate of 41.67 Mpps
 - g. Minimum 2 SFP ports for fiber connectivity
 - h. Manufactures
 - 1) Netgear M4250 Series (Basis of design)
 - 2) Equals by Cisco
6. Network Amplifier
 - a. 100w @ 70v
 - b. Single channel amplifier
 - c. Manufacturers
 - 1) QSC SPAQ Series (Basis of Design)
 - 2) Equals by LEA, Crestron, and Extron
7. Ceiling Mounted Speakers
 - a. See one-line and reflected ceiling plans for quantities.
 - b. Two-way ceiling mount with compatible back can

- c. 6.5" cone woofer and .75" tweeter
- d. Rotary 70v transformer taps at multiple wattages including 7.5 and 15 watts.
- e. Listed under UL1480 and UL2043, safe for use in air handling spaces.
- f. Manufactures
 - 1) QSC AC-C6T (Basis of Design)
 - 2) Equals by Crestron, Community, and JBL
- 8. Conferencing Cameras
 - a. See one-line for quantities.
 - b. Network Pan-Tilt-Zoom conference camera.
 - c. Low noise CMOS Sensor
 - d. Supports resolutions of up to 1080p
 - e. Minimum illumination .5 Lux at F1.8 (AGC ON)
 - f. Signal to Noise greater than 55db
 - g. White balance controls of auto, indoor, outdoor, manual
 - h. Network interface
 - i. POE capable
 - j. Manufacture
 - 1) QSC NC-12X80 (Basis of Design)
 - 2) Equals by Creston, Aver, and PTZ Optics
- 9. Ceiling Microphone
 - a. See one-line for quantities.
 - b. Ceiling array microphone
 - c. Audio shall utilize either Dante™ or AES67 digital audio networking over a single network cable
 - d. The microphone shall be capable of sending and receiving command strings that enable integration with third-party control systems
 - e. The product shall be available in a square form factor at 2 ft dimensions
 - f. The product shall be IP5X rated for dust protection.
 - g. The product shall conform to UL2043 as Suitable for Air Handling Spaces
 - h. Manufacture
 - 1) Shure MXA-920S (Basis of Design)
 - 2) Equals by AudioTechnica and Sennheiser
- 10. Control Processor
 - a. See one-line for quantities.
 - b. The processor must be appropriate for space it is controlling
 - c. Basis of design is QSC Core Nano
 - d. Accepted models are AMX NX-2200, Crestron CP4-N, and Extron IPCP Pro 255 or greater.

PART 3 EXECUTION

3.1. INSTALLATION

- A. This Contractor shall provide all necessary coordination with the Electrical Contractor to assure proper location of all cabling associated with the system. Should coordination not occur, it will be the responsibility of This Contractor to provide all corrective measures. Such required corrective measures should be provided only as approved by the Engineer, Architect AND Owner.
- B. This Contractor shall lead all discipline coordination for exact mounting height and location of power and data/AV rough-ins and faceplate for all projector and monitor locations. Provide exact wall and ceiling mounting template for all trades to review and adhere to.
- C. Route all cabling in a neat and workman-like fashion.
- D. Terminate all field terminating cabling as recommended by the manufacture, and compliant with any applicable industry standards. All bare wire capture terminals shall be installed per manufacturer's recommendations. Where not specifically prohibited by the manufacturer, tin all bare wire compression connections.
- E. All connectors utilizing compression as the method for mechanical attachment to the cable shall utilize connectors that provide a single uniform compression around the entire diameter of the cable.
- F. Provide any/all recommended hardware to properly attach a ceiling or otherwise overhead devices and equipment, including, but not limited to, tile bridges or other ceiling anchor hardware.
- G. Provide labeling of any cable run whether factory provided or field installed cabling. Refer to the labeling requirements herein for further information and requirements.
- H. Configure the video monitor such that audio follows video for the analog sources.
- I. Support and dress all cables. The Contractor shall provide all necessary fixed and flexible wire management to achieve a high-quality installation both visually and operationally, and that would be considered to be within the standard practices of good workmanship. Provide J-Hook supports at regular, though slightly varying, intervals of no greater than 5' for all cabling that must be routed greater than 5'. Provide a removable non-metallic sheath over all exposed cable bundles utilizing an easily flexible braided sleeving solution such as Techflex from the point where the cabling leaves the protection of the pathway to the device(s) being serviced, such as where the cabling leaves the wall or faceplate to the monitor or projector, or where the cabling leaves the wall to the receiver/amplifier and program sources.
- J. Within all equipment enclosures, and at the back of all equipment to the point where the cabling enters the equipment location, the Contractor shall utilize Velcro straps or Milli-Tie wraps for bundling of signal wires.

- K. Test all cabling for shorts, opens or other undesirable conditions. Replace any cabling found to be damaged or compromised in its ability to perform to that of a new and undamaged or uncompromised cable.
- L. Test all I/O and adjustability of the system, including providing any required test source or load that may be required to test any currently unused input or output.
- M. Verify complete operation of all components and the system as a whole. Correct all issues prior to final punch walk through.

3.2. LABELING

- A. The Contractor shall neatly label all cabling to assure easy maintenance and troubleshooting.
- B. Label all cabling at both ends at easily readable location that is no greater than 6" from the ends of the cable.
- C. Labeling shall be either laser-jet printed tags designed to adhere in a self-laminating fashion, or in field machine generated labels utilizing a commercial grade labeling machine designed for labeling cabling in such applications, and label stock designed for this specific application.
- D. Labeling shall be created so as to state the function and/or meaningful ID of the cable in recursive rows down the entire length of the label, so the label is readable around the entire diameter of the cable.
- E. Label font shall be a clearly readable font, such as Arial, bold and no smaller than 1/8" high.

3.3. CALIBRATION AND COMMISSIONING

- A. The contractor shall verify signal level and signal integrity during installation and operation of the system. Should it be required to provide sufficient signal level and signal to noise ratio, as well as other industry accepted signal metrics, the Contractor shall provide distribution or buffer amplifiers to assure these sufficient signal levels as specified previously in this document. These line drivers would be in addition to any explicitly called out in these Documents.
- B. The Contractor shall calibrate all signals so that distribution of the signals shall be of a consistent and acceptable level minimizing and cascading signal to noise ratios while maintaining usable signal level.
- C. All installation and calibration of equipment shall be provided by qualified and certified personnel. All calibrations shall be checked by appropriate calibration equipment. Calibrations made by authoritative and/or experienced eyes and/or ears are not acceptable.
- D. All calibrations and adjustments shall be documented in machine generated print in a neat and organized fashion for t r a n s m i s s i o n to the Owner. All d o c u m e n t a t i o n shall clearly identify the location of the equipment being documented, including, but not limited to manufacturer, model number and serial number. The Engineer reserves the right

to review, reject or require modification or further documentation prior to completion of the project.

- E. The Engineer shall be given a minimum of 72 hours' notice prior to all final calibrations and commissioning and reserves the right to observe any and all final calibrations and commissioning. Should such courtesy not be extended to the Engineer prior to the final calibrations and commissioning, the Engineer reserves the right for the procedures to be completely repeated prior to considering job completion.

3.4. WORK COMPLETION

- A. The Contractor shall provide a complete and functioning system, based on the design intent set forth in these Construction Documents. Any and all equipment, either implied or intentionally omitted from these documents, but generally accepted as being required for the completion of the installation, as represented in these Construction Documents, shall be provided by the Contractor at no additional cost to the Owner.
- B. Each system component shall be individually tested, as well as tested in the complete system configuration, to assure 100% operability of each device, and compatibility of all components. All products and system configurations will be fully tested and operational prior to final payment.
- C. Contractor shall verify and produce documentation that every Sound Reinforcement system does not experience interference from every other Sound Reinforcement system.
- D. The Contractor shall provide a copy of all testing documentation to the Owner at the time of system commissioning and training.
- E. System Commissioning, including testing and certifications, shall be completed by a factory authorized representative prior to final payment. Said representative shall be fully certified by the manufacturer, and not simply an employee of the Contractor relying upon the Contractor's company certifications. All system operation or installation deficiencies shall be documented and submitted to the Owner at time of commissioning and shall be resolved prior to final training and final payment. Final payment shall be held until such time that final commissioning and training is completed to the satisfaction of the Owner and Engineer.
- F. The Contractor shall give a two week notice to the Engineer and Owner prior to system commissioning. The Engineer and Owner reserve the right to be present during the commissioning process to approve system configurations prior to the final punch list.
- G. Complete As-Built documentation shall be a pre-requisite for consideration of job completeness.

3.5. TRAINING

- A. Provide training for each unique system.

- B. Include hands-on demonstrations covering typical uses of the system in day-to-day operations.
- C. Including how to set up system presets for different events.
- D. Provide a condensed (Quick Reference Guide) of no more than two pages for each room to serve as a system operation "cheat sheet".
- E. The Contractor shall utilize a formal sign in sheet that shall be included with the as-built documentation.
- F. Provide personnel twenty (20) hours training for their personnel on the operation, programming and maintenance of the interactive audio-video equipment. 60% of the training shall be done immediately after completion, with 20% to be done within 30 days of completion, and the remaining 20% done in the third month.
- G. Provide two (2) digital video copies of all training.

3.6. WARRANTY

- A. Warranty of the system, including parts and on-site labor, shall be provided by the Contractor for all materials and workmanship for a period of one (1) year, or for the duration of the manufacturer's documented warranty whichever is greater. Should for some unforeseeable reason, the installer not be able to complete the term of the warranty, the manufacturer shall bear the complete responsibility of the warranty for both parts and labor and shall appoint a certified service organization to complete the term of the warranty. The manufacturer shall inform the Owner of this appointment in writing. The Contractor shall present assurance of this stipulation from the Manufacturer to the Owner, in writing prior to commencement of work. Should the Contractor not provide this written assurance, the Owner shall retain the right, as outlined elsewhere in these Documents, to obtain satisfaction, including but not limited to, financial restitution to the Owner.
- B. The warranty period shall begin after substantial completion of all work, including Technology Bid Package systems, at which time, the installer shall provide service within a 48-hour period after notice by the Owner, for the duration of the warranty.

END OF SECTION 274100.00

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SECTION 274101.00 - AUDIO AND VIDEO SYSTEMS CABLING

PART 1 GENERAL

1.1. SUBMITTALS

- A. Product Data:
- B. Bill of Materials
 - 1. Separate list for each system.
 - 2. List to identify the signal format the cable will be used to transport.

1.2. SUMMARY

- A. Section Includes:
 - 1. Cables for the interconnection of audio and video equipment, and related control system products.
 - 2. Standards-of-practice by which products are to be installed and tested.
- B. Related requirements:
 - 1. Section 271513 "Copper Horizontal Cabling" for intra-building, four-pair twisted pair cabling and patch panel termination hardware, including channel rated performance and applications warranty.
 - 2. Section 274100 "Audio and Video Systems."

1.3. REFERENCES:

- A. Comply with standards set forth in 27 00 01 - Common Work Results for Communications: References.

1.4. QUALITY ASSURANCE

- A. Comply with Section 270002 "Quality Assurance for Communications."

PART 2 PRODUCTS

2.1. GENERAL

- A. Refer to the related drawings and specifications to determine the quantity, quality, and performance of products to be furnished. The cables provided as work of this section are fully dependent upon them.
- B. Consult with the manufacturers of the equipment to be interconnected to further determine the quantity, quality, and performance of cable required.

- C. Where the manufacturer of the product being interconnected requires cable featuring more stringent requirements than those identified in this Section, provide cable meeting the more stringent requirements.
- D. Brands and models listed represent the Basis-of-Design and standard of quality for the identified cables. The use of any product other than a Basis-of-Design product in this Section is considered a substitution. These products must include the operational characteristics equal to or greater than the Basis-of-Design.

2.2. FIXED INSTALLATION CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following manufacturers:
 - 1. Belden
 - 2. Liberty Wire and Cable.
 - 3. West Penn Wire.
 - 4. Windy City Wire
- B. General Requirements:
 - 1. Fixed installation cables shall be UL Listed and NEC type acceptable for the location, application and manner of installation.
 - 2. Cables shall meet NEC 300-volt rating, higher where otherwise specified.
 - 3. Cable supplied to satisfy the requirements of a specified cable type shall be as manufactured from a single manufacturer except as otherwise approved by the Designer (e.g. all RG-6 non-plenum analog video cable shall be from single manufacturer).
 - 4. Within a building, cables that are not installed in a totally enclosed pathway system shall be UL plenum rated.
 - 5. Cables used for below grade applications, in-grade floor boxes, and cables used in pathways that may reasonably end up with standing water within them, shall be manufacturer rated for continuous contact with water without performance degradation or compromise in warranty.
- C. Video:
 - 1. HDMI:
 - a. HDMI version 2.0 or greater.
 - b. Resolution and Refresh Rate: $\geq 4096 \times 2160 @ 60 \text{ Hz}$.
 - c. Chroma Sampling: 4:4:4.
 - d. Bit Depth per Color: $\geq 8 \text{ bit}$.
 - e. Data Rate: 18.0 Gbps.
 - 2. DisplayPort:
 - a. DisplayPort version 1.4 or greater.
 - b. Resolution and Refresh Rate: $\geq 4096 \times 2160 @ 60 \text{ Hz}$.

- c. Chroma Sampling: 4:4:4.
 - d. Bit Depth per Color: ≥ 8 bit.
 - e. Data Rate: 21.6 Gbps.
 - 3. USB:
 - a. USB 3.0 Compliant
 - b. Data Rate: 4.8 Gbps
- D. Twisted Pair Cable for Audio/Visual Transport
 - 1. Furnish cable compliant with Section 271513 "Copper Horizontal Cabling"
 - 2. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Manufacturers listed in 271513 "Copper Horizontal Cabling".
 - b. Crestron
 - c. Extron
 - 3. General:
 - a. General Performance: Comply with referenced transmission standards when testing according to test procedures of this standard.
 - 1) Twisted pair cable is required to have the appropriate Category classification as defined by referenced standards. Compliance with these electrical characteristics shall be third party verified by the manufacturer.
 - b. Where applicable, provide the manufacturer recommended cable for the products being interconnected.
- E. Audio, Speaker Level:
 - 1. General:
 - a. Where wire gauge is not specified on the drawings, calculate based on the following requirements:
 - 1) Line loss shall not exceed 2.00 dB.
 - 2) Equation used to calculate the data:
$$P_{loss} = 10 * \text{Log} (1 - ((2 * RL) / (2 * RL + (V_{line}^2 / P_{rated})))$$

$$RL = (R_{ref} / 1000) * D$$

Where:
D = length of wire used
P_{loss} = power loss in dB
P_{rated} = power driven on line
RL = wire gauge resistance
V_{line} = voltage on line
 - 2. 10-Gauge: (n/a)
 - a. Single pair cable with overall jacket.
 - b. Conductors: IOAWG (x 2), bare copper, stranded.
 - c. Nominal diameter: .302 inches.

- d. DCR @ 20 deg C: 1.07 Ohms/1000 feet.
 - e. Capacitance: 28 pF/ft.
 - 3. 12-Gauge: (n/a)
 - a. Single pair cable with overall jacket.
 - b. Conductors: 12AWG (x 2), bare copper, stranded.
 - c. Nominal diameter: .252 inches.
 - d. DCR @ 20 deg C: 1.6 Ohms/1000 feet.
 - e. Capacitance: 36.0 pF/ft.
 - 4. 14-Gauge: (n/a)
 - a. Single pair cable with overall jacket.
 - b. Conductors: 14AWG (x 2), bare copper, stranded.
 - c. Nominal diameter: .210 inches.
 - d. DCR @ 20 deg C: 2.53 Ohms/1000 feet.
 - e. Capacitance: 36.0 pF/ft.
 - 5. 16-Gauge: (applicable to this project)
 - a. Single pair cable with overall jacket.
 - b. Conductors: 16AWG (x 2), bare copper, stranded.
 - c. Nominal diameter: .176 inches.
 - d. DCR @ 20 deg C: 3.8 Ohms/1000 feet.
 - e. Capacitance: 36.5 pF/ft.
 - 6. 18-Gauge: (n/a)
 - a. Single pair cable with overall jacket.
 - b. Conductors: 18AWG (x 2), bare copper, stranded.
 - c. Nominal diameter: .154 inches.
 - d. DCR @ 20 deg C: 6.5 Ohms/1000 feet.
 - e. Capacitance: 34 pF/ft.
- F. Audio, Mic/Line Level:
- 1. 22 AWG, 1 Pair, Shielded:
 - a. Single shielded pair cable with overall jacket.
 - b. Conductors: 22AWG (x 2), copper, stranded.
 - c. Shield: 100% aluminum polyester tape, 22AWG tinned copper drain wire.
 - d. Nominal diameter: .128 inches.
 - e. DCR @ 20 deg C: 16.4 Ohms/1000 feet.
 - f. Capacitance: 55 pF/ft.
 - 2. 22 AWG, 1 Pair, Shielded + 22 AWG, 2 Conductor:
 - a. Single shielded pair cable and single non-shielded pair with overall jacket.
 - b. Conductors: 22AWG (x 2), copper, stranded.
 - c. Shield: 100% aluminum polyester tape, 24AWG tinned copper drain wire.
 - d. Nominal diameter: .180 inches.

- e. DCR @ 20 deg C: 16.4 Ohms/1000 feet.
- f. Capacitance: 55 pF/ft.
- 3. 22 AWG, 2 Pair, Individually Shielded:
 - a. Two individually shielded pairs cable with overall jacket.
 - b. Conductors: 22AWG (x 4), tinned copper, stranded.
 - c. Shield: 100% aluminum polyester tape, plus single 24AWG tinned copper drain wire.
 - d. Nominal diameter: .158 inches.
 - e. DCR @ 20 deg C: 14.7 Ohms/1000 feet.
 - f. Capacitance: 34 pF/ft.
- G. Data/Network/Control:
 - 1. RS-232 1 RS-422 1 RS-485:
 - a. Single shielded pair cable and single non-shielded pair with overall jacket.
 - b. Conductors: 22AWG (x 2), copper, stranded.
 - c. Shield: 100% aluminum polyester tape, 24AWG tinned copper drain wire.
 - d. Nominal diameter: .180 inches.
 - e. DCR @ 20 deg C: 16.4 Ohms/1000 feet.
 - f. Capacitance: 55 pF/ft.
 - 2. RS-485 plus power (Specialized Media Control Networks):
 - a. Cable configuration: Shielded twisted data pair, plus one unshielded pair.
 - b. For use with products requiring combination power and RS485 data interconnections using a single jacketed cable solution. Sample applicable networks include: Crestron Cresnet™, Biamp Remote Control Bus, Lutron GRAFIK Eye@ control bus, and similar RS485 based remote control networks.
 - c. Data conductors: 22AWG, tinned stranded copper, paired.
 - d. Power conductors: 18AWG, tinned stranded copper, paired.
 - e. Shield: 100% aluminum polyester tape, 24AWG tinned copper drain wire.
 - f. Nominal diameter: .205 inches.
 - g. DCR — data conductors: 16.3 ohms per 1000 feet.
 - h. DCR — power conductors: 6.9 ohms per 1000 feet.
 - i. Capacitance — data conductors: 14.0 pF/ft.

2.3. FLEXIBLE / PORTABLE CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following manufacturers:
 - 1. Crestron.
 - 2. Extron.
 - 3. Liberty Wire and Cable.
 - 4. Pro Co Sound.

B. General Requirements:

1. Flexible / portable cables shall be derived from the system diagrams. Provide all products necessary for a complete and working system including those not expressly identified on the documents.
2. Cables designed and recommended by the cable manufacturer for portable and/or flexible applications shall be furnished for such applications.
3. Individual conductors shall be stranded in lieu of solid. Shields shall be braided in lieu of foil only, or foil and drain wire construction.
4. Flexible / portable cables shall be provided wherever cables are exposed to flexing as a natural by-product of their use. This includes cables furnished expressly for "portable" applications as well as furnished for permanent installation but are routinely exposed to flexing as an inherent consequence of their normal use. This overriding flexible requirement does not apply to cables used in tethers that are subject to flexing less than once per year and the flexing occurs to allow access for servicing of equipment.
5. Products depicted on the drawings which are not identified by brand and model are the responsibility of the Contractor to furnish and install. The decision whether a Contractor selected product is acceptable remains with the Designer.

2.4. CONNECTORS

A. Video Connectors:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Belden.
 - b. Liberty Wire and Cable.
 - c. West Penn Wire.
 - d. Windy City Wire
2. 12G-SDI / HD-SDI:
 - a. Connectors shall match the impedance of the cable being terminated.
 - b. Cable connector combination shall allow for a mechanical retention strength of 40 pounds.
 - c. Provide I-piece compression connector.

B. Audio Connectors:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Canare Cable.
 - b. Liberty Wire and Cable.
 - c. Mogami Cable.
 - d. Neutrik.
 - e. Pro Co Sound.

- C. Twisted pair Termination Devices:
1. Furnish =cable compliant with Section 271513 "Copper Horizontal Cabling"
 2. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Manufacturers listed in 271513 "Copper Horizontal Cabling".
 - b. Crestron
 - c. Extron
 3. General:
 - a. General Performance: Comply with referenced transmission standards when testing according to test procedures of this standard.
 - 1) Twisted pair cable is required to have the appropriate Category classification as defined by referenced standards. Compliance with these electrical characteristics shall be third party verified by the manufacturer.
 - b. Provide the manufacturer recommended termination devices for the cable provided.

PART 3 EXECUTION

3.1. CABLE UTILIZATION

- A. General:
1. Where the Contract Documents identify only a general classification of product, the guidelines set forth in these specifications shall be used to determine the cable products to be provided.
 2. Where the Contract Documents, including the drawings and related specification do not identify a specific model or classification of product, the guidelines set forth within these specifications in conjunction with recommendations from the manufacturers of the interconnected equipment, and published industry standards and "best practices" shall be used to determine the appropriate product to be provided.
 3. Cable that is technically appropriate for the application shall be provided. Cables shall be classified by the manufacturer, in publicly available documents, for their intended use. For example, a cable used for RS232 signals shall be published as rated for RS232 applications. Furthermore, the model provided shall be technically sufficient for the length in which it is used.
 4. Provide cable models that are code compliant for the location, use, and method of installation. This includes, but is not limited to, providing plenum-rated cables wherever plenum cables are required by Code.
 5. Provide cable that is designed for portable use when the cable may be used in a portable application.

6. Provide cable that is designed and manufactured to endure routine flexing when, by system design, the cable may be exposed to routine flexing.
 7. Provide cable models that are designed by the manufacturer for direct burial applications when the cable may come in contact with soil.
 8. Provide cable that allows required system performance to be achieved.
- B. Speaker Cables:
1. Where the use of a specific cable is identified on the drawings, the identified cable shall be provided for the scope identified.
 2. Where the use of a specific cable is not identified on the drawings, cables shall be chosen to achieve no more than 1dB of total power loss in the circuit.
 3. The minimum gauge of speaker cable that may be used in any one-way "constant voltage" speaker circuit shall be 18AWG.
 4. The minimum gauge of speaker cable that may be used in any one-way "low impedance" speaker circuit (2-16 ohms) shall be 16AWG.
 5. Speaker cables used for bi-directional (i.e., two-way) intercommunications shall be shielded and twisted pair type cable.
- C. Data, Serial, Parallel, and Control Cables:
1. Provide cables that are designed and rated by the manufacturer for the format of signal that the supplied cable will be used to transport.
 2. The technical specifications of the cables shall be suitable for the length in which it is used, as well as capable of achieving error-free transmission of the signal at the fastest communication rate supported by the products ultimately being interconnected.
- D. RF Communications:
1. Where RF frequencies are to be transported, provide cables that are designed by the cable manufacturer to transport the frequency range, the voltage and the current that is transported.
 2. Provide cables that are sufficiently shielded to comply with FCC regulations, sufficient to prevent ingress and egress interference that adversely affects the system in which the cable is used, and sufficient to prevent egress interference that adversely affects other equipment and systems.
- E. Low Voltage Power Cables:
1. Provided cables that are used for low-voltage power (g 70.7 RMS and 100 Peak) shall be of sufficient gauge to achieve each of the following:
 - a. 5% maximum voltage drop between the power source and the load.
 - b. 18AWG if the cable will transport > 500ma or its length exceeds 20 feet.
 - c. 20AWG if the cable will transport 500ma and its length is than 20 feet.
 - d. Deliver voltage to the load that is not less than the minimum rated input voltage for the load.

F. Water blocked Cables:

1. Water blocked versions of cables shall be provided when:
 - a. The cable may be exposed to water.
 - b. The cable is installed outdoors.
 - c. The cable is installed below grade.
 - d. The cable is installed within conduit within a concrete slab that is above or below grade, and which there are one or more pull-boxes, junction boxes or other device boxes within the concrete slab along the path of the conduit.

3.2. INSTALLATION

A. Non-Plenum Cable in Plenum Areas:

1. Where non-plenum cable is supplied and code-compliant installation requires a plenum rating, provide a code-compliant pathway to enclose the cable.

B. Wiring Within Enclosures:

1. Provide adequate length of conductors. Bundle, lace, and train the conductors to terminal points and achieve clean service loops of appropriate length to the application.
2. Provide maximum possible physical isolation between cables of different operating levels to prevent crosstalk interference that degrades the performance or usability of the system.
3. Replace, reroute, and redress cables that receive or cause negative interference of any form.

C. Splices, Taps, and Terminations:

1. Install cables continuous and without splices, intermediate connections or terminations between products, except where expressly required by the Contract Documents.
2. When required by the Contract Documents, splices, taps and terminations shall be made within an UL rated enclosure. In addition:
 - a. Cables shall be joined using standardized inline connectors of the type and rating compatible with and approved by the Designer in advance for use with the cable and signal types being spliced.
 - b. Wire nuts are not permitted.

D. Drain wire and shield preparation:

1. Non-insulated conductors (e.g., shields and drain wires) that are a part of a multiconductor cable shall be individually insulated where the conductor exits the cable jacket. The conductor shall be covered with flexible high-temperature heat-shrinkable tubing of a size appropriate to the conductor.
 - a. Green color tubing shall be used except where it conflicts with another conductor's color within the same cable. Clear and white tubing (listed in order

of preference) shall be used as necessary to maintain a non-conflicting conductor level color code.

2. When a drain wire or shield conductor is insulated with tubing, as identified above, an additional piece of flexible high-temperature heat-shrinkable tubing shall also be installed over a portion of the cable jacket and the individual conductors where the individual conductors exit the cable jacket. This additional covering shall both insulate the remaining exposed portion of the shield/drain wire conductor and protect it to reduce the risk that this conductor can be bent easier than the manufacturer insulated conductors.

E. Signal Cable Grounding and Bonding:

1. As a matter of practice, non-signal carrying, and non-power passing shield and drain conductors shall be bonded to ground at one end only. The opposite end of the conductor shall be left floating. The shield shall be bonded at the signal sync (load, input) end of the cable. This practice shall be employed to reduce the risks of ground loops between the various interconnected audio components.
2. Unterminated shields and drain wires shall not be cut off. Instead, these conductors shall be insulated and prepped for termination and then folded back, protected and secured to the side of the cable jacket or stowed inside the connector shell (where space permits). These conductors shall remain intact and reserved for future and selective use when more challenging ground loop anomalies need to be remediated with the system.
3. Alternate means of handling signal cable shield bonding may be considered when a well documented grounding and bonding scheme has been submitted for review.

F. Cable Separation:

1. Cables carrying different signal types shall be kept separate to prevent interference between cables.
2. Cables carrying similar signal types but at different nominal operating levels shall be kept separate to prevent interference between cables.
3. Cables from different systems shall be kept separate to better organize and identify systems as well as to prevent interference between systems.

G. Strain Relief:

1. Cables that are subject to changes in mechanical stress, and, especially those that are used in portable applications, shall be equipped with strain relief.
2. Cables that are probable to connect and disconnect more than once per year shall be equipped with strain relief at each end of the cable.
3. Conductors of cables shall not be exposed to any stress that could deteriorate either the mechanical or electrical integrity of the physical connection between the cable conductor and the connector to which it is attached.

H. Cable Management and Support:

1. Install cables in a neat and organized manner.

2. Route cables parallel to the product in which they are located.
 3. Secure cables to wire management products using reusable hook-and-loop type fasteners.
 4. Do not use nylon cable ties and other fasteners that pinch and stress cables.
 5. Provide cable fasteners that are code compliant for the location and manner of installation.
 6. Do not bend cables to a radius that is less than 8-times the cable diameter, nor less than the cable manufacturer's recommended minimum radius.
- I. Flexible Cable Management and Support:
1. Provide expandable flexible sleeving:
 - a. Over bundles of two or more cables that have at least one end connected to movable / portable equipment.
 2. Provide flexible strain relief:
 - a. Install strain relief products at each end of flexible cable assemblies so that no consequential strain is applied to a signal carrying component of the assembly nor to any connector or terminal to which the assembly interconnects. Size the strain relief to suite the assembly size. Provide an anchor for attachment of the strain relief and ensure that the anchor is attached to a sound structure that will not be damaged if strain is applied.

3.3. IDENTIFICATION

- A. Comply with Section 270553 "Identification for Communications."
- B. Provide identification of each end of cables. Nomenclature shall be clearly visible and accurately recorded on the as-built drawings.
- C. Use color-coded conductors, color-coded heat-shrink and color-coded permanent adhesive tape to designate individual conductors and cable unit. Record the color code on the as-built drawings.

3.4. TESTING

- A. Perform tests of cables after installation to confirm that each is performing effectively as an integral part of the system in which it is used. Test individual cable channels to confirm continued compliance with the Contract Documents and manufacturer's published specifications.

3.5. FIRESTOPPING

- A. Comply with Section 270550 "Firestopping for Communications."

END OF SECTION 274101.00

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SECTION 274103.00 - AUDIO AND VIDEO SYSTEMS SOFTWARE DEVELOPMENT

PART 1 GENERAL

1.1. SUBMITTALS

A. Control and DSP Programming:

1. Prior to the pre-construction meeting (described below), submit for review the initial DSP and control programs. Programs shall include the following at a minimum:
 - a. DSP
 - 1) Preliminary program structure including all expected blocks for the system.
 - 2) Speaker voicing based on manufacturer specifications.
 - 3) Appropriate Gain structure based on inputs as shown on plans.
 - 4) Control logic.
 - 5) Preliminary touch-panel layouts if DSP will be used for control.
 - b. Control System
 - 1) Preliminary program structure including all components for equipment that will be controlled by the system.
 - 2) Preliminary touch-panel layouts.

B. Qualifications:

1. Programmer qualifications (see Quality Assurance).

C. Closeout:

1. Electronic Documentation:
 - a. "Copyright, Ownership and Licensing Declaration" as described elsewhere in this Section, PDF version.
 - b. Storyboarding / flowcharting documentation, PDF version.
 - c. Software source code files.
 - d. Touch panel and other graphical user interface source code files.
 - e. Compiled graphics files.
 - f. Editable layered graphics files for Project specific custom graphics.
 - g. Current-version device drivers for controlled devices.
 - h. Controlled-device protocol documentation.

1.2. REVIEW MEETINGS

A. Pre-Construction Review

1. Prior to commencing on-site construction, the contractor shall attend a meeting with the designer to review the client expectations and system design considerations. The meeting shall not be scheduled without reviewed submittals including the reviewed program submittal described above. At a minimum, the project manager and system

programmer for the contractor shall be present. This meeting shall not exceed four (4) hours in length and will cover the following topics at a minimum:

- a. DSP structure and programming.
- b. Control panel design.
- c. Staff qualifications.
- d. Testing and balancing materials and methods.

B. Post-Construction Review

1. Upon substantial completion of the system, the contractor shall meet on-site and demonstrate the operation of the system to KLH personnel for review. KLH will review the operation of the system based on the system drawings and the Pre-Construction meeting to ensure the system adheres to the design intent. The system should be fully tested and tuned prior to scheduling this review. This review shall not exceed four (4) hours in length.

1.3. PRICE AND PAYMENT PROCEDURES

A. Payment Procedures:

1. Requests for payment for Work will not be considered until Phases 1, 2 and 3 of the software development has been completed.
2. Progress payments for shall not be considered without electronic submission of Work progress. See also "Penalties for Non-Performance."

1.4. REFERENCES

- A. InfoComm International's publications: "Modern Approaches to Control Systems Design", <http://www.infocomm.org/>.

1.5. DEFINITIONS

- A. Controlled Device: A product with which the Software communicates. A controlled device is a physical or software-based product that receives commands/data from, or sends commands/messages/data to, the Software.
- B. IR: Infra-Red.
- C. GUI: Graphical User Interface.
- D. User Interface: Any physical or software-based product, custom or standard, that connects to and/or communicates with the control system and Software for the purpose of providing interactive interface between a system user and the Software.
- E. Software Developer: The entity responsible for performing Work of this Section.

1.6. QUALITY ASSURANCE

- A. Comply with Section 270002 "Quality Assurance for Communications."
- B. Programmer Qualifications:
 - 1. Control Systems:
 - a. Manufacturer Certified Programmer. Certification shall be, at minimum, equivalent to Crestron Master Certified — Silver Level.
 - b. Resume of 20 programs or 5 years full-time computer programming experience.
 - 2. Shall be a full-time employee of the company providing the Division 27 41 00.00 work. Programing subcontractors are not permitted.

1.7. SOFTWARE LICENSING AND OWNERSHIP

- A. Supply a perpetual, irrevocable and royalty-free global license to use Software Work.
- B. Grant to the Owner the following number of licenses:
 - 1. One for each Audio and/or Video system identified in these Contract Documents.
- C. Source Code:
 - 1. Furnish fully editable source code for each processor, user interfaces and other control electronics.
 - 2. Layered electronic graphics files shall be furnished for user interface graphics.
- D. Rights to Modify Source Code:
 - 1. The Owner shall have the right to view and modify the source code and other files supplied. The Owner shall have the right to change the Software in any way it deems necessary, including but not limited to the right to evolve the Software to accommodate equipment changes, additions, deletions, or functional changes to the system.
- E. Payment of Licensing Fees:
 - 1. The Software Developer is responsible for properly licensing and making payment for any Software modules and graphics incorporated into Software Work, including license fees arising from the use of any part of software furnished by the Owner for the Software Developer's benefit in creating Software Work.
- F. Copyright, Ownership and Licensing Declaration:
 - 1. In the event the Software Developer incorporates copyrighted work from any third-party entity into the Software Work, the Software Developer shall declare the lawful copyright holder and include valid contact information for the entity.
- G. Non-Disclosure:
 - 1. The name of the Owner may not be used in any advertisements, publications, lectures or any other public medium as it relates to the Software Developer's role in creating this Software Work.
 - 2. The Software Developer may not reuse or demonstrate Software Work or any portion thereof that includes the name of the Owner, references to the Owner, copyrighted

material obtained from the Owner, or any other trade or service mark that could identify the Owner.

3. Should the Software Developer desire the right to publicly reference the Owner in any way, including demonstration of Software Work to others, the Software Developer shall obtain the express permission from the Owner, in writing.

1.8. WARRANTY

- A. Software furnished shall be warranted for a period of 365 days following final acceptance of the Software Work.
- B. During the warranty period, the resources necessary to resolve Software bugs shall be provided at no cost to the Owner. Software bugs that are catastrophic in nature shall be resolved within 3 business days following their report to the Software Developer by the Owner. Non catastrophic bugs shall be resolved within 5 business days.
- C. Software bugs are defined as:
 1. Any Software feature, operation, behavior, or mode that makes the system unstable or operationally unusable for the Owner's intended use of the system.
 2. The absence of any Software feature, operation, behavior, or mode determined necessary during the Software development phases that has not been implemented, not implemented completely, or not implemented reliably.
 3. Any Software feature that does not perform in the manner agreed to by the Owner's representative, or that otherwise performs in a manner that is counter-productive to the task to be performed by the Control System.
 4. The absence from the Software of any feature, operation, behavior, or mode expressly identified in the Contract Documents and not otherwise expressly removed from the Project scope in writing by the Designer.
 5. Incorrect labeling or misspelling of text on a programmable user interface.

1.9. MAINTENANCE

- A. Following final acceptance of the Software, the Software Developer shall return to the Project site at planned 30, 90 and 180-day intervals to make minor adjustments to the Software. The Software Developer shall contact the Owner at each interval to determine what, if any, Software adjustments are necessary. The Owner reserves the right to use these visits any time during the warranty period.

PART 2 FUNCTIONALITY

2.1. GENERAL

- A. This Section is not a programming Manual. In general, this Section describes the capabilities and functionality expected of the Software product used to control related AV systems. The

- Software Developer shall be fluent in programming skills and well versed and experienced with the operational and programming needs of systems of the size, type, and complexity as those for which the Software is to be developed.
- B. This Section applies to multiple systems. Due to the presence of different equipment in each system, and the possible use of equipment with various capabilities, functionality described herein may not be completely possible with each system.
 - 1. Example: An AV system without remote controllable audio equipment shall not be required to have Software written with audio control capability unless express written direction to the contrary is identified.
 - C. System functionality that is described in related Sections and Drawings that can only be achieved using custom Software are additive to the requirements of this Section. Review related Sections and Drawings.
 - D. Due to the differences between products, including differences between products of like type, no attempt has been made to enumerate every remote-control function, operation and behavior that shall be accommodated by the Software.
 - E. Functions described in the Contract Documents may not directly be available on the product being controlled. In such cases, functionality shall be achieved through development of suitable Software modules (e.g., intelligent macro) to achieve the desired effect. In select cases, the Designer or Owner may conclude the function is no longer required:
 - 1. Example: A motorized drapery or screen may not have an inherent "Preset" function. Therefore, a preset function may need to be emulated in the Software by timing the motor to run for a defined duration from a known position.
 - F. Functionality and behaviors articulated in the Contract Documents are requirements of the Software Work until or unless otherwise modified and agreed to, in writing, with the Owner's Representative.

2.2. PERFORMANCE

- A. The Software performance shall be robust, predictable, reliable and stable.
- B. User interfaces shall accurately reflect the state of the system and controlled devices.
- C. Normal use of the system, including new-user encounters with the system, shall not result in a lock up of any portion of the system.
- D. System operation shall be restored to normal following a power failure to any controlled component or a control component. System and personnel-safe conditions shall be ensured by the Software following such conditions.
- E. The Software shall perform to the satisfaction of the Owner's representative.

2.3. SOFTWARE-AWARE PROGRAMMING

- A. The Software shall employ a coding methodology herein referred to as "Software-Aware programming."
 - 1. Software shall be aware of and locally buffer the status of the properties of a controlled device. This shall be true regardless of whether the settings of a controlled device are changed by this Software via a device's local user interface, an external Software interface, a third-party software application, or by other means.
 - a. Example 1: If a projector input is changed, the Software shall be aware of the current projector input change.
 - b. Example 2: If the program audio gain is changed using a third-party client application, the Software shall be aware of the current gain value.
 - c. Example 3: If a user presses play on a Blu-ray player, the Software shall be aware that the Blu-ray player is playing.
 - 2. Software shall be aware of the current settings of controlled devices that are material to achieving accurate, responsive, and repeatable AV System performance under Software control.
 - 3. The Software shall leverage up-to-date information of the status of a device to achieve expedient and accurate logic decisions.
 - 4. Software user interface shall accurately represent the state of a device when the associated device status display is visible.
 - 5. Software decisions shall be made reliably, without having to routinely query a controlled device for a response immediately before taking the next logical step.
 - 6. Software Aware programming shall not rely on real-time on-demand polling for making routine logic decisions.
- B. In Software Aware programming, the Software shall not send commands to a controlled device to perform an action that the controlled device is already performing.
 - 1. Example 1: If a video projector needs to be on Input 1 in order to display the most recent source selection, and if the projector is on Input 1 at the time the source selection is made, then the projector shall not be sent a command to change inputs, since it is already on the one it needs to be on. Conversely, if the projector had been changed to Input 2 (by the Software or other means), then the projector shall be switched to Input 1.
 - a. In this example, commanding the projector to switch to an input that is already active may cause video resynchronization which may result in a blank screen, flickering or other unnecessary and undesirable visual effects. It may also slow the responsiveness and performance of the system.
 - 2. Example 2: If a matrix already has Input 12 assigned to Output 14, the matrix shall not be sent a command to assign Input 12 to Output 14. Doing so may slow down the responsiveness and performance of the system.
- C. Software Aware programming requires a strategic mix of the following techniques:
 - 1. Querying a controlled device to obtain critical device status properties.

2. Querying controlled devices in the background, in a controlled manner, when the user is not actively making changes to the system.
 3. Monitoring and processing events and command acknowledgements of a controlled device software.
 4. Processing status messages received from controlled devices.
 5. Buffering device properties locally, within the control system hardware using arrays, objects, buffers, and modules.
 6. Highly modular, flexible and professional Software coding techniques.
- D. In Software Aware programming, a two-way touch panel shall accurately display settings of a selected device immediately when the device control page is activated. One second (or longer) delays while the Software queries the device and then processes and reports the status to the user shall not be acceptable.
- E. Software Aware programming requires advanced programming skills and experience.
- F. Appropriately employed, Software Aware programming techniques shall result in Software performance that is robust, responsive, familiar, fast performing and does not result in Software induced, Software preventable aural or visual glitches.
- G. User interfaces that are part of a Software Aware programming solution shall be highly responsive to user stimulus to such an extent that users are not inclined to execute a command a second time because of a lack of user interface responsiveness.

2.4. USER INTERFACE FEEDBACK

A. General:

1. Implement controllable feedback on user interfaces (i.e., sound, lights and color change) as a means to achieve the following:
 - a. Supply an immediate acknowledgement to the user that the command has been received. Examples include the following:
 - 1) Changing the color of a button immediately in response to the user touching the button.
 - 2) Playing a sound in response to the user touching the button.
 - b. Supply immediate responses to the user to indicate the status of the command request. Examples include the following:
 - 1) Illuminating a power indicator "Green" when a device is powered up and ready for use.
 - 2) Illuminating a power indicator "Red" when a device is powered down and available to be power back on.
 - 3) Illuminating a power indicator "Flashing Red" when a device is in process of powering down.
 - 4) Illuminating a power indicator "Flashing Yellow" when an operation is in process.

- 5) Displaying a progress bar while device is powering up and down and if this information is necessarily material to the user's next actions.
2. Where the user interface capability permits, supply separate means of achieving feedback to the user. Examples include the following:
 - a. Use a temporary button color change as an acknowledgement that the button has been pressed and was acknowledged by the system.
 - b. Use LED-like indicators to communicate device status.
- B. Managed Feedback:
 1. Feedback reporting shall be accurate and appropriate for the device(s) under control, including reporting of status changes that occur through direct interaction with a controlled device or other means.
 - a. Example 1: If the user makes a manual signal routing change via the control panel on a matrix, the Software shall monitor the matrix's events, or controlled background querying, to be aware of the change so it can be correctly reported to the user interface.
 - b. Example 2: If the user hits play directly on a media player, the Software shall be aware of the change and correctly report that the media player is playing.
 2. When status information returned from a device to the Software is delivered slowly, (not fast enough to directly deliver an immediate response to the user) then a hybrid feedback solution shall be implemented. The hybrid solution shall result in immediate feedback to the user acknowledging their action, followed by command status feedback to advise the status of the request.
 - a. Example Situation: A lighting system takes 3 seconds to acknowledge a successful change from "Preset 1" to "Preset 3" following a user's command to change.
 - 1) Example Solution:
 - a) Step 1: The "Preset 3" button immediately changes colors while it is being pressed as a means for the Software to acknowledge it has received the command. The button returns to normal color after the user's finger is removed from the button.
 - b) Step 2: The Software initiates the request of the lighting system to change presets, and immediately begins to flash the "Preset 3" status indicator.
 - c) Step 3: The "Preset 3" status indicator illuminates solid on when the lighting system completes the transition to "Preset 3."
 - b. Example Situation: A video projector takes 30 seconds to warm up, does not supply a warming-up status message, and does not acknowledge that it is On until after it is fully warmed up and ready for use:
 - c. Example Solution 1:
 - 1) Turn off the Power Off indicator and immediately begin flashing the projector Power On indicator.

- 2) Once the projector acknowledges that it is On, change the projector Power On indicator from flashing to constant.
 - d. Example Solution 2:
 - 1) Use a progress bar or similar control that communicates that the projector is warming up, incrementing the bar to emulate the warming process. Hide the progress bar, turn on the projector Power On indicator and turn off the projector Power Off indicator once the projector acknowledges it is On.
 - e. The manner in which hybrid solutions are deployed in the Software shall be as consistent as technically possible throughout the Software.
- C. Infra-Red (IR) Controlled Devices:
- D. Supply emulated status information for one-way controlled devices that do not otherwise supply status feedback. Review logic options with the Owner's representative. In select cases, momentary feedback may be acceptable.

2.5. CONTROL METHODOLOGY

- A. To enhance overall Software performance, bi-directional communication control methods shall be used with controlled devices wherever possible in order to take advantage of device status information. Common bi-directional communication control methods include:
1. RS232.
 2. RS485.
 3. RS422.
 4. TCP/IP.
- B. Single direction communication control methods shall be used only where expressly specified or where it is the only method of control available on a specified product.
- C. Hybrid / Dual-Control communication methods shall be used when required functionality cannot be achieved through a single communication port. Such may be the case in a product that can achieve 98% of the desired functionality via its RS232 port, and the remaining functions are only available on an IR port. Hybrid methods shall be used as necessary to improve the stability and robustness of the Software application.

2.6. USE OF PRESETS OR MACROS

- A. The Software shall not use preset or macro functions of a controlled device if:
1. Use results in system performance that is slower than it would be if the applicable settings on the device were managed directly by the Software
 2. Use results in the loss of video or audio at any critical point in the system.
 3. Use results in any perceptible video or audio artifacts.
 4. Use results in negative effects on the system use or performance.
 5. Use results in any undesirable level or signal routing changes.

- B. Research the use of controlled-device presets or macros to obtain a thorough understanding of impact on the system performance. Use of presets and macros requires review and authorization of the Designer.

2.7. BEHAVIORS

A. General:

- 1. The Software shall be written to include behaviors that would be considered familiar (i.e., intuitive) to the system users. Such familiarity may be derived from interaction with various other real-world interfaces such as personal computers, car radios, IPODs™, microwave ovens, home entertainment equipment or other products.

B. User Interfaces:

- 1. User interface designs shall employ navigational schemes that limit the number of steps and interface layers that a user must navigate in order to perform a desired action. The more frequent a command must be executed in real-world use, the fewer actions the user shall be required to take in order to achieve the goal.
- 2. One of the major objectives of Software user-interface design is to enable simple control of otherwise complex systems.

C. Audio Breakaway and Audio-Lock:

- 1. Software shall incorporate functionality that permits the user to achieve the following:
 - a. Listen to audio from a multi-media (i.e., program) source without the necessity of having a video display powered on.
 - 1) Example: Listen to music or a lecture from audio-only media.
 - b. Listen to audio from a multi-media (program) source, while viewing the video from a different source:
 - c. Example: Listen to audio from a PC, while displaying video from a document camera.
- 2. AV systems with two or more video displays (used for audience/participant viewing), Software shall include the ability to listen to the audio from either (but not both) of the visible multi-media sources.
- 3. When changing the active multi-media source, audio switching shall function, by default, as an audio-follow-video switch, whereby a change in the video source, also results in a corresponding audio switch as well.
- 4. In addition, an on-demand Audio-Lock feature shall be implemented to achieve the following:
 - a. Stop subsequent audio-follow-video switching.
 - b. Continued manual audio source assignment.

D. Multi-Level Multi-Media Source Selection:

- 1. When user-interfaces featuring Graphical User Interface capability (i.e., touch panels) are used, and the user interface layout includes an approved two (or more) level

approach to multi-media source selection, the Software shall include behavior that does not require the user to make a subsequent selection on the lowest level menu, unless the desired selection differs from the last selection.

- a. Example: A level-one source select menu is implemented with the following choices: PC, Laptop, Doc Cam, Blu-ray, and Floor Pocket. The Floor Pocket has four (4) inputs. Touching the Floor Pocket source selection exposes a level-two source select menu that includes each of the four (4) floor pocket inputs. When the level-one Floor Pocket button is pressed, the level-two menu shall appear, the last used floor pocket input shall be active, and the signal associated with the last selected floor pocket input shall be routed to the associated display. The user shall not be required to make a level-two choice, unless it differs from the last selection. The act of pressing the Floor Pocket source select button therefore shall also have the effect of making active the last floor pocket input selection.
 2. At system initiation, default assignments shall be made for level-two source selection menus.
 3. This multi-level approach shall be employed similarly to other applicable controls. Deviation from this methodology shall occur only with written approval.
- E. Video Display Power Up:
1. Audience/Participant Video Display(s) shall, by default, power up under the following conditions:
 - a. The user assigns a video enabled multi-media source to the video display.
 - b. The user manually powers up the video display.
 2. Video displays shall not automatically power up when the System is powered up, unless this feature is deemed appropriate during the Software Development review with the Owner's representative.
- F. Video Swap:
1. A video swap feature shall be implemented in systems with two or more video displays serving the audience/participants. This feature is applicable when the AV system includes the inherent capability to route video signals to each display independently. The video swap function shall re-route/swap the video images on the two displays. The swap shall be temporary. Subsequent video multi-media assignments made by the user shall route to and appear on the correct user-designated display.
 2. When a video swap is performed, the system user interface(s) shall correctly reflect the assignment.
- G. Audio Level Changes:
1. Audio level changes shall occur in real time. Audio level adjustments shall commence when a control is touched and shall cease immediately when the control is released. Audio changes shall not occur subsequent to the release of the control.

2. The rate of increase and decrease of audio settings shall be field adjusted to the satisfaction of the Owners representative. Depending upon the product being controlled, this adjustment may require that the unit of change per cycle and/or the cycle/repetition rate (among others) be modified.
 3. Bar graphs (and similar level reporting devices) shall accurately represent the relative gain of the device under control. This includes accurately displaying the gain settings anytime the bar graph is visible to the user, including immediately following a power up cycle, and following the recall of a preset or macro.
 - a. In the interest of performance, the Software Developer shall consider coding and control techniques that favor responsive control of a device by using a hybrid feedback solution while adjustments are being made. For example:
 - 1) If processing of gain status messages returned from a device causes delays in the speed at which commands to increase or decrease the level can occur, then locally emulating the level changes on the bar graph may be necessary. A subsequent release of the level control shall then be used to trigger an accurate refresh, or the bar-graph based upon the devices actual gain setting. The bar graph and actual device values shall match.
 4. Use Software variables that are readily accessible to a technician and that do not require recompiling of Software.
- H. Limited Range Controls:
1. User adjustments benefit from range limit settings. Where range limiting benefits the Owner, the Software Developer shall implement accordingly.
 - a. For example: The presenter microphone gain control may have a maximum gain that can be applied to it before acoustic feedback occurs. The same microphone may have minimum usable gain setting (e.g., one where the gain is not usable for a very loud-spoken presenter). The specific limits of the controls shall be determined in the field during system testing and demonstration with the Owner's representative.
- I. Preset Status — Correct Reporting:
1. When a device is assigned a preset / scene by use of the Software, or by other means, the Software user interfaces shall correctly report the preset / scene currently active.
 2. When either the Software user or an external user makes a manual change to a controlled device, and such change may mean that the device is no longer representing the preset I scene last selected, then the Software shall deactivate the user interface feedback that indicates the last scene selection.
 - a. For Example: If a camera is instructed to go to Preset 1 and the camera complies, then the Preset 1 status indicator shall become active. If the user subsequently manually changes a camera position, the camera is no longer at Preset 1. Therefore, the act of manual repositioning shall result in the deactivation of the Preset 1 indicator.

- J. Disable Controls Not Applicable in Current Context:
 - 1. The Software user interface shall expose only those controls that are applicable to the current context and operations. If a control has no purpose within the current context, the control shall either be hidden or systematically grayed out to indicate it is disabled, unusable and out of context.
 - a. Example 1: If an interface features three computer select buttons, and within the context of desired operation, one of the computers is in use by another room and it is (by design) not to be accessible locally, then the select button for the inaccessible computer shall be inoperable and either grayed out or hidden.
 - b. Example 2: A user interface includes source select buttons along the top of the screen. Operationally, if assigning a source requires a destination selection button to be visibly active, then if the destination button is neither active nor visible (because of another operation in process), the source select buttons shall also be disabled and grayed out or hidden.
 - c. This theme can be observed using various Microsoft Windows™ applications that gray-out selections that are not applicable in the current context.
 - 2. Disabling and/or hiding of controls shall be handled in a consistent manner throughout the Software.

2.8. DEFAULT SETTINGS

- A. Software shall ensure that controlled devices are in a known state when the system it controls is powered on, off, or placed into or taken out of standby.
 - 1. Default values shall be set when the system is powered off so that in the event the controlled system is powered up using a means other than the control system interfaces, the system shall power up to a known state.
- B. Default settings shall include, but shall not be limited to:
 - 1. Volume settings.
 - 2. Switcher / matrix settings.
 - 3. Mode settings.
 - 4. Video and audio processor settings.
 - 5. Screen positioning.
 - 6. Display status.
 - 7. Others as determined appropriate and necessary by the Software Developer and the Owner's Representative.
- C. Properly deployed default settings shall guarantee that proper settings are set in controlled devices when the system is powered on, regardless of what the settings were when the system was last used, and regardless of what setting changes may have been made locally to a controlled device by the user.
- D. Default settings shall be stored in a non-volatile memory location of the control system components.

2.9. CONTROLLED DEVICES

A. General:

1. Refer to related Sections and Drawings for identification of controlled devices.
Controlled devices include:
 - a. Control system products appearing in the Drawings.
 - b. Products appearing on control system diagrams.
 - c. Products noted on control system diagrams as being connected to or otherwise communicating with the control system.
 - d. Products appearing in system diagrams and noted as being connected to the control system.
 - e. Products noted on related Drawings.
 - f. Products identified in related Sections.
2. Following are various controlled products that may be encountered, as well as common device-specific functions that shall be performed.

B. Multi-Media Sources:

1. Blu-ray, DVD, and similar devices:
 - a. Play, Stop, Pause.
 - b. Fast-Forward, Fast Reverse.
 - c. Step-Forward, Step Reverse.
 - d. Counter-Reset.
 - e. Power On/Off.
 - f. Channel Up/Down
 - g. Discrete Channel and track selection.
 - h. Channel Display On/Off.
 - i. On-screen Display On/Off.
 - j. Closed Caption On/Off.
 - k. Menu Navigation Controls.

C. Recording Equipment:

1. Blu-ray, DVD, DVRs, NVRs
 - a. Play, Stop, Pause, Record.
 - b. Fast-Forward, Fast Reverse.
 - c. Step-Forward, Step Reverse.
 - d. Counter-Reset.
 - e. Counter/Track/Chapter Display.
 - f. Finalize/Close Disc.

- D. Video Display Equipment:
 - 1. Source selection based control.
 - 2. Manual signal routing.
 - 3. Power On/Off.
 - 4. Standby/warming-up/cooling-down messages.
 - 5. Lamp status/hours used/hours remaining.
 - 6. Video mute.
 - 7. Video freeze.
 - 8. Alignment controls.
 - 9. Menu navigation controls.
- E. Cameras:
 - 1. Pan, Tilt, Zoom.
 - 2. Storage and recall of presets, as required for the intended operation of the system:
 - a. Separate preset registers shall be implemented for each room layout.
 - b. Separate preset registers shall be implemented for each mode of camera automation as deemed necessary.
- F. Microphones:
 - 1. Software control of Status Lights/LEDs.
 - 2. Software monitoring of switch status, followed by execution of desired actions.
- G. Lighting Systems:
 - 1. Control of lighting levels of discrete lighting zones: Up, Down, Off.
 - 2. Recall of presets.
 - 3. Monitoring and display of current lighting preset(s).
 - 4. Store lighting presets.
- H. Drapes, Shades, Curtains, Screens:
 - 1. Up, Down, Open, Close, Stop.
 - 2. Recall presets.
- I. Routers and Matrices — Audio, Video, Data:
 - 1. Source/Destination based switching.
 - 2. Audio and Video breakaway switching.
 - 3. Manual switcher control.
 - 4. Input trim levels.
 - 5. Preview
- J. Switchers — Audio, Video, Data:
 - 1. Source/Destination based switching.
 - 2. Audio and Video breakaway switching.
 - 3. Manual switcher control.
 - 4. Input trim levels.

5. Seamless transition.
 6. Preview.
- K. Audio Products:
1. Gain Up/Down.
 2. Mute.
 3. Routing.
 4. Preset Recall.
 5. Macro Recall.

2.10. CAMERA AUTOMATION

- A. Systems with cameras for video teleconferencing, broadcasts, recording and similar uses shall implement camera automation modes to manage which camera(s) and camera position(s) are active based upon various criteria. Common modes that shall be accommodated in the Software include the following:
1. Push-To-Talk.
 2. Push-To-See.
 3. Automatic (gate based).
 4. Queued — First in, first out (i.e., manual "Next Question" selection).
 5. Manual Telemetry Control.
 6. Manual Preset Recall.
- B. The behavior of each mode shall be established during Software development.
- C. Camera automation shall regulate camera positioning and switching so that camera movement is not normally seen when the camera is live. This requires camera queuing and pre-positioning before the camera is made live.
- D. Visible movement from a camera shall only occur when a user manually positions a camera after it is live.
- E. Camera automation shall permit camera(s) to be taken out of service when a camera fails or is otherwise not available for use, and the remaining camera(s) shall pick up the work load of the camera(s) that are not available.
- F. The Software shall support multiple room configurations, where applicable, and shall manage separate camera selection and preset values for each configuration.

2.11. PREVIEW AND CONFIDENCE MONITORING

- A. Where the system under control is equipped with video preview and confidence monitoring equipment, the Software shall enable preview and confidence monitoring in a manner agreed to during Software development.

- B. When, where, what and how signals are triggered for monitoring shall be determined during Software development.

2.12. GLOBAL MONITORING AND CONTROL

- A. Control systems shall be programmed to communicate with, be controlled by, and supply status and statistical data to global management software, as applicable to the brand of control system hardware used on the Project. Sample applications include but are not limited to: AMX Media Manager and Crestron Room View.

2.13. HELP REQUEST

- A. User interfaces shall incorporate a "Call for Help" or similarly labeled button. This button shall be used to send an email, trigger the sending of a numeric or text page, or send a command/message to any other notification device connected to the system.
- B. The specific action taken shall be as agreed to during Software development.

2.14. HELP MESSAGES

- A. Graphical user interfaces shall incorporate the use of text-based help messages and operating instructions.
- B. Unless additional help messages are requested elsewhere in the specifications, at a minimum provide one unique pop-up style help message for each controlled device.
- C. Help messages shall be context sensitive. The message presented to the user shall be relevant to the current user interface view and mode at the time the button is activated.
- D. The manner in which the messages are activated and presented to the user shall be determined during Software development.

2.15. E-MAIL MESSAGING

- A. Software shall include provisions for sending automated email messages from the system.
- B. Up to 20 distinct email messages shall be programmable into each system.
- C. The system events that trigger messages shall be determined during Software development.

2.16. SHUTDOWN TIMERS

- A. General:
 - 1. Timers shall be implemented to shutdown select equipment or a complete system as described herein.
 - 2. Timer values shall be consistent values, stored in non-volatile memory.

3. Time-of-day shutdown timers shall include a one-time-only bypass capability, whereby the user can instruct the system to bypass the next logical shutdown event so that shutdown will not occur at the next regularly scheduled time.
 4. Prior to automatic shutdown, the Software shall present a message on the various graphical user interfaces warning of a pending system shutdown. The message shall present options to the user, including options to shut down now, ignore the shutdown event altogether, or extend/delay shut down by a fixed amount of time. The amount of the advance warning and the amount of the time delay shall be determined during Software development. Initial values shall be five (5) minutes and one (1) hour.
 5. Shutdown parameters shall be changeable by an advanced user or system administrator without the aid of a programmer. Updating these parameters shall be achieved through the use of one of the system's user interfaces, PC interface or database provided by the Software Developer.
 6. If suitable replacement timers are incorporated into global monitoring and control application, local timers may not be necessary.
- B. Visual Display Shutdown Timers:
1. Auto shutdown timers shall be programmed to place displays into standby or equivalent state, based upon various conditions. Common conditions include:
 - a. When a display has been assigned a Black or Blank source, a countdown timer shall commence that places the display into standby when the countdown timer reaches Zero.
 - b. When a predefined time of day is reached.
 2. Display shutdown timer durations shall be global; however, each display shall feature a unique timer.
- C. System Auto Shutdown:
1. Automatic system shutdown timers shall be programmed to power down the system under the following conditions:
 - a. When a user defined time of day has been reached.
 - b. After a user defined period of user interface inactivity.
 2. Two separate time-of-day shutdown timers shall be programmed. One shall be used for weekends, and one shall be used for weekdays.
 3. When a global management application is used, system auto shutdown timers may be relegated to the global management application instead of the local Software provided this is agreeable to the Owners representative.
- D. Special Circumstance Timers:
1. Where controlled devices other than those represented here are prone to excessive wear, operating or maintenance expense when left in a particular state, the Software Developer shall implement additional discrete timers adapted to the product. Software Developer shall consult with the Designer to determine which controlled devices may require special timers.

2.17. DATE, TIME, CLOCK AND TIMERS

A. Setting Date and Time:

1. The Software shall include the ability for the Owner to set the current date and time or feature an agreed upon alternate method for ensuring that the current date and time is accurate (e.g., network time server).
2. Special software or a programmer shall not be required to set these values.

B. User Interface Clock and Timer:

1. The Software shall incorporate clocks and timers on the user interfaces, visible at such locations as agreed to during Storyboarding, as described in Part 3 below.
2. Clocks shall be configured to permit 12-hour and 24-hour time. Consult with the Owner's representative.
3. Clocks shall be configurable to allow operation as timers. Each shall be programmed to achieve count-up and count-down operation. The user shall have the ability to switch between the various modes of operation.
4. Count-up and Count-down timers shall also be programmed to present some form of indication to the user that warns time is about to expire. The appearance of this indication (e.g. color change, dialog box, flag) shall be determined during Software development. Means shall also be included for a technician to change the warning period, means that does not require recompiling Software.

PART 3 EXECUTION

3.1. DEVELOPMENT PROCESS

A. General:

1. Software Development shall be the responsibility of the Software Developer.
2. Development shall be a multi-phased interactive and iterative process led by the Software Developer. Development shall involve input from, and interactive review with, the Owner's representative.
3. Development shall begin not less than two weeks after award or notice of intent to award. Work shall be completed within such timeframe as to permit Work to be completed prior to the Owner's scheduled completion date(s).
4. The Software Developer shall closely collaborate with parties providing related Work.

B. Development Phases:

1. Phase 1 — Needs Analysis:
 - a. This phase shall be used to refine the general expectations of the Software for each system that the Software controls, from a very high level perspective.
 - b. One or more meetings per system shall be expected.
 - c. The first meeting shall be scheduled within two weeks following Contract award, and the first meeting shall be held within three weeks following Contract award.

- d. Information gathered during this phase, in the Contract Documents, and in subsequent development phases, shall be used to evolve expectations of the final Software Work.
2. Phase 2 — Storyboarding / Flow-Charting:
 - a. The Software Storyboarding / Flow-Charting phase (henceforth called Storyboarding or Storyboards) shall be where the Software Developer creates physical documents to depict the navigational flow of the system (from a user interface/operation standpoint) and document the operation of the Software relative to the system(s) being controlled.
 - b. This shall be an iterative phase whereby the Developer creates, presents, discusses and revises storyboards until there is a mutual agreement with the Owner.
 - c. At the conclusion of this phase, the resulting documents shall include information that:
 - 1) When reviewed by the Owner, the documents clearly communicate the operation and behavior of their system.
 - 2) When reviewed by a qualified programmer (including one with no prior knowledge of the system that the Software controls), communicates sufficiently to permit the writing of code that would meet the requirements of the Contract Documents and the intent of the Owner.
 - 3) When reviewed by the system installer, clearly communicates the intended operation and behavior of the system.
 - d. Storyboards shall be presented in hard-copy form on paper, either 24 inches by 36 inches or 30 inches by 42 inches in size.
 - e. Storyboards shall evolve to contain images of the permutations of each user interface. User interface images shall be drawn and interconnected in a flow chart fashion, and each element of the user interface shall be represented and described. Each button that performs a navigational action shall be interconnected to the view that results. Buttons performing an action shall also be described. The reader of the storyboard shall be able to follow it like a map, navigating through the operation of the system from start-up to shut-down and how to take advantage of features of the Software in-between.
 - f. The review meetings covering a single user interface shall be kept as short as is practical, preferably not more than (2) to (3) days.
3. Phase 3 — User Interface Development:
 - a. This phase shall result in the final appearance and operation of each user interface. This is an iterative process conducted between the Software Developer and the Owner's representative.
 - 1) This phase shall involve reworking of the storyboards to accommodate modified Software flow, behaviors and conditions not evident or fully understood during prior phases.
 - b. This phase includes the following:

- 1) Creation of real world user interfaces based upon the storyboarding documents.
- 2) Development and implementation of graphics.
- 3) Final sizing, shaping and positioning of buttons, indicators and text.
- 4) Identification and assignment of color themes.
- 5) Creation/implementation of companion emulation Software that brings the user interface to life and enables evaluation of appearance, operational and navigational flow, behavior, and general responsiveness. Acceptable emulation Software allows the user interface to behave as though it were actively controlling the associated system.
 - a) Emulation Software includes: (a) Full navigational operation, (b) Button feedback, (c) Device status emulation, (d) System status emulation, (e) Working screen changes, page changes, pop-ups and messaging, and (f) Variable text change emulation.
- c. This phase is complete when the Software Developer has completed each prior development phase, and:
 - 1) Conducted working hands-on user interfaces demonstrations with the Owner's representative.
 - 2) Received conditional acceptance of the user interfaces from the Owners representative.
 - 3) Final versions of this phase of Work, in electronic form, have been turned over to the Designer and the Owner's representative.
4. Phase 4 — Programming:
 - a. The Programming phase is the where the Software Developer shall write the Software to perform in accordance with the specifications and decisions made during prior Software development phases.
5. Phase 5 — Loading, Testing and Debugging:
 - a. The Loading, Testing and Debugging phase begins during, but near the end of the programming phase. During this phase, the Software shall be refined to make it fully usable by the Owner.
 - b. Software shall be loaded into the memory of applicable processors and components.
 - c. The Software shall be tested and debugged as an integral part of the complete systems being controlled. Adjustments shall be made to ensure that the Software meets the expectations of the Owner's representative.
 - d. If during this phase the Software Developer determines that the Software does not function as desired; the user interfaces do not operate in a familiar manner; the Software is unstable; or interactions with controlled equipment render the Software unstable, awkward to use, or unusable for the intended purpose, the Software Developer shall take remedial action. Should this be necessary, the Software Developer shall review the issue(s) with the Owner's representative and

offer suggestions for remedial action. Acceptable remedial actions may include modifying user interfaces or adding, modifying or deleting Software features.

3.2. CHALLENGE RESOLUTION

- A. If for technical reasons it is not possible to achieve a specific functionality identified in the Contract Documents or included in the storyboards, consult with the Designer and the Owner's representative to review alternative options and assist in reaching a compromise solution.

3.3. OWNER'S MANUAL

- A. Software Developer shall provide custom printed and editable electronic documentation containing high quality graphical representations of user interfaces.
- B. Documentation shall include descriptive text that describes the use, flow, and operation of the system from a user perspective.
- C. Documentation shall be suitable for printing, photocopying and distribution by the Owner to users of the Software.
- D. Documentation shall include information covering advanced modes, hidden buttons, and other pertinent advanced features, as well as service information that a technical person, advanced user, and/or system administrator will need for the operation, management, maintenance and expansion of the system. Information regarding these advanced features shall be included on separate pages from the documentation so that they can easily be omitted from the information duplicated by the Owner and distributed to less advanced users of the Software.

END OF SECTION 274103.00

SECTION 281301.00 - SECURITY ACCESS CONTROL SYSTEM

PART 1 GENERAL

1.1. GENERAL DESCRIPTION

- A. The Security Management System (SMS) shall be a modular secure access management system used to better control employee and visitor movements at various establishments. The SMS shall be designed to maximize all tools offered by the Windows platform. All commands shall be accessible using only a mouse, and keyboard use shall be limited to documenting fields requiring numeric or alphanumeric data.
- B. The operating program shall be multi-user and multi-tasking and capable of running on a non-proprietary CPU. The application software shall be based on a standard, high level programming language. The SMS shall be modular to facilitate its installation and the development of its capabilities while avoiding major modifications in its operation and in saving all defined system and historical data.
- C. The server shall be a database server for a Paradox database. All database management tools shall be included, such as back-up, indexing, and database cleaning tools. No third party database tools or licensing shall be required. The corporate gateway shall communicate system information between the server and controllers. The workstations shall be the main user interface to perform supervisory and programming functions.
- D. The SMS shall enable the selection of at least two user languages. The basic dictionary shall include English, French, Spanish, Italian and German. However, the system shall include a vocabulary editor to be used in designing custom language dictionaries. The operator's profile shall permit the integration of one of the two basic languages.
- E. The SMS shall include RS-232 / RS-485 communication link between the various system components as well as TCP/IP network interface capability. Field devices such as card readers, alarm inputs, control points, etc. shall be connected to fully distributed intelligent field panels capable of operating without host computer intervention.
- F. The SMS shall be able to design customized ID cards directly from the access management software. No specific program or software other than the access management software and no additional licensing shall be required for this function. Any workstation shall be capable of being used as a badging station. Badging shall be fully integrated with the card database.

1.2. SUBMITTALS

- A. Shop Drawings
 - 1. Prior to assembling or installing the SMS, the Contractor shall provide complete shop drawings which include the following:

- a. Architectural floor plans indicating all system device locations.
 - b. Full schematic wiring information for all devices. Wiring information shall include cable type, cable length, conductor routings, quantities, and point-to-point termination schedules.
 - c. Complete access control system one-line block diagram.
 - d. Statement of the system sequence of operation.
 - e. Riser diagrams showing interconnections.
 - f. Detail drawings showing installation and mounting.
 - g. Fabrication drawings for console arrangements and equipment layout.
2. All drawings shall be fully dimensioned and prepared in DWG format using AutoCAD.
- B. Product Data
1. Prior to assembling or installing the SMS, the Contractor shall provide the following:
 2. Complete product data and technical specification data sheets that includes manufacturer's data for all material and equipment, including terminal devices, local processors, computer equipment, access cards, and any other equipment provided as part of the SMS.
 3. A system description, including analysis and calculations used in sizing equipment required by the SMS. The description shall show how the equipment shall operate as a system to meet the performance requirements of the SMS. The following information shall be supplied as a minimum:
 - 1) Central processor configuration and memory size
 - 2) Description of site equipment and its configuration
 - 3) Protocol description
 - 4) Hard disk system size and configuration
 - 5) Backup/archive system size and configuration
 - 6) Start up operations
 - 7) System expansion capability and method of implementation
 - 8) System power requirements and UPS sizing
 - 9) A description of the operating system and application software
- C. As-Built Drawings
1. At the conclusion of the project, the Contractor shall provide "as built" drawings. The "as built" drawings shall be a continuation of the Contractors shop drawings as modified, augmented, and reviewed during the installation, check out and acceptance phases of the project. All drawings shall be fully dimensioned and prepared in DWG format using AutoCAD.
- D. Manuals
1. At the conclusion of the project, the Contractor shall provide copies of the manuals as described herein. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each security system integrator installing equipment and systems and the nearest service representatives

for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The manuals shall include all modifications made during installation, checkout, and acceptance. The manuals shall contain the following:

2. Functional Design Manual
 - a. The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included for all system operating modes.
3. Hardware Manual
 - a. The hardware manual shall describe all equipment furnished including:
 - 1) General description and specifications
 - 2) Installation and check out procedures
 - 3) Equipment layout and electrical schematics to the component level
 - 4) System layout drawings and schematics
 - 5) Alignment and calibration procedures
 - 6) Manufacturers repair parts list indicating sources of supply
4. Software Manual
 - a. The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:
 - 1) Definition of terms and functions
 - 2) Use of system and applications software
 - 3) Initialization, startup, and shut down
 - 4) Alarm reports
 - 5) Reports generation
 - 6) Data base format and data entry requirements
 - 7) Directory of all disk files
5. Operators Manual
 - a. The operator's manual shall fully explain all procedures and instructions for the operation of the system including:
 - b. Computers and peripherals
 - c. System startup and shut down procedures
 - d. Use of system, command, and applications software
 - e. Recovery and restart procedures
 - f. Graphic alarm presentation
 - g. Use of report generator and generation of reports
 - h. Data entry
 - i. Operator commands
 - j. Alarm messages and reprinting formats

- k. System access requirements
- 6. Maintenance Manual
 - a. The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

1.3. QUALITY ASSURANCE

A. Manufacturer Qualifications

- 1. The manufacturers of all hardware and software components employed in the SMS shall be established vendors to the access control/security monitoring industry for no less than five (5) years and shall have successfully implemented at least 5 systems of similar size and complexity.

B. Contractor / Integrator Qualifications

- 1. The security system integrator shall have been regularly engaged in the installation and maintenance of integrated access control systems and have a proven track record with similar systems of the same size, scope, and complexity.
- 2. The security system integrator shall supply information attesting to the fact that their firm is an authorized Kantech Corporate Dealer.
- 3. The security system integrator shall supply information attesting to the fact that their installation and service technicians are competent factory trained and certified personnel capable of maintaining the system and providing reasonable service time.
- 4. The security system integrator shall provide a minimum of three (3) references whose systems are of similar complexity and have been installed and maintained by the security system integrator in the last five (5) years.
- 5. There shall be a local representative and factory authorized local service organization that shall carry a complete stock of parts and provide maintenance for these systems.

C. Testing Agencies

- 1. The SMS shall be tested and listed by Underwriters Laboratories (UL) for UL 294 for Access Control System Units.
- 2. The SMS shall be tested and listed by Underwriters Laboratories (UL) for UL 1076 for Proprietary Alarm Units.
- 3. The SMS hardware shall comply with the following regulatory requirements:
 - a. FCC Part 15 Class A
 - b. FCC Part 15 Class B
 - c. FCC Part 68 (TIA968)
 - d. ICES-003
 - e. CE
 - f. ECCN for AES 128 bit encryption for IP communication

- g. Government standards NISPOM 5-313 Automated Access Control Systems, DICD Annex F 2.3 Accept/Reject Threshold Criteria, JAFAN Annex D 2.3 Accept/Reject Threshold Criteria
- 4. The SMS shall support Americans with Disabilities Act (ADA) compliance in door and access operation.

1.4. WARRANTY

- A. The Security Management System (SMS) shall be provided with a 12 month product warranty from date of registration. Software version updates shall be available for no charge during this warranty. The software media warranty shall be 90 days.

PART 2 PRODUCTS

2.1. MANUFACTURERS

- A. The Security Management System (SMS) shall be the Kantech EntraPass Corporate Edition.

2.2. DESCRIPTION

- A. The Security Management System (SMS) shall be an integrated system that utilizes a Paradox database for the storage and manipulation of related data. The SMS shall include a server with applications software, corporate gateways for communication between the server and controllers, operator and administrator workstations with appropriate software, hard copy printers and secure backup media. The security field devices (readers, door position switches, REX, etc.) shall communicate with the field panels via a dedicated cable network. The field panels shall communicate to the server via a Fast Ethernet 10/100, TCP/IP network, RS 232/RS 485 connection, or dial-up modem.
- B. The SMS shall allow for growth and scalability from a smaller system to a larger, high-end, or enterprise system. The SMS shall be modular in nature, allowing system capacities to be easily expanded without requiring major changes to system operation. All defined system data as well as historical information shall be maintained. Customizable user interfaces shall allow management of system information and activity for administrators and operators. The response time between the moment when a card is presented at the reader and when the door is unlocked shall not exceed one second. The SMS shall include a badging solution with a GUI for badge design. No extra licensing shall be required for the badging solution.
- C. The SMS shall support up to:
 - 1. 20 Workstations
 - 2. 4 Concurrent WebStations
 - 3. 20 Redundant servers
 - 4. 128 digital video recorders

5. 41 Corporate gateways
6. 17,408 Door controllers per Corporate gateway
7. 69,632 Card readers and/or keypads and/or elevator cabs of 64 floors each per Corporate gateway
8. Unlimited Access cards
9. Unlimited Card families or site codes
10. 4,456,448 Monitored points per Corporate gateway
11. 4,456,448 Control relays per Corporate gateway
12. 2 Simultaneous user languages

2.3. PERFORMANCE - MONITORING

A. Monitoring Mode

1. The SMS shall enable every operator to customize his/her desktop configuration. It shall be possible to modify the desktop appearance and to create up to eight desktops and to associate up to ten different display screens to each. It shall be possible to modify the size and position of all screens. It shall be possible to determine if these screens shall be floating anywhere on the desktop or fixed on the desktop. If the workstation is equipped with a dual output video card and two or more monitors, it shall be possible to distribute the screen to multiple monitors. However, each screen shall be able to be viewed alone or together depending on operator needs. Once these parameters are saved, the configuration shall automatically take effect whenever the operator logs in. For all types of screens, it shall be possible to access the general properties of the screen by simply right clicking at the center of the screen. From there it shall allow for linkage between associated screens without having to exit the current screen or section. It shall be possible to right click events on the desktop for editing which shall bring the user directly to the card, door, or component window and back.
2. Message Screen
 - a. All events that occur shall appear in real time. The text shall include at least the date, time, and a pertinent description of the event as well as its condition. The display of this screen shall be customizable and a different background and message color can be used for every type of event.
 - b. Every in-coming event shall be documented by one or more icons representing video images, photos, access card, server, gateway, controller, card reader, and relay or supervision point. It shall be possible to classify the events on the screen by sequence, date and time, type of event, or type of message. In addition, a text filter shall be available to facilitate searching. It shall be possible to access the last up to 100,000 transactions from this window without the need to request a special report.
3. Card Holder Photo Screen

- a. When a card is presented to a card reader, the software shall automatically display the photograph of the cardholder in this window. From this screen it shall be possible to select the cardholder's name, card number, event text, and comments as well as specify a door or group of doors for which the operator would like to display a photo. The SMS shall support the display of up to 4 pictures simultaneously.
 4. Filtered Message Screen
 - a. This screen shall be a copy of the text messages screen except it shall be possible to select a specific message filter. The SMS shall include a choice of pre-configured filters and the ability to create customized filters. For every new filter it shall be possible to associate a name to it, select the type of event, select door, select workstation, select gateway, select supervision input, and select output.
 5. Alarm Screen
 - a. Alarms that require an acknowledgement by an operator shall be displayed on this screen in text form only. The text shall include at least the date, time and description of the alarm, and its condition. It shall be possible to classify events on the screen by sequence, date and time, type of event, or type of message. A text filter shall be available in order to facilitate the search.
 - b. If instructions about an alarm are envisaged, they shall automatically appear in a second window on the screen. If a graphic is associated with the alarm, it shall appear automatically on the screen defined to this effect. The icon associated to the control point shall be represented and show the actual state of the point.
 - c. The operator shall be able to access a log book in order to document the alarm that occurred. Once this information is recorded in the log it shall not be erasable or modifiable.
 - d. It shall be possible to associate video call-up with an alarm. When this occurs, the main screen shall become the video screen, not the alarm screen.
 6. Video Screen (Video View)
 - a. When the SMS is integrated with American Dynamics digital video recorders, it shall be possible to view the video images of cameras associated with them. The SMS shall enable the creation of an unlimited number of video views, each one associated with up to 16 different cameras or graphics. It shall be possible for an operator to edit or modify an existing view or create a new one directly from this screen. For each video view it shall be possible to select sequential, mosaic pattern, or preset viewing modes.
 - b. It shall be possible for an operator to access all the commands of a motion PTZ camera to include rotate on its axis, adjust its focus, and have a larger view of the image. Accessibility to camera images and commands shall be limited by operator security level.
 - c. No additional licensing shall be required to perform this function.
- B. Graphics Screen

1. There are three options for graphics that appear as background on the screen. The first is a reproduction of the building(s) floor by floor. The graphic module shall be capable of importing files in BMP, EMF, WMF, JPEG, GIF, PCX, PNG, TIF, or PCD formats.
 2. The second option is using web pages, or WebViews, as background on the screen. This can be used in the following manners:
 - a. Accessing to DVR web servers
 - b. Embedding default web pages into operator desktops
 - c. Adding an IP camera onto a video view
 - d. Embedding intranet pages or directories into the operator environment
 - e. Adding PDF, Word documents, etc. to the desktop
 - f. Accessing to network cameras from the WebStation
 - g. HTML or PDF pop-up instruction on alarm
 - h. Integrating report folders in the desktop for quick access
 3. The third option is to assign a live video view as background on the screen if video integration is being utilized.
 - a. For all three options, control points shall be represented by a descriptive icon. Control points include workstations, gateways, controllers, card readers, doors equipped with either card readers or supervision contacts, cameras, relays, and input monitoring points such as motion sensors. The icons shall be animated, meaning they shall represent the state of the point to which they are associated in real time. Every graphic shall support at least 100 control points. Right clicking on an icon shall directly access the manual commands of each control point. A door shall be capable of but not limited to temporarily unlocking, manually unlocking or locking, and enabling or disabling a reader. A supervision point shall be capable of being enabled or disabled. A control relay shall be capable of being activated, deactivated, or temporarily activated. Cameras shall be capable of viewing images or live video. No additional licensing shall be required to perform this function.
- C. Communication Methods
1. The SMS shall ensure the communication to remote sites over a LAN or WAN/Internet using a dedicated communication server device, Kantech IP Link or the KT-400 controller. This shall only be applicable with the use of Corporate Gateways. It shall ensure secure communications by the use of 128-bit AES Encryption. It shall reduce bandwidth consumption by managing the communication protocol of Kantech controllers at the remote site. Polling of Kantech controllers shall be done by the Kantech IP Link or KT-400 in the field and not over the network. The Kantech IP Link or KT-400 shall provide support for up to 32 door controllers. The Kantech IP Link or KT-400 shall be configured from the access software or from a web page which has the security feature of being disabled after successful use.
 2. For sites that do not have network links, communication to remote sites shall be ensured by Dial-up modems. This shall only be applicable with the use of Corporate

Gateways. The SMS shall support up to 32 such modems that can simultaneously communicate and transmit or receive data from remote sites. No modem shall be dedicated to specific sites; communication shall be established such that the first site calling shall have access to the first available modem, and so on.

3. Each Corporate Gateway should be able to control 32 local controller loops by using the RS-232/RS-485 protocols via serial or USB port. In addition, each Corporate Gateway should be able to control up to 512 Ethernet loops using TCP or UDP protocols, via the use of the Kantech IP Link, or KT-400 of 32 controllers each.
4. In all communication methods, the door controller shall retain in their memory all necessary data for controlling doors that they supervise. In case of communication failure, the door controller shall execute all its functions normally.

2.4. PERFORMANCE – PROGRAMMING & CONFIGURATION

A. User Section

1. This section shall include all functions involved in the issuance of an access or ID card as well as database search and importation tools. During the addition or modification of a card, information about the card shall be sent to the door controllers affected by these new parameters as soon as the operator accepts the addition or modification. An additional command requiring a reloading of the cards database in the door controllers shall not be acceptable.
2. The SMS shall enable the creation and definition of a user access card. There can be up to five cards per user and users can be managed by cardholder name or card number. When creating user cards, the operator shall be able to select a card format directly from a Card dialog and enter the card number as it is printed on the card.
3. The following user information shall be able to be saved in the user section:
 - a. Card number
 - b. First and last name
 - c. Card type
 - d. Additional information (10 fields)
 - e. Start date
 - f. Expiry date
 - g. Personal ID number (PIN)
 - h. State of the card
 - i. Comments
 - j. In addition, it shall be possible to associate a photograph, signature, and badge template to a card.
4. The SMS shall allow for the creation of an unlimited number of card templates to be used as ID cards. Template parameters include name, number of sides, and size. It shall be possible to directly print a template on an access card. The operator shall be able to design customized badging templates directly from the access management software. No specific badging program or software other than the latter and no

additional licensing shall be required for this function. Any workstation shall be capable of creating ID cards based on operator security level. The following items shall be capable of being added to and modified on a badge template:

- a. All information fields associated to a cardholder
 - b. Bar code
 - c. Text zone
 - d. Start date, expiry date, today's date
 - e. Saved images and logos
 - f. Borders
 - g. Rectangles (including rounded rectangles, ellipse)
 - h. Lines and arrows
 - i. Photograph (can be cropped)
 - j. A background
5. The SMS shall allow for the creation of a day pass to be issued to visitors for a single day. The SMS shall also have the ability to create temporary ID visitor cards.
 6. The SMS shall offer the possibility of modifying the parameters of a group of cards simultaneously based on Card Type. The system shall enable the creation of an unlimited number of card types. The following fields shall be modifiable:
 - a. Card status (valid, invalid, lost, stolen)
 - b. Card monitored (yes, no)
 - c. Start date (schedule)
 - d. End date (schedule)
 - e. Delete after expiration (yes, no)
 - f. Wait on keypad (yes, no)
 - g. Access group (selection menu)
 - h. Template model (selection menu)
 7. The operator shall be able to search for a card by last or first name, card creation date, card number, or any of the ten fields of user definable information. The system shall display the last card transactions, namely the latest sixteen denied access events, authorized events, database events, and/or time & attendance events.
 8. The SMS shall enable the creation of an unlimited number of Import/Export models, give them a name, select required fields, select their layout, and determine the filed delimiter. This shall allow for acceleration of the data entry process by importing databases from a spreadsheet.
 9. The SMS shall allow for 250 access levels programmed per Corporate Gateway. Every card shall be assigned an access level which shall determine where and when the access card will be valid. When the system consists of several sites or gateways, it shall be possible to use batch programming of access levels.
 10. The SMS shall allow for creation of tenant lists that can be imported in the (Kantech Telephone Entry System) KTES units. The lists shall be easy to fill up and allow for up

to 3000 tenants in each list. The SMS shall support the creation of unlimited amounts of tenant lists.

11. The SMS shall allow of importing and exporting of tenant lists. The operator shall have the ability to choose which fields to import and export.
12. The following tenant information shall be able to be saved for each tenant.
 - a. Tenant name
 - b. Tenant ID (customizable in length per tenant list)
 - c. Primary Telephone Number
 - d. Secondary Telephone number
 - e. Tenant PIN (customizable in length per tenant list)
 - f. Pin access schedule
 - g. Tenant level
 - h. Tenant language
 - i. Card number
 - j. Disable card trace
 - k. Start/End date
13. The SMS shall allow for a card number to be assigned to specific tenant. The KTES unit will be able to send the card number to other controllers of a Wiegand protocol.

B. Video Section

1. The SMS shall be capable of being combined with up to 128 American Dynamics Intellex digital video recorders. From any of the workstations it shall be possible to do the following:
 - a. View one or more camera images from different sources
 - b. Query the history of each recorder and view images saved on disk
 - c. View, modify, or delete programming parameters of a recorder
 - d. Control the movement of all motion cameras directly with the workstation mouse of the SMS (PTZ control)
 - e. Export camera images to hard disk and video vault (capable of exporting multiple formats, password protected to protect chain of evidence)
2. The SMS shall ensure the time management and synchronization for all digital video recorders. It shall be possible to determine the time refresh frequency on the network. The SMS shall allow for configuration of each digital video recorder. For each recorder it shall be possible to:
 - a. Assign a name
 - b. Determine the recorder type
 - c. Determine the network IP address
 - d. Manually configure the video, communication and event ports
 - e. Determine the number of cameras
 - f. Determine the query frequency

- g. Determine the number of failed queries required before a loss of communication message is displayed on the screen
 - h. Import camera details from existing video servers
 3. The SMS shall define the programming parameters for every camera connected to a digital video recorder. For each camera it shall be possible to:
 - a. Assign a name
 - b. Determine the type of camera
 - c. Assign a representative icon for identification on a graphic screen
 - d. Determine if the camera image can be visible on a video view
 - e. Determine the type of recording
 - f. Determine which events from the recorder should display an alarm message on the screen
 - g. Determine the number of pre-selections desired
 - h. Determine the number of patterns desired
 - i. Add comments to record in the video vault
 4. The SMS shall allow for the creation of an unlimited number of video views. For each video view it shall be possible to connect up to 16 cameras from various sources. The video view programming parameters make it possible to:
 - a. Assign a name
 - b. Determine the view size
 - c. Determine the refresh rate of the image
 - d. Determine whether to show metrics
 - e. Determine whether to show camera controls
 - f. Determine whether to show overlays
 - g. Determine whether to auto-hide text
 - h. Determine whether to activate image zoom
 - i. Determine whether to activate video sequence
 - j. Determine delay before sequence launch
 - k. Determine camera display delay
 - l. Determine display pre-selection delay
 - m. Determine pattern display delay
 - n. Determine graphic display delay
 - o. Determine display mode
 - p. Incorporate up to 16 cameras from various sources or 16 graphics
 5. The SMS shall be able to trigger, from one or more specific events, the start of a recording on a recorder with one or more cameras connected to it. The SMS shall allow for the creation of an unlimited number of video triggers. The SMS shall allow for the creation of an unlimited number of recording parameters. For each recording parameter it shall be possible to:
 - a. Define a name

- b. Select the digital video recorder to which this recording parameter refers
 - c. Select the camera to which this recording parameter refers
 - d. Associate a pre-selection or size
 - e. Determine the start recording trigger
 - f. Determine the pre-alarm time
 - g. Determine the total recording time
 - h. Determine the stop recording trigger
6. It shall be possible for a video event on one digital video recorder to trigger an action on another digital video recorder.
 7. The SMS shall allow the playback of all recordings stored on the hard drive of any of the digital video recorders. The operator shall be able to save the video into the video vault.
 8. The SMS shall provide the operator access to the complete list of normal and abnormal events that required the activation of video recording. The sequence of images can be saved to a hard drive for subsequent consultation and shall be encrypted. The SMS shall allow the operator to access a complete list of alarm recordings in progress including origin of the alarm. The SMS shall be capable of displaying a list of exported videos.
 9. It shall be possible to view recorded video tagged to an Access or Video event by quick linking from the Message desktop.
- C. Definition Section
1. The SMS shall allow the creation of 100 schedules per Corporate Gateway and an unlimited number of system schedules. Each schedule can include up to 4 intervals. A schedule can be associated with a supervision point, a relay, an access level, a door, elevator floor, an operator, or an event. The SMS shall allow time zone management.
 2. The SMS shall allow the creation of 366 holidays. It shall be possible to define a name, define a date, and determine the type. The SMS shall allow the operator to view all the holidays defined in holiday type and sites by viewing them all in a yearly calendar.
 3. The SMS graphics shall enable operators to view the exact location of a component installed at the site, or the state of components and peripherals represented in the graphic such as doors, contacts, motion sensors, controllers, and cameras. The SMS shall allow for the creation of an unlimited number of graphics. The components on the graphics represented by icons as well as the graphics themselves shall have the ability to be modified. The SMS shall allow for printing of the graphics with their respective components on the graphical floor plan.
 4. The SMS shall allow the management of 2,048 elevator cabs of 64 floors each for each gateway. It shall be possible to associate a schedule to the call button. Outside of the schedule, a valid card for a particular floor will have to be presented to the cab reader for it to be activated. The floor selection button group associated with the card's access level will become operational for a predefined duration and all other buttons

shall become inactive. The SMS shall allow the creation of groups of floors and access levels.

5. The SMS shall provide the possibility of setting up guard tours with existing components of the system. Card readers, magnetic contacts and motion sensors can be used as control stations for the guard tour. Key switches can also be located at strategic points for the guard to activate.
6. The SMS shall provide the possibility to setup unlimited amount of tasks via the user friendly task builder. The operator shall be able to create emails templates that can incorporate variable to dynamically populate the emails. Using the command GUI menu, the operator can program commands for any component in the SMS. Commands such as but not limited to lock, unlock, temporary unlock, toggle, back to schedule for the doors, relays, inputs and enable and disable readers. The operator can also program commands for specific card count. The commands should be able to accept specific components or variables that can filled dynamically.
7. The SMS shall provide the possibility to setup unlimited batch card operations via the user friendly task builder. The mass card modifications shall take effect in real time. Each mass card modifications task shall allow for mass cards to be changed based on their card type. The mass card modification task shall be able to change:
 - a. Card State
 - b. Supervisor level
 - c. Card count value
 - d. Card Tracing
 - e. Start Date
 - f. End Date
 - 1) With deletion on expiration
 - g. Waiting for keypad
 - h. Card access group
 - 1) Replacing access levels
 - 2) Updating access levels
 - 3) Adding new access levels
 - 4) Updating and adding new access levels
 - i. Card Badge layout
8. The SMS shall provide the possibility to assign the tasks previously created to be triggered on specific components and specific events.
9. The SmartLink Task Commander shall process the command from the first available SmartLink application on the SMS.
 - a. The use of a specific SmartLink to run the SmartLink Task Commander shall not be accepted. The SMS shall accept many SmartLinks to be installed thus providing a redundant SmartLink for all SmartLink Task Commander tasks.

D. Devices Section

1. The physical components of the SMS including workstations, corporate gateways, gateway, site, controllers, Kantech Telephone Entry System (KTES), doors, relays, and monitored inputs shall be individually configured and defined. Individual sites shall also be defined. The software shall allow the use of a controller Express Setup feature in order to minimize the time needed for controller definition.
- E. Alarm Interface
1. The SMS shall allow interface with any external alarm system thereby arming or disarming the system by presenting a valid card to an entry / exit door. It also shall be possible to associate a keypad with a reader forcing the cardholder to enter a number in the keypad after presenting a card. This integration shall only be possible with the use of a Corporate gateway. It shall be possible at a minimum to:
 - a. Set a monitored input as an arming button
 - b. Associate a usage schedule with an arming button
 - c. Set the exit and entry delay
 - d. Determine whether the system must wait for a valid access to arm
 - e. Determine whether the door must relock on arming request
 - f. Associate a monitored input with an alarm panel condition
 - g. Lock a door unlocked by a schedule when armed
- F. Intrusion Integration
1. The SMS shall allow interface with the DSC PowerSeries® intrusion panel thereby eliminating hardwired integration between the SMS controllers and the DSC PowerSeries® intrusion panel. The DSC PowerSeries® intrusion panel shall communicate with the Corporate gateway via rs-232 or directly to a KT-400 controller. The SMS shall allow for:
 - a. Single / multiple partition arming and disarming via reader
 - b. Single / multiple partition arming and disarming via operator commands
 - c. Receive events from intrusion panel
 - d. Receive partition names, user codes and zone names programming.
 - e. Update user codes
 - f. Assign user codes to cardholders
- G. System Section
1. The SMS shall define the profile of a system operator based on name, password, language, privileges, login schedule, security level, workspaces, and password expiry date. The SMS shall provide the possibility to force the operators to assign a mandatory card type to the users. The operator shall be able to provide a default card type for every card.
 2. The SMS shall determine access rights granted to an operator based on security levels. There shall be three predefined access levels called Installer, Administrator, and Guard. The SMS shall have the ability to create an unlimited number of security levels that can be assigned to one or more operators. It shall be possible to determine from

which system components the operator shall be authorized to receive events and take action. It shall be possible to specify for each programming window if the operator can (any combination):

- a. View the component in read only
 - b. Add new components
 - c. Modify existing components (cannot add new)
 - d. Delete components
 - e. Save as
 - f. Print components
 - g. View links
3. The SMS shall allow System Administrators to grant or deny operators access to system physical components such as gateways, sites, relays, etc. using Workspaces. This allows greater ease for larger sites to locate and assign components that pertain to specific gateways and sites. System administrators shall be able to tailor specific system applications and workstations Workspaces, therefore restricting access to information to all levels of operators. Operators shall be able to use temporary workspaces to narrow their fields of view when accomplishing specific tasks, and then easily revert back to their main workspace.
 4. The SMS shall allow for the creation of unlimited instructions. These instructions shall be attributed to one or more events that will be used in documenting the event and guide the operator on duty in performing tasks. It shall be possible to edit the instructions in two different languages.
 5. The SMS shall make it possible to customize system events. All events shall be pre-defined to display on all system workstations. For each event it shall be possible to:
 - a. Determine a display schedule
 - b. Determine a color
 - c. Assign a printer
 - d. Associate one or more workstations
 - e. Associate an instruction
 - f. Associate a schedule for an acknowledgement request
 - g. Determine the priority level

H. Report Section

1. The SMS shall include templates for various types of reports to include the following:
 - a. Card use reports
 - b. Manual operations reports
 - c. Alarm reports
 - d. Historical reports
 - e. Time & Attendance reports
 - f. Detailed reports
 - g. Summary reports

L. Video Vault

1. Video Vault is an optional remote networked application used to automate recovery of video data from the digital video recorders and save it on a disk for long term video storage and retrieval. The information can be stored on an independent system or within the server. The footage that shall be tagged and recoverable from the digital video recorders shall include SMS triggers, manual triggers, and saved video server footage.
2. For the archived video files it shall be possible to:
 - a. Assign a folder name to index the archived files
 - b. Create sub folders based on day of the week, day, week, month of the year, month, video server name, camera name and/or event description name.
 - c. Determine the hard drive to store the recovered videos
 - d. Determine the composition of the name of the saved file
 - e. Determine the format of the saved video
 - f. Assign a frame from the saved video to represent as a saved file
 - g. Determine the number of simultaneous downloads
 - h. Determine a size limit for recoverable videos
 - i. Assign a password to videos stored
 - j. Determine a delay between requests to the server
3. There shall be scheduled transfers for archiving thereby reducing video network traffic during peak times.

2.5. PERFORMANCE – WEBSTATION

A. WebStation

1. WebStation is an optional tool that will allow for performing certain functions from a remote location to be used with the regular SMS system via Web Browser. The WebStation provides card management to guards, secretaries, or managers without the need to deploy a full workstation. A concurrent connection option shall provide access to a pre-determined number of users.
2. The WebStation shall have the ability to be viewed in multiple languages. Each WebStation shall come in English and French. Customer Languages can be created using an easy to use tool. The WebStation shall automatically detect the Web Browser's preferred language.
3. The following functions are available using WebStation:
 - a. Card management (including 5 cards per username)
 - b. Viewing the card's last transactions
 - c. Forgot Password & Reset password
 - d. Create, modify and delete access levels
 - e. Create, modify and delete schedules
 - f. Assigning access levels

- g. Performing door operation
- h. Performing relay operation
- i. Performing input operation
- j. Performing elevator operations
- k. Requesting historical reports via email
- l. Using WebViews

2.6. INTEGRATION

A. SmartLink

1. The SmartLink application offers the ability to send messages to pagers and cell phones and through the use of e-mail. SmartLink provided instant e-mail notification of alarm events and the ability to e-mail reports.
2. Integration with other systems can also be done through the SmartLink API. This tool is used for advanced integration with third party applications like visitor management software, human resources systems, time and attendance systems, video systems, HVAC, etc.

B. Card Gateway

1. The Card Gateway is an optional external interface that shall allow the client to make modifications to the system card database through an Oracle or MS-SQL database. The application may be installed and run on the server's CPU. It shall allow for HR software integration and enable operators to modify, add, or obtain information on cards in real time.

2.7. REDUNDANCY & MIRRORING

A. Redundant Server

1. The SMS shall be able to support an optional redundant server whose main function shall be to monitor the primary server and ensure automatic (Hot Standby) take over if necessary. The redundant server shall have all the same characteristics and functions as the primary server.
2. The transition between these servers shall be completely transparent. When the primary server is operational once more, it shall be capable of synchronizing its database automatically with the redundant server and then resume absolute control of the access management system. No human intervention shall be required in this operation.
3. The operator shall be able to perform any and all operations during a fail-over synchronization between the primary server and redundant server.
4. The system shall support the use of multiple simultaneous redundant servers. The need to install third party (not EntraPass) licensing shall not be acceptable.

2.8. OPERATION

- A. The SMS shall perform the following tasks:
1. Allow card access management for one or more buildings.
 2. Control access to various doors equipped with a card reader. Allow the ability to set card use count options to limit the number of times a card can be used.
 3. Allow automatic transfer of cards to an unknown area by a push of a button for emergency exit purposes.
 4. Monitor all defined alarm points as well as all doors controlled by card readers based on programmed schedules.
 5. Send transactions for which printing is required to one or more printers, based on a set schedule.
 6. Access the system using the main and secondary menus (to which access is limited by a password) to make additions and required changes to various data files so that they can be updated by the user without the manufacturer's assistance.
 7. Enable the entry of access code data for every card or group of cards.
 8. Seamlessly connect to onsite alarm systems.
 9. Fully functional virtual keypad with DSC® PowerSeries alarm system. The operator shall perform all functions available on a standard keypad with the PowerSeries alarm system. The operator shall be able to use the computer keyboard or the mouse to perform actions on the virtual keypad.
 10. Associate to each event a recording schedule for each destination (hard drive, monitor).
 11. Automatically display all alarms on screen in text with optional graphic or picture and trigger a sound requiring an acknowledgement on the keyboard to stop the alarm.
 12. Each event should print on a log printer. For security reasons, each event shall be incremented with a print number. Numbering shall start from 0 every day.
 13. Generate reports and view them on the screen, output them to a printer, or send them to an email address.
 14. Supervise based on programmed schedules of specific points such as door contacts, volumetric detectors, mechanical points, high and low temperature sensors, or any other equipment necessary for good building management.
 15. View and/or save video images.
 16. When integrated into a digital video recording system (American Dynamics), allow the management of the recordings of all the cameras via access system workstations.
 17. When connected to a digital video recording system (American Dynamics), allow the orientation of all PTZ cameras directly using the workstation mouse of the access system.
 18. When connected to a digital video recording system (American Dynamics), allow the recovery and storage of selected videos to an independent server.
 19. Save the database manually or automatically backup following a schedule.
 20. Uninterrupted backups. The operator shall be able to perform any task during a SMS backup.

21. The operator shall be able to perform any and all operations during a fail-over synchronization between the primary server and redundant server.
22. When the access control system manages parking lot entry and exit, it shall be possible to set a maximum number of vehicles authorized to simultaneously access the parking area. Once the parking lot is full, the system shall prevent access to any cardholder for as long as a parking space has not become available.
23. Allow for a Dual Custody option to add extra security to a door by requesting that two card holders must access the door together.
24. Save events on a hard drive according to required criteria.
25. Perform the following operations from all workstations:
 - a. Lock or unlock one door or a group of doors.
 - b. Activate or deactivate a relay or a group of relays.
 - c. Activate or deactivate the recording of one camera or a group of cameras.
 - d. Activate or deactivate a point or a group of points.
 - e. Program or modify one card or a group of cards.
 - f. Validate or invalidate one card or a group of cards.
 - g. Change time and date.
 - h. Demand the system state in text or graphic mode.
 - i. Query, create and/or modify data on: Access levels, Schedules and holidays, Access card, Instructions, Reports and log, Doors, Supervision points and relays, Operator levels, and Graphics.
 - j. Ability to use a easy to use system tree view to select the components.
 - k. View which cards are in the roll call sectors.
 - l. View the card's last known access in the roll call sector.
26. Perform the following operations from the SmartLink Task Commander:
 - a. Lock, unlock toggle, return to schedule, temporary unlock, arm and disarm any door.
 - b. Disable and enable any reader.
 - c. Lock, unlock, temporary unlock return to schedule, disable enable any elevator and elevator floor.
 - d. Activate, deactivate, temporary activate, toggle and return to schedule of any relay.
 - e. Shunt, unshunt, temporary shunt, toggle, return to schedule and continuous supervision of any input.
 - f. Set count usage, manually overwrite the count, disable count usage, decrement count usage, increment count usage for all the cards.
 - g. Send alarm emails.
 - h. The use of variables in the SmartLink Task Commander can be used instead of hard coded values.
 - i. Mass card modifications on without operator intervention.

- j. Ability to use generically created commands to perform task on different components.
 - k. Each specific card shall have the ability to activate a specific component in the above mentioned states without the need to create hard coded the commands.
 - l. The SmartLink Task Commander shall process the commands on the first available SmartLink on the SMS.
- B. The use of a specific SmartLink to run a specific SmartLink Task Commander shall not be accepted.
- C. The SMS all allow for many SmartLinks to be installed without the need to purchase additional option codes.
- D. The SmartLink Task Commander shall be run from any of the available SmartLink.

2.9. EQUIPMENT

A. Server and Redundant Server Requirements

1. The SMS server and redundant server shall meet the following minimum requirements:
 - a. The server shall have an Pentium IV processor, 1.8 GHz or better
 - b. The server shall have a 500-watt power unit
 - c. The server shall have 1 GB RAM.
 - d. The server shall have 20 GB hard disk drive space
 - e. The server shall have a 48x CD-ROM drive
 - f. The server operating system shall be Windows 2000/XP/2003 Standard and Enterprise Server Edition/ Vista Home, Home Premium, Enterprise, Business and Ultimate/ Windows 2008 Server / Windows 7 Pro. All OS's must be 32-bit.
 - g. The server shall have a 10/100/1000 Base-T network adapter
 - h. The server shall have a high quality multilingual keyboard
 - i. The server shall have a two button ergonomic mouse
 - j. The server shall have an On-Off switch
 - k. The server shall have an appropriate UPS

B. Corporate Gateway Requirements

1. The SMS corporate gateway shall meet the following minimum requirements:
 - a. The corporate gateway shall have an Pentium IV processor, 1.8 GHz or better
 - b. The corporate gateway shall have a 500-watt power unit
 - c. The corporate gateway shall have 1 GB RAM.
 - d. The corporate gateway shall have 20 GB hard disk drive space
 - e. The corporate gateway shall have a 48x CD-ROM drive
 - f. The corporate gateway operating system shall be Windows 2000/XP/2003 Standard and Enterprise Server Edition/ Vista Home, Home Premium, Enterprise,

Business and Ultimate/ Windows 2008 Server / Windows 7 Pro. All OS's must be 32-bit.

- g. The corporate gateway shall have a 10/100/1000 Base-T network adapter
- h. The corporate gateway shall have a high quality multilingual keyboard
- i. The corporate gateway shall have a two button ergonomic mouse
- j. The corporate gateway shall have an On-Off switch
- k. The corporate gateway shall have an appropriate UPS

C. Workstation Requirements

- 1. The SMS workstations shall meet the following minimum requirements:
 - a. The workstation shall have an Pentium IV processor, 1.8 GHz or better
 - b. The workstation shall have a 500-watt power unit
 - c. The workstation shall have 1 GB RAM.
 - d. The workstation shall have 20 GB hard disk drive space
 - e. The workstation shall have a 48x CD-ROM drive
 - f. The workstation operating system shall be Windows 2000/XP/2003 Standard and Enterprise Server Edition/ Vista Home, Home Premium, Enterprise, Business and Ultimate/ Windows 2008 Server / Windows 7 Pro. All OS's must be 32-bit.
 - g. The workstation shall have a 10/100/1000 Base-T network adapter
 - h. The workstation shall have a high quality multilingual keyboard
 - i. The workstation shall have a two button ergonomic mouse
 - j. The workstation shall have 32 MB graphic adapter card
 - k. The workstation shall have a 24-bit (16 million colors) color depth monitor with a screen resolution of 1024 x 768
 - l. The workstation shall have an On-Off switch
 - m. The workstation shall have an appropriate UPS

D. Controllers

- 1. The SMS shall support the following door controllers:
 - a. Kantech KT-400
 - 1) The KT-400 is an Ethernet-ready four door controller with sixteen monitored points, on-board door strike power, sixteen reader outputs, four relay outputs, and auxiliary power output. It shall accept Wiegand, proximity, ABA clock and data, bar code, magnetic, integrated keypad, and smart card reader types. It shall also support FIPS 201 cards, with and without checking the expiration date. It supports RS-232, RS-485 and 128-bit AES Encrypted Ethernet 10/100Base-T communication. It supports expansion modules to provide 256 inputs and 256 outputs. It shall support 136 double end of line inputs.
 - b. Kantech KT-300

- 1) The KT-300 is a two door controller with eight monitored points on board expandable to sixteen, door strike power, auxiliary power output, and two auxiliary outputs. It shall accept Wiegand, proximity, bar code, magnetic, and integrated keypad reader types. It supports RS-232, RS-485, and Combus communication. It supports relay, input, and output expansion modules. The KT-300 is available in 128k and 512k memory versions.
 - c. Kantech KT-100
 - 1) The KT-100 is a one door controller with four monitored points, door strike power, and four auxiliary outputs. It shall accept Wiegand, proximity, bar code, magnetic, and integrated keypad reader types. It supports RS-485 communication.
 - d. Kantech KT-200 (Legacy)
- E. KTES (Kantech Telephone Entry System)
1. The KTES enables tenants to grant access to the building, to their visitors, via their own telephone line or cellular telephone. The KTES supports 125 tenants with the option of supporting up to 3000 tenants. The KTES also includes:
 - a. 4 lines x 20 characters LCD module with controllable LED backlighting
 - b. Programming menus available in three (3) languages (English, French and Spanish)
 - c. Built-in RS-485
 - d. 128-bit AES encrypted Ethernet
 - e. Internal modem
 - f. Three (3) relays
 - g. Microphone
 - h. Speaker
 - i. Backup battery
 2. Optional KTES accessories are:
 - a. Heater kit
 - b. Postal lock
 - c. Color camera
 - d. Goose neck mounting
 - e. Paper index (flush mounted)
 3. The KTES shall be programmed via the keypad and LCD for stand alone mode or via the SMS.
 4. The unit shall support a Wiegand reader that will allow tenants to wipe their cards and enter the building.
 5. The KTES shall employ flashable firmware with auto update.
- F. Card and Reader Support
1. The SMS shall support configuration of unlimited card formats.
 2. The SMS shall support up to 2 card formats per controller (3 with DUAL ioProx driver).

3. The SMS shall support readers that provide Wiegand signaling and magnetic ABA signaling to include:
 - a. Kantech ioProx family of readers
 - b. Wiegand swipe readers
 - c. Proximity readers
 - d. Biometric readers
 - e. Smart card readers
 - f. Wireless readers
 - g. Magnetic readers

PART 3 EXECUTION

3.1. TESTING

- A. The software shall be entered into the SMS computer systems and debugged. The Contractor shall be responsible for documenting and entering the initial database into the system. The Contractor shall provide the necessary blank forms with instructions to fill-in all the required data information that will make up the database. The database shall then be reviewed by the Contractor and entered into the system. Prior to full operation, a complete demonstration of the computer real-time functions shall be performed. A printed validation log shall be provided as proof of operation for each software application package. In addition, a point utilization report shall be furnished listing each point, the associated programs utilizing that point as an input or output and the programs which that point initiates.
- B. Upon satisfactory on-line operation of the system software, the entire installation including all subsystems shall be inspected. The Contractor shall perform all tests, furnish all test equipment and consumable supplies necessary and perform any work as required to establish performance levels for the system in accordance with the specifications. Each device shall be tested as a working component of the completed system. All system controls shall be inspected for proper operation and response.
- C. Tests shall demonstrate the response time and display format of each different type of input sensor and output control device. Response time shall be measured with the system functioning at full capacity. Computer operation shall be tested with the complete data file.
- D. The Contractor shall maintain a complete log of all inspections and tests. Upon final completion of system tests, a copy of the log records shall be submitted as part of the as-built documentation.

3.2. TRAINING

- A. The Contractor shall provide a competent trainer who has extensive experience on the installed systems and in delivering training to provide the instruction. As an alternate, the Contractor may propose the use of factory training personnel and coordinate the number of personnel to be trained.

3.3. MAINTENANCE

- A. The Contractor shall offer a Kantech Advantage Program (KAP) to provide twelve additional months of free software updates and online training for the end user.
- B. Technical support is available at no charge to all Kantech dealers whether or not they have a KAP activated for the systems they are supporting.

END OF SECTION 281301.00

SECTION 281302.00 - SECURITY VIDEO SURVEILLANCE SYSTEM

PART 1 PART 1 – GENERAL

1.1. SUMMARY

- A. Section Includes: Description, architectural and functional requirements, data security requirements, operational capabilities, and computer equipment requirements for a single or multi-site on-premises Video Management Software (VMS) supporting an unrestricted number of Section Includes: Description, architectural and functional requirements, data security requirements, operational capabilities, and computer equipment requirements for a single or multi-site on-premises Video Management System (VMS) supporting an unrestricted number of intelligent video walls, users, devices, servers and sites.
- B. Compliance: System equipment and installation shall comply with all provisions and requirements of this specification as well as all applicable national, state and local codes and standards.
- C. Related Requirements:
 - 1. Section 27 00 00 Communications (Division 27).
 - a. Section 27 05 00 Common Work Results for Communications.
 - 1) Section 27 05 28 – Pathways for Communication Systems.
 - b. Section 27 10 00 – Structured Cabling.
 - 1) Section 27 13 00 – Communications Backbone Cabling.
 - 2) Section 27 15 00 – Communications Horizontal Cabling.
 - 2. Section 28 00 00 Electronic Safety and Security (Division 28).
 - a. Section 28 05 00 – Common Work Results for Electronic Safety and Security.
 - b. Section 28 08 00 Commissioning of Electronic Safety and Security.
 - 1) 28 08 11 Testing for Baseline Performance Criteria.

1.2. SYSTEM DESCRIPTION

- A. General
 - 1. The system shall be an expansion of the client’s existing Milestone system.
 - a. Coordinate licensing and server requirements with district IT manager.
 - 2. The system shall be constructed of products from one or more manufacturers that are designed by the manufacturer to integrate and interoperate with one another to the degree necessary to achieve compliance with these specifications.
 - 3. The system shall be capable of and enabled to communicate across a LAN and WAN for both fundamental and administrative functions.
 - 4. The system shall allow upgrades of both hardware and software seamlessly without the loss of database, system configuration, and historical data.

5. The system shall feature integrated user interface maps that enable viewing of system status and control of devices (end points), e.g. doors.

1.3. REFERENCES

A. Trademarks Used in This Document:

1. Apple: Safari®
2. Digital Living Network Alliance: DLNA®
3. Google: Google Chrome™
4. Intel: Intel®, Core™, Xeon®
5. Microsoft: Microsoft®, Outlook®, Windows®, Active Directory®, Hyper-V®, SQL Server®, Microsoft Internet Explorer®
6. Milestone: XProtect®, Milestone Husky™, Milestone Federated Architecture™, Milestone Interconnect™, Scalable Video Quality Recording™
7. Milestone: XProtect®, Milestone Husky™, Scalable Video Quality Recording™
8. NVIDIA: NVIDIA®
9. Mozilla: Mozilla®, Firefox®
10. Veracity: COLDSTORE™
11. VMware: VMware®
12. Western Digital: MyCloud™

B. Abbreviations and Acronyms:

1. ACC: Advanced Audio Coding.
2. AES: Advanced Encryption Standard.
3. API: Application Programming Interface.
4. CA: Certificate Authority.
5. DES: Data Encryption Standard.
6. DLNA: Digital Living Network Alliance.
7. DWG: Drawing file format.
8. DXF: Drawing Interchange Format or Drawing Exchange Format.
9. EULA: End User License Agreement.
10. FPS: Frames per Second.
11. Full HD: High Definition video resolution of 1920 x 1080 pixels.
12. GB: Gigabyte.
13. GIS: Geographic Information System.
14. GOP: Group of Pictures.
15. H.264/H.265: Video compression formats.
16. HD: High Definition video resolution of 1280 x 720 pixels.
17. HTML: Hyper Text Markup Language.
18. HTTPS: Hyper Text Transfer Protocol Secure.
19. I/O: Input/Output.

20. IP: Internet Protocol.
21. JPEG: Joint Photographic Experts Group (image format).
22. LAN: Local Area Network.
23. LPR: License Plate Recognition.
24. MFA: Milestone Federated Architecture.
25. MPEG: Moving Picture Experts Group (video format).
26. NAS: Network Attached Storage.
27. NAT: Network Address Translation.
28. NVR: Network Video Recorder.
29. ONVIF: Open Network Video Interface Forum.
30. PTZ: Pan-Tilt-Zoom.
31. RTSP: Real Time Streaming Protocol.
32. SDK: Software Development Kit.
33. SNMP: Simple Network Management Protocol.
34. SVQR: Scalable Video Quality Recording.
35. UPnP: Universal Plug and Play.
36. UPS: Uninterruptible Power Supply.
37. VMS: Video Management System.
38. WAN: Wide Area Network.

C. Definitions:

1. AAC Audio Codec: Advanced Audio Coding is a proprietary audio coding standard for lossy digital audio compression.
2. Active Media Storage: High-performance media storage used for active video, audio and metadata recording.
3. Application Programming Interface (API): Set of clearly defined methods of communication between various software components.
4. Archived Media Storage: Secondary media storage used for storing video, audio and metadata beyond an initial retention period.
5. Authentication: Process that establishes the origin of information or determines an entity's identity.
6. Authorization: Process that associates permission to access a resource or asset with a person and the person's identifier(s) for the purpose of granting or denying access.
7. Bit Rate: Number of bits per time unit sent over a network.
8. Contractor: Firm selected by Owner and any of Contractor's subcontractors, vendors, suppliers or fabricators, to perform work specified in these contract documents and supporting documentation. Contractor shall supply all equipment, labor, material and services necessary to complete the project construction in accordance with Contract Documents.

9. Central Processing Unit (CPU): General purpose electronic circuitry within a computer that carries out the instructions of a computer program, typically contained in a single integrated circuit chip.
10. Digital Living Network Alliance: Standards-making group for consumer electronics manufacturers establishing interoperability among consumer devices for picture and video display.
11. Dwg-files: Proprietary binary file format used for storing two- and three- dimensional design data and metadata.
12. Dxf-files: CAD data file format developed by Autodesk for enabling data interoperability between AutoCAD and other programs.
13. EuroPriSe: European Privacy Seal, an independent and recognized certification institute.
14. G.711 Audio Codec: ITU-T standard audio codec that provides toll-quality audio.
15. G.726 Audio Codec: ITU-T ADPCM speech codec standard covering the transmission of voice.
16. Graphics Processing Unit (GPU): Specialized electronic circuit designed to rapidly decode video, manipulate images and accelerate the creation of video images in a video frame buffer intended for output to a display device, much more efficiently than can be done by general purpose computer CPUs. GPUs are used in mobile phones, personal computers, workstations and game consoles.
17. Group of Pictures (GOP): In video coding, a group of pictures, or GOP structure, specifies the order in which intra- and inter-frames are arranged. The GOP is a collection of successive pictures within a coded video stream. Each coded video stream consists of successive GOPs, from which the visible frames are generated. Encountering a new GOP in a compressed video stream means that the decoder doesn't need any previous frames to decode the next ones and allows fast seeking through the video.
18. Hardware Acceleration: Use of computer hardware (such as a GPU) to perform some functions more efficiently than is possible in software running on a more general-purpose CPU.
19. Kerberos: Ticket-based network authentication protocol designed to provide strong authentication for client/server or server/server applications.
20. Multicast: Communication between a single sender and multiple receivers on a network.
21. Multi-site: Reference to a VMS that spans multiple physical site locations.
22. Open Network Video Interface Forum (ONVIF): Global and open industry forum for the creation of standards for how IP-networked products within video surveillance and other physical security areas can communicate with each other.
23. Pre-buffering: Temporary storage of video and audio for pre-recording.
24. Pre-recording: Automatically recording video and audio starting a specified number of seconds just before the event or time condition that initiated the recording.

25. Post-recording: Automatically continuing the recording of video and audio for a specified number of seconds after the end of the event or time condition that initiated the recording.
 26. PTZ Patrolling or PTZ Tour: Automatically moving a camera through a specified series of preset PTZ positions, dwelling on those positions for a specified amount of time, and transitioning between the preset positions at a specified speed.
 27. Reseller: Contractor authorized by manufacturer to furnish, install and maintain manufacturer's VMS, who may be the primary contractor or a subcontractor for the provision of this project's VMS.
 28. Simple Network Management Protocol (SNMP): Internet-standard protocol for collecting and organizing information about managed devices on IP networks and for modifying that information to change device behavior and to be alerted to changes in device status.
 29. SNMP Trap. Alert messages sent from an SNMP-enabled device or application agent to a central collector such as SNMP management software.
 30. Universal Plug and Play (UPnP): Set of networking protocols that permits networked devices, such as personal computers, printers, Internet gateways, Wi-Fi access points, IP video cameras and mobile devices to seamlessly discover each other's presence on the network and establish functional network services for data sharing and communications.
 31. Video Wall: Video display wall composed of consumer-grade video display monitors, whose contents are managed manually by operator or by event-based or time-scheduled application rules applied in real-time.
- D. Brand Names Used in This Document:
1. Milestone Husky™ M20
 2. Milestone Husky™ M30
 3. Milestone Husky™ M50
 4. Milestone Husky™ M500 Advanced
 5. Milestone Husky™ M550 Advanced
 6. Milestone Husky™ X2
 7. Milestone Husky™ X8
 8. XProtect® Corporate
 9. XProtect® Enterprise
 10. XProtect® Expert
 11. XProtect® Express
 12. XProtect® Express+
 13. XProtect® LPR
 14. XProtect® Professional
 15. XProtect® Professional+
 16. XProtect® Retail

17. XProtect® Transact

1.4. SUBMITTALS

- A. Submission: Submit under provisions of Section 01 30 00 - Administrative Requirements.
- B. Product Data: Provide manufacturer's data sheets and installation manuals on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Shop Drawings: Provide the following drawings.
 - 1. Schematic of system components with physical space requirements.
 - 2. System network topology diagram.
 - 3. Connecting riser diagrams for all interfacing equipment.
 - a. List of all equipment with part numbers.
 - b. Locations for all components to be installed under this scope of work.

1.5. CLOSEOUT SUBMITTALS

- A. As-Built Drawings: Provide original shop drawings modified to reflect changes made to comply with installation/configuration requirements and actual field conditions.
- B. Maintenance Contracts: Submit a maintenance service agreement, including cost and services for a two-year period for Owner's review.
- C. Warranty Documentation: Submit manufacturer's standard VMS warranty.

1.6. QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, material and services specified for this project for commercial, military or industrial use.
 - 2. Contractors / Installers:
 - a. Licensure: Contractor or security sub-contractors shall be licensed to perform security installations in the state/region where the work is to be performed if so required.
 - b. Experience: Contractor or security sub-contractor shall have a minimum of three years of experience installing and servicing systems of similar scope and complexity.
 - c. References: Contractor shall provide four current project references from clients with systems of similar scope and complexity which became operational in the past three years.

- 1) At least three references shall be utilizing the same system components, in a similar configuration as the proposed system.
 - 2) References shall include a current point of contact, company or agency name, business address, telephone number, and if the contact agrees, include a basic system description and date of project completion. The owner reserves the option to visit the reference sites, with the site owner's permission and representative, to verify the quality of installation and the reference's level of satisfaction with the system.
- d. Technician Certification: Utilize only manufacturer-trained technicians to install, program, and service VMS equipment.
- 1) Provide copies of system manufacturer certification for all technicians.
 - 2) Ensure technicians have a minimum of five continuous years of technical experience in electronic security systems including IP networking and VMS solutions.
- e. Dealer Certification: Provide evidence that installing service company is an authorized dealer in good standing for the product's manufacturer, and that it meets the manufacturer's technical certification requirements.

1.7. DELIVERY, STORAGE AND HANDLING

- A. Deliver software installation packages via download directly from manufacturer's web site
- B. Software installation packages must be digitally signed by the manufacturer.

1.8. WARRANTY AND SUPPPORT

- A. Manufacturer Warranty and Support:
1. Software Warranty:
 - a. Manufacturer's software warranty must be described in the manufacturer's EULA for the product.
 2. Software Support:
 - a. Provide free access to any software service updates or hot fixes released due to a material defect or error in the product.
 - b. Provide new device driver packs, multiple times per year, to extend support for additional devices without the need for a new version of the product.
 - c. Provide free access to self-paced interactive e-training.
 3. Software Updates and Upgrades:
 - a. Make software upgrades available for a period of one year from activation of the software license. Coverage options shall include:
 - 1) Free access to any new product versions for the purchased VMS software product.
 - 2) 100% credit on owners current VMS product when upgrading to a more advanced version of the same VMS product.

- 3) Case Management online tool for submitting and tracking technical cases.
 - 4) Direct Access to technical support via e-mail and phone.
 - 5) Prioritized handling of support phone call response times based upon criticality of issue, for questions submitted by email or that cannot be answered in initial phone call.
 - 6) Additional years of software upgrades available for purchase separately.
- B. Contractor Warranty:
1. Fully warrant parts, materials and labor for a minimum of one year from date of the final acceptance of the VMS, including wiring, software, hardware and third-party products, including:
 - a. Provision of all new software service releases during the warranty period.
 - b. Provision of all new device driver packs.
- C. Maintenance and Service:
1. General Requirements:
 - a. Provide all services required and equipment necessary to maintain VMS in an operational state as specified for one year from formal written acceptance of system.
 - b. Provide all necessary material required for performing scheduled adjustments or other non-scheduled work.
 - c. Minimize impacts on facility operations when performing scheduled adjustments or other non-scheduled work.
 2. Description of Work: Deployment of VMS includes installation and setup of new server hardware and software, plus any new and existing equipment specified in Article 2.1. OWNER-FURNISHED PRODUCTS.
 3. Personnel: Service personnel shall be certified in the maintenance and repair of the selected type of equipment and integrations, and qualified to accomplish all work promptly and satisfactorily.
 4. Schedule of Work: Work shall be performed during regular workweek working hours, as determined by the deployment facility's locale, excluding federal/public holidays.
 5. Verification of Operation: As part of scheduled adjustments and repairs, verify operation of system as demonstrated by performance verification testing.

PART 2 PRODUCTS

2.1. GENERAL

- A. The scope of this work includes:
1. Camera, mounts, and Accessories
 2. Extended distance transmission (if needed)

3. Video Surveillance Server with a minimum of 30 days video retention (coordinate with client)
 4. Aiming of cameras (coordinate with client or their designee)
- B. Work by owner
1. Client will provide the Milestone software for the server and its configuration.
 2. Client will provide instruction on the actual view for each camera (i.e. aiming).

2.2. MANUFACTURER

- A. Qualification: Manufacturer shall have regularly produced, as one of the manufacturer's principal products, a VMS similar to that specified for this project for at least five years.
- B. Substitution Limitations: Product substitutions must conform to the functional requirements of this specifications document. System architectural differences are acceptable as long as functional requirements are met under the alternate architecture. Windows 32-bit applications shall not be substituted for 64-bit applications.

2.3. VIDEO MANAGEMENT SYSTEM

- A. Description: Video surveillance management software (referred to as "system" or "VMS") supporting an unrestricted number of users, devices, servers and sites, with options for high availability, intelligent video walls, central surveillance operations and mobile devices.
- B. GDPR-Ready Certification: The VMS must have a GDPR-ready seal from EuroPriSe.
1. The vendor shall provide comprehensive guides and templates to aid in configuring a GDPR compliant system.
- C. System Architecture: The VMS shall consist of:
1. Servers: One or more VMS servers.
 - a. Physical or virtualized Windows servers.
 - b. Virtualized Windows servers, using:
 - 1) Microsoft Hyper-V.
 - 2) VMWare.
 - c. UPS provided to physical servers, network infrastructure and devices such as cameras.
 2. Server Software Components: One or more software components by Manufacturer, or software components made by others as noted, per VMS server.
 - a. Management Server: Central service component of the VMS responsible for handling system configuration, distributing the configuration to other system components, such as recording server services, and for facilitating user authentication.

- b. Failover Management Server: Installation of the management server service in a Microsoft Windows Failover Cluster, or similar, which ensures that another server takes over the management server function, should the first server fail.
- c. Recording Server: Service responsible for communications, recording and event handling for all devices (cameras, video and audio encoders, I/O modules, metadata sources, etc.), including:
 - 1) Retrieving video, audio, metadata and I/O event streams from devices.
 - 2) Recording video, audio and metadata.
 - 3) Providing access to live and recorded video, audio and metadata.
 - 4) Transmit live audio from operator's microphone to one or more camera speakers or supported IP speakers.
 - 5) Providing access to device status.
 - 6) Triggering system and video events on device failures, events, etc.
 - 7) Writes video streams, audio streams and their metadata to a high-performance media database.
 - 8) Performing motion detection and generate smart search metadata.
 - 9) Communicating with other Milestone products when using the Milestone Interconnect technology.
 - 10) Communicating with other VMS products when using interconnected technology.
- d. Failover Recording Server: Implementation of recording server service designated to take over recording and other tasks should an active recording server fail.
 - 1) Failover recording server shall operate in two modes: cold-standby for monitoring multiple recording servers and hot-standby for monitoring a single recording server.
 - 2) Both cold- and hot-standby mechanisms shall offer fully automatic and user transparent failover in the event of hardware or system failure, with automatic synchronization of video, audio and metadata at system recovery.
- e. Event Server: Service that handles various tasks related to events, alarms, maps and third-party integrations via the Software Development Kit (SDK).
- f. Failover Event Server: Implementation of event server service by installing event server in a Microsoft Windows Failover Cluster, to ensure that another server takes over should the first server fail.
- g. Log Server: Service that writes all system, audit and rule-triggered log messages to database.
- h. Service Channel: Service responsible for communicating the following:
 - 1) Service and configuration messages to full viewing client.
 - 2) Updates to a video wall monitor layout.
 - 3) Communicating that a specific failover recording server is active.
- i. Mobile Server: Service responsible for hosting the web client and for providing access to the VMS for web client and mobile client users.

- j. ONVIF Out: Optional server, plus 64-bit plug-in for management client. This is to enable private-to-public video integration.
 - k. DLNA Out: Service to enable display of live video on any DLNA compliant TV or displays without the need for additional equipment.
 - l. Microsoft SQL Server: Microsoft database server service for the management server, event server and log server services.
 - m. Microsoft Active Directory (required for MFA): Microsoft Active Directory (required for federated architecture): Active Directory is not required for single-site systems but is recommended for cyber security purposes.
3. PC or Laptop Workstations: One or more PCs or laptops for client software applications intended to run on Windows-based PCs and laptops.
- a. Management Client: The administration interface for all parts of the VMS, designed to be run remotely from, for example, an administrator's computer.
 - b. Full Viewing Client: Designed for day-to-day use by dedicated operators, to be run remotely on the operator's computer. Full viewing client provides dedicated task-oriented tabs for Live Video, Video Playback, Search, plus dockable tabs for System Monitor and Alarm Monitor. Full viewing client supports definable keyboard and joystick button shortcuts for frequently-used actions, including window or camera selection.
 - c. Web Client: Browser-based application for the occasional or remote user that needs easy access to live video monitoring and audio listening with PTZ control including use of presets, and video and audio playback and export, with defined exports available for later usage or download.
4. Tablets or Smartphones: One or more tablets or smartphones using web client (see above) or mobile client.
- a. Mobile Client: Native mobile app for smartphone or tablet users, for easy access to live and playback of cameras, and to activate system events and outputs. Additionally, for use as a remote recording device by using the mobile device's built-in camera, whereby video from the device's camera is streamed back to the VMS and recorded like a standard camera.
5. Video Walls: Optionally one or more video walls.
6. Wide-Area Surveillance System: Optionally one or more individual Milestone VMS products connected to gain central surveillance operation across geographically dispersed sites.
7. Wide-Area Surveillance System: Optionally one or more individual VMS products connected to gain central surveillance operation across geographically dispersed sites.
8. Networks:
- a. Multiple Network Segments: The VMS must support network segmentation into separate device, server and internet-connected networks.

- b. Device Network: Local network whose capacity and configuration are suitable for the level of video, audio and metadata data transmission established by the system design and its intended usage.
 - c. Server Network: Local network whose capacity and configuration are suitable for the level of video data transmission, systems integration, and user operations established by the system design and its intended usage.
 - d. Internet-Connected Network: Internet-connected network providing connection to remote VMS sites and private-to-public connection via ONVIF Out. This network is also used for remote user access via the mobile server.
 - e. Network Traversal:
 - 1) Enable software clients to access recording server services from outside a NAT firewall, by the use of public addresses and port forwarding.
 - 2) Provide Remote Connect Services that enable secure remote connections to devices across different types of private and public networks.
- D. Multi-System Architectures: Provide three architecture options for multi-site deployments:
- 1. Distributed Recording Server Services: Intended for sites with stable network connections between the central site and any number of remote sites.
 - a. Management Server at central site is providing user authentication and authorization for all distributed Recording Server services.
 - b. Each site has at least one Recording Server.
 - 2. Distributed Recording Server Services: Intended for sites with stable network connections between the central site and any number of remote sites.
 - a. Management server at central site is providing user authentication and authorization for all distributed recording server services.
 - b. Each site has at least one recording server.
 - 3. Milestone Federated Architecture: Intended for sites with stable network connections between all sites, establishes central management of, and central surveillance operations for, geographically dispersed sites via one or more levels of parent/child system connections. The federated architecture shall:
 - 1) Management Server at parent site is providing user authentication for the full federated system and each child site Management Server is providing authorization.
 - 2) Each site is equipped with one Management Server and at least one Recording Server.
 - 3) Parent systems must be XProtect Corporate systems.
 - 4) Child systems may be any number of XProtect Corporate, XProtect Expert, Milestone Husky M500 Advanced, Milestone Husky M550 Advanced, Milestone Husky X2 and Milestone Husky X8 systems.
 - 5) Child XProtect Corporate and XProtect Expert systems function as autonomous sites even upon loss of network connectivity.

4. Federated Architecture: Intended for sites with stable network connections between all sites, establishes central management of, and central surveillance operations for, geographically dispersed sites via one or more levels of parent/child system connections. The federated architecture shall:
 - a. Allow a federated site to have maximum one parent site and unrestricted children sites.
 - b. Management server at parent site is providing user authentication for the full federated system and each child site management server is providing authorization.
 - c. Each site is equipped with one management server and at least one recording server.
 - d. Allow central handling of alarms from all sites in the hierarchy in a unified alarm interface.
 - e. Must not require additional licenses as long as all sites are owned by the same legal entity. Deployment of the federated architecture between two or more video management software owned by different legal entities shall be subject to the following licensing:
 - 1) Each legal entity must have a base license for the VMS and device licenses for all the cameras in the respective system.
 - 2) Child VMS function as autonomous sites even upon loss of network connectivity.
 - f. Make site details, including name, address, administrators and additional information, defined in the federated system available in the site navigation.
5. Interconnected Architecture: Suitable for providing central surveillance operations capabilities for a centrally XProtect Corporate-managed distributed system where some or all network connections between the local systems are unstable or intermittent. Interconnected Architecture: Suitable for providing central surveillance operations capabilities for a centrally managed distributed system where some or all network connections between the local systems are unstable or intermittent. Capabilities shall include:
 - a. Management Server at central site is providing user authentication and authorization for all interconnected cameras.
 - b. Remote site is providing authentication and authorization to its cameras on central system access.
 - c. Central site is equipped with one Management Server and at least one Recording Server.
6. Capabilities shall include:
 - a. Management server at central site is providing user authentication and authorization for all interconnected cameras.
 - b. Remote site is providing authentication and authorization to its cameras on central system access.

- c. Central site is equipped with one management server and at least one recording server.
- d. Remote site is one of the following products and their later editions:
 - 1) XProtect Corporate 2013
 - 2) XProtect Expert 2013
 - 3) XProtect Enterprise 8.0
 - 4) XProtect Professional 8.0
 - 5) XProtect Professional+ 2017 R2
 - 6) XProtect Express 1.0
 - 7) XProtect Express+ 2017 R2
 - 8) Milestone Husky M20 2016 R2
 - 9) Milestone Husky M30 2013
 - 10) Milestone Husky M50 2013
 - 11) Milestone Husky M500 Advanced 2016
 - 12) Milestone Husky M550 Advanced 2016
 - 13) Milestone Husky X2 2018 R2
 - 14) Milestone Husky X8 2018 R2
- e. Site Independence: Remote sites using the interconnected systems functionality shall operate as a full and separate VMS and NVR systems.
- f. Different Network Domains: All or some systems may run on different network domains.
- g. Number of Remote Sites: Any number of remote sites, which may run any size and any number of separate supported VMS and NVR systems.
- h. Upload Management: Provide for the transfer of recordings from remote sites to the central site. It shall be possible at the central site to automatically or manually request recordings from the remote site, which requests shall be queued for execution once the remote site is connected to the central site's network. Users may define time intervals and bandwidth caps for upload of video from a remote site.
- i. Mobile and On-Premise VMS Support: Remote sites can be on-premise systems or mobile systems, for example busses, trains and ferries and should be resilient to intermittent connectivity to central site.
- j. Status Detection: VMS proactive detection of errors and cost-efficient management of connected sites by propagation of system status events and embedded remote management of connected system.
- k. Remote Management: VMS detection of system problems and remote management of interconnected sites.
- l. Device Driver: Connect the high-end VMS with most other VMS and NVR versions made by the software manufacturer through a device driver-based interconnected systems functionality.

- m. Central Video View and Playback: Live video and playback of video for cameras from the remote site shall be the same as for cameras connected directly to the central site.
- n. Remote Camera Licenses: VMS shall require a dedicated camera license for each interconnected camera that is enabled on the central site.

2.4. SYSTEM DESIGN CRITERIA

- A. Scalability: Provide component-based system architecture to support scaling of VMS from small systems (up to 100 devices) to very large systems (several thousand devices) for single-site or multi-site deployment, whereby:
 - 1. For Small Systems: All software components can be installed on the same server if the server is able to handle the combined load.
 - 2. For Large Systems: Software components can be installed on separate dedicated servers to scale and distribute the load.
- B. Availability and High Performance: Provide the following capabilities to ensure high VMS availability and performance.
 - 1. Failover Recording Server: Provide hot and cold failover recording server capabilities.
 - 2. Management Server, Event Server, Log Server: Support Windows Server Failover Clustering, or similar.
 - 3. Storage solution shall be configured with RAID10 for Live database and RAID5 or RAID6 for archive database.
- C. Operating Systems: Provide server and client software applications that are native 64 bit Microsoft Windows applications.
- D. Network Addressing: Support both IPv4 and IPv6 addressing.
- E. Video Standards: Provide simultaneous digital multi-channel live streaming and recording of video from IP cameras and IP video encoders without any software limitations on the number of cameras per Recording Server, with support for the following codecs and options:
- F. Video Standards: Provide simultaneous digital multi-channel live streaming and recording of video from IP cameras and IP video encoders without any software limitations on the number of cameras per recording server, with support for the following codecs and options:
 - 1. Codecs:
 - a. H.264 and H.265
 - b. MPEG-4 and MPEG-4 ASP
 - c. MJPEG
 - d. MxPEG
 - 2. Options:
 - a. Toggling between recording key frames only or full video stream for MPEG-4, H.264 and H.265 video.
 - b. Adjustable GOP length for MPEG-4, H.264 and H.265 video.

- c. Toggle between recording full framerate from the camera and any lower FPS for MJPEG video.
- G. Video De-Interlacing: Provide live video views with an adaptive de-interlacing option, to improve the quality of interlaced video, based on the actual video content received, for example, to smooth area of an image where object lines would otherwise appear as jagged lines.
- H. Multi-Live Video Streaming: Provide multiple streams for live viewing using any combination of supported standards, video resolutions and frame rates.
- I. Adaptive Streaming: Provide automatic selection between the live video streams configured for multi-live video streaming from the Recording Server to the XProtect Smart Client or XProtect Smart Wall depending on the requested resolution.
- J. Adaptive Streaming: Provide automatic selection between the live video streams configured for multi-live video streaming from the recording server to the Full Viewing Client or video wall depending on the requested resolution.
- K. Audio Standards: Provide simultaneous digital two-way audio streaming and recording of audio from IP speaker and IP microphone devices without any software limitations on the number of devices per recording server, with support for the following codecs and options:
 - 1. Codecs:
 - a. AAC
 - b. G711
 - c. G726
 - 2. Options:
 - a. Playback of audio files on rule.
- L. DLNA Support: Provide the ability to easily display live video from the installed cameras directly onto any modern consumer-grade TV supporting DLNA functionality.
- M. Hardware Acceleration Full Viewing Client: Provide the following hardware acceleration capabilities to offload full viewing client video processing from the computer CPU to dedicated hardware video processing capabilities:
 - 1. NVIDIA GPU: Automatically detect and use all available NVIDIA GPUs, for hardware accelerated decoding, color correction, and scaling.
 - 2. Intel Quick Sync: Automatically detect and use Intel Quick Sync Video GPU integrated into select Intel processors for hardware accelerated decoding, color correction, and scaling.
 - 3. Provide the ability to use both NVIDIA and Intel GPUs at the same time and automatically load balance the requests for optimal performance.
 - 4. Provide the ability to show which GPU is used to decode which stream.

- N. Hardware Acceleration Recording Server: Provide the following hardware acceleration capabilities to offload recording server video processing from the computer CPU to dedicated hardware video processing capabilities:
1. NVIDIA GPU: Automatically detect and use all available NVIDIA GPUs, for hardware accelerated decoding to enable server-side motion detection.
 2. Intel Quick Sync: Automatically detect and use Intel Quick Sync Video GPU integrated into select Intel processors for hardware accelerated decoding to enable server-side motion detection.
 3. Provide the ability to use both NVIDIA and Intel GPUs at the same time and automatically load balance the requests for optimal performance.
- O. Hardware Acceleration Mobile Server: Provide the following hardware acceleration capabilities to offload mobile server video processing from the computer CPU to dedicated hardware video processing capabilities:
1. NVIDIA GPU: Automatically detect and use all available NVIDIA GPUs, for hardware accelerated decoding to enable adaptive transcoding.
 2. Intel Quick Sync: Automatically detect and use Intel Quick Sync Video GPU integrated into select Intel processors for hardware accelerated decoding to enable adaptive transcoding.
 3. Provide the ability to use both NVIDIA and Intel GPUs at the same time and automatically load balance the requests for optimal performance.
- P. ONVIF Out Functionality: Provide access to live and recorded video, and the ability to control pan-tilt-zoom cameras in compliance with the relevant ONVIF Profile G and Profiles S standards.
- Q. Camera-Independent Motion Detection: Provide real-time, camera-independent motion detection with:
1. Configurable Sensitivity: Configurable and automatic motion-detection sensitivity per camera
 2. Searchable Metadata: Searchable motion detection metadata created during motion detection.
 3. Exclusion Zones: Multiple motion exclusion zones definable per camera to keep irrelevant motion from triggering recording.
- R. PTZ Control Priorities:
1. Provide 32,000 PTZ priority levels for control of rights between different operators and automatic scanning and patrolling schemes.
 2. PTZ Scans and Patrols shall pause for higher-priority manual or event-based camera control, and resume after manual session timeout and completion of event camera control period.
- S. Configurable Pre-Buffering: Provide pre-buffering with variable buffer length, with the ability to place buffer on disk or in memory.

- T. Device Video Quality Optimization: Provide video quality optimized per available bandwidth, device screen resolution, and camera view window sizes in these clients:
 - 1. Full Viewing Client Optimization:
 - a. Switch between all configured live video streams from the cameras to optimize bandwidth consumption and workstation performance.
 - b. Optimize viewing performance for remote viewing according to the available bandwidth and view layouts, maximizing video stream quality per display capabilities of defined views.
 - 2. Web Client and Mobile Client Optimization: Optimize transcoding by capping video stream resolution and frame rate for transmission to web client and mobile client.
- U. Multicasting: Provide optimization of network load in systems with many users viewing the same camera live, by sending one video stream per camera to multiple XProtect Smart Client and XProtect Smart Wall instances.
- V. Multicasting: Provide optimization of network load in systems with many users viewing the same camera live, by sending one video stream per camera to multiple full viewing client and video wall instances.
- W. Multiple Language Support: Provide support for multiple languages in these clients:
 - 1. Management Client User Interface: American English, Chinese (Simplified), Chinese (Traditional), Danish, French, German, Italian, Japanese, Korean, Portuguese (Brazilian), Russian, Spanish, Swedish and Turkish.
 - 2. Management Client Built-In Help: American English, Chinese (Simplified), French, German, Japanese, Korean and Portuguese (Brazil).
 - 3. Full Viewing Client, Web Client and Mobile Client User Interface: American English, Arabic, Bulgarian, Chinese (Simplified), Chinese (Traditional), Croatian, Czech, Danish, Dutch, Farsi, Finnish, French, German, Hebrew, Hindi, Hungarian, Icelandic, Italian, Japanese, Korean, Norwegian (Bokmål), Polish, Portuguese (Brazilian), Russian, Serbian, Slovak, Spanish, Swedish, Thai and Turkish.
 - 4. Full Viewing Client Built-In Help: American English, Arabic, Chinese (Simplified), Chinese (Traditional), Czech, Danish, Dutch, French, German, Italian, Japanese, Korean, Polish, Portuguese (Brazilian), Russian, Spanish, Swedish and Turkish.
 - 5. Web Client and Mobile Client Built-In Help: American English, Danish and Japanese.
- X. True Multi-Window Support: Provide true multi-window support in full viewing client whereby secondary windows have full functionality and can be operated in independent mode or synchronized mode where they follow the control of the main window.
- Y. SNMP Agent: Provide VMS functionality to act as SNMP agent that can generate an SNMP trap upon rule activation.
- Z. System Capacities: Provide the following maximum capacities, constrained only by the physical performance capabilities of installed server hardware and network infrastructure:
 - 1. Unrestricted devices.

2. Unrestricted client software users.
3. Unrestricted mobile devices.
4. Unrestricted client PCs or laptops.
5. Unrestricted servers.
6. Unrestricted video walls, with an unrestricted number and combination of display monitors.
7. Unrestricted sites.
8. Unrestricted system rules.
9. Unrestricted time profiles.
10. Unrestricted software client profiles.
11. Unrestricted media storage.
12. Recording rates of at least 30 FPS per camera, limited only by hardware capabilities.

2.5. SYSTEM SECURITY

- A. Control and Information Security: Provide the following data protection measures and user rights management capabilities in support of system confidentiality, integrity and availability:
 1. Data in Transit:
 - a. HTTPS connections from devices to recording server that support HTTPS connections.
 - b. Encrypted communication between the recording server and services that retrieve streaming data.
 - c. Encrypted communication between the management server and the recording server.
 - d. HTTPS connections from recording server to VMS clients, SDK clients and services that support HTTPS connections.
 2. Data at Rest Integrity and Encryption: Provide encryption and digital signature settings per media storage container.
 - a. Two modes of video database encryption using 256-bit AES encryption:
 - 1) Light Encryption. Encrypts only the first part of the MJPEG or MPEG-4/H.264 video, audio and metadata, to use less processing power for encrypting the video. Video cannot be decoded without the information contained in the encrypted header.
 - 2) Strong Encryption. Encrypts all parts of the video, audio and metadata stored in the database.
 - b. Digital sign media databases with SHA-2 algorithm to establish a means of detecting modification of stored video, audio and metadata.
 3. Off-Premises Live and Recorded Video in Transit: HTTPS connections must use trusted CA certificates and support HTTPS connections from:
 - a. Mobile server to browser-based web client and mobile client app.
 - b. ONVIF Out to remote public systems.

4. Data Integrity of Exported Video:
 - a. Export video in database format that can only be viewed in the Full Viewing Client – Player.
 - b. Per-export password protection for playback.
 - c. 56-bit DES; 128, 192 and 256-bit AES encryption.
 - d. Digital sign exported media with SHA-2 algorithm to establish a means of detecting modification of exported video.
 - e. Include any digital signatures applied in the media database.
 - f. Full Viewing Client – Player’s Verify Signatures function to validate authenticity of exported video recording.
 - g. Option to prevent re-export of exported video.
 5. Digital Certificates: Use of customer-provided CA digital certificates for connections to the mobile server.
 6. Data Access Control: Provide:
 - a. User profiles restricting device access and video viewing, playback and export, including by day and time-of-day.
 - b. Timestamped audit log of who logged in, viewed live or recorded video, or exported video.
- B. User Authentication:
1. Log-in Options: Log-in authentication via:
 - a. Microsoft Active Directory.
 - b. Local Windows user accounts.
 - c. Basic user system account (username and password credentials).
 - d. Dual authentication, a.k.a. two-person rule, requiring two verified persons to gain access.
 2. Auto-Log-In: Use of last used credentials for authentication, with Auto-log-in and auto-restore of camera views.
 3. Kerberos Authentication: Provide strong authentication via Kerberos support.
- C. User Rights Management: Provide common and central detailed management of user rights across all user and programmatic (SDK) interfaces, using roles, users, and user groups:
1. Tiered User Rights: Assign partial management of permissions to system administrators using the Management Client.
 2. User Rights: Define roles, add and delete users, manage permissions for roles, user groups and users, generate user rights management reports. Tiered user management rights shall enable differentiated administrator rights per administrator role.
 3. User Rights Inheritance: Create sub-management domains where management of a specific set of devices can be assigned to a specific system administrator.
 4. Roles: Defining roles establishes permissions (also called “rights”) that determine which system features may be accessed by users and groups. Provide the following security settings for roles:

- a. Role Info:
 - 1) General: Management Client profiles, Smart Client profiles, evidence lock profiles, dual authorization rights, system log-in time profile.
 - 2) General: Management client profiles, full viewing client profiles, evidence lock profile, dual authorization rights, system log-in time profile.
 - 3) Applications: Login to full viewing client, web client and mobile client.
 - 4) Anonymous PTZ Sessions: Enabling anonymous user information for PTZ sessions.
- b. Users and Groups: Users and groups can be assigned to multiple roles.
- c. Overall System Permissions: Globally allow or deny permissions for servers, devices and functions (such as manage, read, edit and delete).
- d. Specific System Permissions: Allow permissions for specific individual devices and functions:
 - 1) Cameras: Visibility, live view (within time profile), playback (within time profile), search sequences, smart search, export, manual recording, bookmark functions, AUX commands, evidence lock functions.
 - 2) Microphones and Speakers: Visibility, listen to live audio (within time profile), playback audio (within time profile), search sequences, export, manual recording, bookmark functions, evidence lock functions.
 - 3) Inputs and Outputs: Visibility, activation.
 - 4) PTZ Control: Manual control, activate PTZ presets, PTZ priority, manage PTZ presets and patrolling, reserve and release PTZ session.
 - 5) Speech: Speak to speakers, speak priority.
 - 6) Remote Recordings: Retrieve remote recordings.
 - 7) Video Wall: Visibility, edit, delete, operate, playback.
 - 8) External Events: Visibility, edit, delete, trigger.
 - 9) View Groups: Visibility, edit, delete, operate.
 - 10) Servers: Professional server access and authentication details, Milestone Federated Architecture site permissions.
 - 11) Servers: Professional server access and authentication details, federated architecture site permissions.
 - 12) Matrix: Visibility.
 - 13) Alarms: Manage, view, disable alarms, receive notifications.
 - 14) SDK: SDK plug-in permissions.
- D. Client Authentication: Provide management server authentication and authorization of connecting clients (full viewing client, management client and SDK clients) and use a session-limited access token for controlling access to the recording server.
- E. System Hardening: System hardening guide that:
 - 1. Describes data security, network security and physical security measures and best practices for securing the installed VMS against cyber-attacks. This includes security

considerations for the hardware and software of servers, clients and network device components of a video surveillance system.

2. Incorporates standards-based and best-practice-based security and privacy controls and maps them to each hardening recommendation.

2.6. LOGGING

- A. Provide logging of errors, warnings, system information, user activity, and logs about rules to a centralized database with time, date, and other related information. Logs provide multi-system support and configurable logging limits.
 1. System Logs: Log all system related errors, warnings and system information, to be used for troubleshooting.
 2. Audit Logs: Log user activity in client applications including, but not limited to, user system access, configuration changes and operator actions.
 3. Rule-Triggered Logs: Log rules in which the system administrator has specified the "Make new log entry" action.
 4. Log Exporting: Logs can be exported as comma-separated-values (.csv) files.
 5. Log Filtering: Logs can be filtered based on time frame, source name, source type, user, user location, rule name, etc.
 6. Log-Related Options: Settings can be changed about:
 - a. Log retention time.
 - b. Which levels (error, warning, and system information) are logged.
 - c. Log security.

2.7. SYSTEM FUNCTIONALITY

- A. Configuration Management:
 1. Real-Time Configuration Change Application: Immediately apply authorized changes of system configuration data for all sites, including, but not limited to licenses, devices, rules, schedules, users, maps, alarms, recording, client views, including while recording is in operation.
 2. Configuration Data Caching for Continued Operation: Cached recording server configuration data shall ensure continuous operation of recording server during periods where the management server is inaccessible.
 3. Backup and Restore: Built-in backup and restore support for manual system backup of all configuration data, including but not limited to:
 - a. All system configuration data.
 - b. Full device configuration data.
 - c. Maps.
 - d. Alarm settings and definitions.
 - e. Software client views.
 - f. User-defined rules, events and dashboard customizations.

- 4) Storage container used.
 - 5) Used space.
 - 6) Live FPS.
 - 7) Recording FPS.
 - 8) Live video format.
 - 9) Recording video format.
 - 10) Media data received.
 - d. Historical Reporting: On-screen and PDF report of historical performance data going back 30 days.
 3. Monitoring Multiple Servers and Federated Systems: Provide multiple dockable tabs in XProtect Smart Client with system performance and use information for different servers and federated systems.
 4. Monitoring Multiple Servers and Federated Systems: Provide multiple dockable tabs in full viewing client with system performance and use information for different servers and federated systems.
- C. Application Workspace Optimization:
1. Options for optimizing application workspaces in the management client software:
 - a. Application Layout: Rearranging layout via drag-and-drop.
 - b. Management Client Profiles:
 - c. Management Client Profiles:
 - 1) Centralized management of application options for optimization application for different user categories and skill levels.
 - 2) Ability to tailor the availability of main/sub functions for different user roles.
 2. Options for optimizing application workspaces in the full viewing client software:
 - a. General: Control general look and feel and navigation properties, such as color mode, camera title bar, grid sizes.
 - b. Personal or Centrally Enforced: Optimization can either be made as individual personalization managed by each operator, or centrally enforced using Smart Client profiles.
 - c. Personal or Centrally Enforced: Optimization can either be made as individual personalization managed by each operator, or centrally enforced using full viewing client profiles.
 - d. View Layouts: Availability of specific view layouts enforced using Smart Client profiles.
 - e. View Layouts: Availability of specific view layouts enforced using full viewing client profiles.
 - f. Themes: User interface color schemes enabling user choice of dark or light themes.
 - g. Simple and Advanced Modes: Optional simplified user interface with toggling between "Simple" and "Advanced" mode.

- h. Control Panes Availability: Control availability of control panes and functions in live and playback tabs, and in setup mode.
 - i. Timeline Information: Control information included in timeline in playback tab.
 - j. Export Behavior: Control behavior and availability of export function.
 - k. Keyboard and Joystick Setup: Setup of keyboard short cuts and joystick controls.
 - l. Alarm and Access Control Notifications: Control behavior of alarms and access control notifications.
 - m. Application Language: Control application language.
 - n. Advanced Application Settings: Control advanced application settings such as use of multicast, hardware acceleration, adaptive streaming, videos diagnostics overlay and time zone settings.
- D. Device Discovery and Management:
- 1. Add Hardware wizard to automatically discover and upon approval add devices to system using Universal Plug and Play (UPnP) discovery, IP network range scanning, or manual device detection.
 - 2. Replace Hardware wizard for swift replacement of malfunctioning devices with preservation of configuration settings and recordings, including those for attached cameras, microphones, speakers, inputs, outputs and metadata devices.
 - 3. Move Hardware wizard for moving devices and related devices from one Recording Server to another during runtime with no loss of settings, recordings, rules, permissions etc.
 - 4. Move Hardware wizard for moving devices and related devices from one recording server to another during runtime with no loss of settings, recordings, rules, permissions etc.
 - 5. User ability to enable and disable devices for purposes of maintenance or temporary deactivation.
 - 6. User ability to change the password of one or multiple devices based on a pre-configured time interval. Must be supported for Axis, Bosch, Hanwha Techwin, Panasonic, Hikvision and ONVIF-compliant devices.
 - 7. For ONVIF Profile T & Q compliant devices. User ability to manage a VMS user account that communicates with a device. Add a user, list an existing user, and delete a user.
 - 8. For ONVIF Profile T & Q compliant devices. User ability to manage network configuration. Change IP address, subnet mask, and default gateway.
- E. Camera Image and Video Stream Management: Adjustment of per-camera and per-video stream settings, with each camera allowed one or more streams for live viewing and one stream for recording, including an optional per-camera or per-camera-group preview window:
- 1. Per Camera:
 - a. General Settings: Change all camera specific general settings such as brightness, color level, compression, maximum bit rate, resolution and image rotation.

- b. Camera Video Stream Settings: Define as many different streams as specific camera support. Change individual stream settings such as FPS, resolution, image quality, video encoding format and resolution.
 2. Per Camera Group:
 - a. General Settings: Change all common camera specific general settings for the camera group such as brightness, color level, compression, maximum bit rate, resolution and image rotation.
 - b. Camera Video Stream Settings: Define as many different streams as specific camera support for the camera group. Change individual stream settings such as FPS, resolution, image quality, video encoding format and resolution.
 - c. One camera can be associated to multiple camera groups.
 3. Video Streams: Define one camera video stream used for recording and multiple cameras video streams to be used for live viewing.
 4. Recording: Manage recording functionality including:
 - a. Related device recording.
 - b. Manual recording timer.
 - c. Pre-buffer use.
 - d. Recording framerate.
 - e. Media storage assignment.
 - f. Automatic retrieval of edge recordings.
 5. Fisheye Lens Viewing: Capability for fisheye lens camera views provided through utilization of panomorph lens technology.
 6. Motion Detection: Manage motion detection functionality including:
 - a. Motion sensitivity.
 - b. Processing all frames or keyframes only.
 - c. Generation of motion metadata for smart search.
 - d. Exclusion zones.
 7. Camera Events: Define which camera events will be forwarded to the VMS.
 8. Client Settings: Define client related functionality including:
 - a. Use multicast for live stream.
 - b. Related devices.
 - c. Keyboard shortcut.
 9. Privacy Masks: Permanent and liftable system-defined camera image privacy masks hide certain areas in the camera image for live view, recording, and video export.
 - a. Permanent Masks: Allow a system admin to mask areas in cameras at all times and for all users. Permanently masked areas cannot be revealed once recorded.
 - b. Liftable Masks: Allows a system admin to establish default mask areas in cameras at all times and for all users, but with the option to sufficiently privileged operators to temporarily remove the masks for authorized users if needed – such as during investigation.

- c. Masking Level: When establishing a privacy mask, system admins may select a mask level on a scale between 'light blur' to 'solid grey'.
- F. PTZ Camera Control: Camera-based and system-based PTZ camera control including the following capabilities.
 1. Camera PTZ preset positions: Camera-based PTZ presets may be imported from the camera and renamed for use in system-based manual and automatic PTZ control.
 2. Automated Use of PTZ Presets: Scheduled and event-based rules capability to move PTZ cameras to pre-set positions.
 3. System-Based PTZ Preset Positions: System-based PTZ presets are definable for use in system-based manual and automatic PTZ control.
 4. PTZ Patrolling: Multiple per-camera PTZ patrolling schemes may be defined with the following options:
 - a. Adjustable wait times between preset position changes.
 - b. Disabling of motion detection to avoid false detection alarms.
 - c. Multiple patrolling schedules per camera per day, with different schedule for days, nights and weekends.

2.8. EVENT AND ALARM MANAGEMENT

- A. Rules Engine: Provide rules for automating of different aspects of the system, including camera control, system behavior and external devices, based on events or time profiles, or a combination of events and time profiles.
 1. Trigger Events: Provide a Microsoft-Outlook-style configuration dialog where pre-defined and custom-defined events are used in rules to trigger actions.
 - a. Event Categories: Organize events into the following categories:
 - 1) Hardware: Physical hardware devices connected to the system.
 - 2) Devices: Certain functions and states of devices available via connected hardware devices.
 - 3) External: Relating to VMS integrations.
 - 4) Recording Server: Archiving, failover and database functions.
 - 5) Analytics: From integrated analytics applications and systems.
 - 6) User-Defined: Custom-configured events enabling users to manually trigger actions and events in the system.
 2. Start Actions: Triggering events may initiate a wide set of system actions, including, but not limited to:
 - a. Control start and stop of recording, including scheduled and event-based recording.
 - b. Change camera stream properties.
 - c. Change of video wall content and layout.
 - d. PTZ camera preset positions and patrols.

- e. Event-based notifications, including email notifications to single or multiple recipients with optional attachment of a camera still image or AVI video clip.
 - f. External system interactions.
 - g. Bookmark creation.
 - h. Play pre-recorded audio.
 - i. Retrieve video and audio from edge storage devices and video from interconnected systems.
 - j. Single rule allows for executing multiple system actions.
 - k. Rule actions shall be triggered by event, time interval or a combination of event and time.
 - l. Rules shall be optionally stopped by event or after a specified time.
 - m. Unrestricted number of rules.
- B. Time Profiles: Provide the following time profile functionality for use with profiles, rules and triggers:
- 1. Dynamic day-length time profile that follows daylight changes over a year including Daylight Savings Time for a given location defined by a GPS position.
 - 2. Time profiles contain one, or more, single or recurring periods of time.
 - 3. A single time period may span one or more days, defined by a starting date and time and an ending date and time.
 - 4. A recurring period of time is defined as a time range with recurrence pattern and range:
 - a. Time range is a starting and ending time within a day.
 - b. Recurrence pattern may be Daily, Weekly, Monthly or Yearly.
 - c. Recurrent range is a starting and ending date, or a starting date with a duration in days.
 - 5. Unrestricted number of time profiles.
- C. Single-Point Event/Alarm Management: Provide central management of all internal system alarms and external security alarms. Events are pre-defined or user-specified incidents on the VMS that can be set up to trigger an alarm, including analytics events and manual control actions. Event and alarm management capabilities shall include but not be limited to:
- 1. Alarm Data Settings:
 - a. Customizable alarm priorities, statuses and categories to enable alignment of the alarm handling workflow with existing workflows and security systems.
 - b. Optional sound notifications for different alarm priorities for notification of new incoming alarms.
 - c. Manage which alarm priorities trigger desktop notifications for alarms.
 - d. Manage which alarm data are shown in the Alarm Manager, including but not limited to:
 - 1) ID.
 - 2) Image.

- 3) Location.
 - 4) Message.
 - 5) Owner.
 - 6) Priority Level.
 - 7) Source.
 - 8) State Level.
 - 9) State Name.
 - 10) Time.
 - e. Optional Reasons for Closing to be chosen when an alarm is closed.
 - f. Add audio files in wav-format to be used as alarm notification sounds.
 - g. Manage how long alarms instances are kept in the system before being automatically deleted.
2. Alarm Configuration:
- a. User-definable alarm descriptions and work instructions.
 - b. Select triggering event and source.
 - c. Alarm time profiles specifying that response actions must take place within the specified time profile.
 - d. Select start and stop events specifying that response actions must take place within the specified event window.
 - e. Select a user defined event to be triggered if an alarm is not acknowledged within a defined time limit.
 - f. Association of alarms with one or more cameras, with automatic display of camera video in the alarm preview window, with a minimum of 15 cameras showing simultaneously in the alarm preview window.
 - g. Association of alarms to maps.
 - h. Association of initial alarm owner (individual user or group) and priority.
 - i. Association of alarm category.
 - j. Select user defined event to be triggered by the alarm.
 - k. Enable or disable desktop notifications for alarms.
3. Alarm Manager:
- a. Alarm list with extensive sorting and filtering capabilities.
 - b. Instant preview of recorded video from primary and related cameras, at the time of the incident.
 - c. Thumbnail image from primary camera, at the time of the incident.
 - d. Alarm disabling option shall enable users to suppress alarms from a given device for a specified time period.
 - e. Common alarm list for all interconnected systems and cameras.
 - f. Common alarm list for all sites in a Federated Architecture.
 - g. Alarm handling reports providing information about alarm inflow and alarm handling performance.

4. Alarm Handling:
 - a. Instant preview live video of primary camera.
 - b. Instant preview of recorded video from primary and related cameras, at the time of the incident.
 - c. Option to select any related cameras to be displayed in the live and playback view items.
 - d. Present the alarm work instructions.
 - e. Change priority and status of the alarm.
 - f. Alarm escalation with option to forward alarms to operators with appropriate skills to handle specific types of alarms.
 - g. Present time logged alarm activities.
 - h. Add time logged comments to the alarm incident.
 - i. Desktop notifications shall allow immediate access to alarm handling.
5. Map Integration:
 - a. Present incident location automatically on map.
 - b. Tight integration with the map function allowing operators to indicate and acknowledge active alarms via map.
 - c. All other map functionality must be available when viewing maps in the Alarm Manager.
6. Web Client: Provide the following alarm list, alarm handling and investigation functionality:
 - a. Alarm List:
 - 1) Alarm list with filtering capabilities:
 - a) All or personal alarms.
 - b) All or specific alarm states.
 - c) All or specific alarm priorities.
 - 2) Thumbnail image from primary camera, at the time of the incident.
 - 3) Click to handle alarm.
 - b. Alarm Handling:
 - 1) Instant preview of recorded video from primary and related cameras, at the time of the incident. Available incoming audio for cameras that have related microphones.
 - 2) Present the alarm work instructions.
 - 3) Change priority and status of the alarm.
 - 4) Alarm escalation with option to forward alarms to operators with appropriate skills to handle specific types of alarms.
7. Mobile Client: Provide the following alarm notification, alarm list, alarm handling and investigation functionality:
 - a. Alarm Notification: Receive alarm notifications using Push Notifications. Notifications include access to:
 - 1) Video.

- 2) Alarm information.
- 3) Work instructions.
- b. Alarm List:
 - 1) Alarm list with filtering capabilities:
 - a) All or personal alarms.
 - b) All or specific alarm states.
 - c) All or specific alarm priorities.
 - 2) Thumbnail image from primary camera, at the time of the incident.
 - 3) Click to handle alarm.
- c. Alarm Handling:
 - 1) Instant preview of recorded video from primary and related cameras, at the time of the incident.
 - 2) Present the alarm work instructions.
 - 3) Change priority and status of the alarm.
 - 4) Alarm escalation with option to forward alarms to operators with appropriate skills to handle specific types of alarms.

2.9. VIDEO PROCESSING AND VIEWING

- A. Multiple Monitor Support: Support multiple monitors where each monitor shall show multiple floating or full-screen windows for display of views or individual view items.
- B. View Window Aspect Ratios: Support multiple views optimized for 4:3 and 16:9 display settings in both landscape and portrait orientations.
- C. Private or Shared Views: Private views can only be access by the user who created them. Views may be shared generally and available to all roles or restricted to specific roles. Viewing of a content item in a shared view is subject to the viewer's permissions relating to the content item.
- D. View Groups: View groups facilitate view navigation and simplify searching across multiple views by narrowing search scope.
- E. View Layout Persistence: Same view layout in both live and playback modes.
- F. View Arrange and Restore: Support simple drag-and-drop re-arrangement of cameras in views for optimized monitoring of incidents, including replacement of individual cameras with different cameras, with single-click restore of original view layout.
- G. View Creation: Views that display up to 100 view items including cameras, web pages, still images, text and interactive items. View capabilities include, but are not limited to:
 1. Camera View Item: Live and recorded camera video displayed in resizable view windows, utilized in several workspaces within the application. Each camera view item contains the following:
 - a. Video Status Indicator: A round dot indicating one of four states:

- 1) Green: A connection to the camera is established.
 - 2) Red: Video from the camera is being recorded.
 - 3) Yellow: Playing back recorded video.
 - 4) Gray: The video has not changed for more than two seconds.
 - b. Motion Indicator: An icon of a moving person that appears only when motion is detected since it was last cleared.
 - c. Bounding-Box Display: Display of metadata bounding boxes as provided by supported cameras and integrated analytics in live and playback views.
 - d. Update on motion only: Optimizes CPU use by allowing motion detection to control whether the image should be decoded and displayed.
 - e. PTZ Camera View Item: PTZ camera view item can be configured to provide virtual joystick camera control and PTZ navigation overlay buttons on the video image.
 - f. Overlay Buttons: Used to add manually controlled speakers, events, outputs, PTZ cameras and to start/stop recording.
2. Camera Navigator: User-defined views of specific sets of cameras in relation to each other, for example, according to floor plan, to enable visually tracking people and objects as they move from one camera's field of view to another. Camera Navigator function provides an add-on to the Map with no special configuration needed.
 3. Carousel: Allow a specific view item to automatically sequence rotate through pre-defined set of cameras that are not necessarily present in the view at the same time. Operators may select default or custom display times for each camera, and they are able to manually switch to the next or previous camera in the carousel list.
 4. Hotspot: Global hotspot function shall allow users to work in detail with any camera selected from any view. Local hotspot function shall allow users to work in detail with a camera selected from the same view.
 5. HTML Page: Show interactive HTML page.
 6. Image: Show a still image.
 7. Matrix: Shows live video from multiple cameras in any view layout with customizable rotation paths, remotely controlled by the computers sending matrix remote commands.
 8. Navigable Map Pages: Static or active map pages may be used to provide a good overview of premises, and for switching between different views, such as map page displaying a floor plan.
 9. Text: Add text.
 10. Video Wall: Display video wall control providing the following functionality:
 - a. Show monitor layout of currently selected video wall.
 - b. Drag-and-drop views to any monitor.
 - c. Drag-and-drop cameras to any view item location in any monitor.
 - d. Change video wall via dropdown.
 - e. Activate video wall preset via dropdown.
 11. 3rd party plug-ins: Add 3rd party plug-ins to extend the behavior of full viewing client.

- H. Live Video: Views provide camera live viewing capabilities including, but not limited to:
1. Live Viewing: View live video of camera view items on the Live tab.
 2. Manual PTZ Control: Manual PTZ control options:
 - a. Video overlaid PTZ control.
 - b. Joystick.
 - c. Virtual joystick function.
 - d. PTZ point-and-click control.
 - e. Reserve and release PTZ control.
 - f. PTZ preset positions.
 - g. Overlay buttons to activate PTZ preset positions.
 - h. PTZ zoom to a defined rectangle.
 - i. Start, stop, and pause patrolling.
 - j. View who have PTZ control and time to automatic release, including anonymous users.
 3. Stream Selection: Change to any defined live video stream.
 - a. Manual selection of defined live video stream.
 - b. Adaptive Streaming: Automatic selection of defined live video streams with the best match to the requested resolution.
 4. Send Video to Destination: Option to send current camera to the following destinations:
 - a. View item in an existing window.
 - b. New floating window.
 - c. View item in any defined video wall.
 5. Digital Zoom: Magnification of video to facilitate detail viewing.
 6. Bookmarks: Create quick or detailed bookmarks, to facilitate incident review and documentation.
 - a. System generated headline for quick bookmark.
 - b. Optional headline and description information for detailed bookmark.
 7. Independent Video Playback:
 - a. Playback of video in multiple camera view items, each on its own independent timeline.
 - b. Option to initiate playback mode and synchronizing playback timeline with current time in independent playback.
 8. Instant Change of Camera: Drag-and-drop placement of a different camera in a camera view item, instantly changes the content to video from the new camera, according to the camera view item's current timeline position.
 9. Smart Map: Enable quick navigation to smart map, showing the geographic location of the camera, even camera located on a specific level inside a multistory building.
 10. Centralized Search: Initiate Centralized Search for the camera in a new window.

11. Manual Recording: Start and stop manual recording with automatic stop of recording after a configurable number of minutes.
- I. Video Playback: Views provide additional camera playback capabilities including, but not limited to:
 1. Playback: Time synchronized play back video of camera view items on the Playback tab.
 2. Navigation: Advanced video navigation includes:
 - a. Forward and backwards playback at different speeds:
 - 1) Playback Speeds: ¼x, ½x, 1x, 2x, 4x, 8x, 16x.
 - 2) Instant Realtime Speed: Toggle 1x playback speed or selected playback speed.
 - 3) Forward and backwards frame-by-frame.
 - 4) Skip to next or previous recorded sequence.
 - 5) Skip to beginning or end of recordings.
 - 6) Jump to date/time.
 3. Timeline: An overview of recorded sequences and bookmarks via integrated video timeline with time navigation and playback controls, including the following functionality:
 - a. Timeline Video Playback: Video from multiple camera view items integrated to a common video timeline, with common timeline control from any of the integrated camera view item.
 - b. Single and Consolidated Timeline: Two timelines with the first showing overview of selected camera view item and second showing a consolidated overview of all camera view items in the view.
 - c. Timeline Period: Select which period timeline covers.
 - 1) 5, 10, 20 minutes.
 - 2) 1, 2, 4, 8, 12, 16, 20 hours.
 - 3) 1, 2, 4 days.
 - 4) 1, 2, 4 weeks.
 - d. Recorded Sequences Overview: Recorded sequences of video and audio are shown in the timeline. The timeline displaying light-red to indicate recording, red for motion, light-green for incoming audio, and green for outgoing audio. If there are additional sources of data available, these are displayed as other colors.
 - e. Bookmarks Overview: Bookmarks are shown in the timeline with instant preview of the recorded video.
 - f. Integrated Time Interval Selection: Integrated function to select a time interval for export, evidence lock or video and audio retrieval from edge storage devices and interconnected systems.
 - 1) Visual selection on timeline.
 - 2) Select start and end date/time.

- 3) Loop selected period on playback.
- g. Multi-Window Timeline: Ability to use one timeline to control playback of cameras in multiple view windows.
4. Recording Search: Search listing of camera sequences or bookmarks.
 - a. Preview: Search results may be previewed.
 - b. Print: Print of still image from the selected video clip may be initiated.
 - c. Export: Export of selected video clips may be initiated, reducing time needed to prepare forensic video material.
- J. Send View Item to Video Wall: Option to send current view item content to any defined video wall.
 1. Smart Map: Send smart map to video wall with the current geographic location, zoom level, and layers.
- K. Two-Way Audio: Audio from cameras with built-in or attached microphones can be configured for listening. Camera built-in or attached speakers can be configured for use to talk to individuals near speakers. Additional capabilities include:
 1. Broadcast: Broad announcements can be made by selecting the All Speakers option when talking.
 2. Lock to Selected Audio Devices: Enables continued use of microphones and speakers from selected cameras, while viewing video from a different set of cameras. This enables, for example, informing an individual at risk about the safety status of nearby areas.
 3. Level Meter: Level meter indicates the volume of the speaking operator's voice, to indicate whether the operator is at a correct distance from the microphone.
- L. Centralized Search: Provides search categories and filters to allow users to find recording sequences, bookmarks, recordings with motion, alarms, events, vehicle license plates and data from third-party systems, with the ability to preview video and take direct action, e.g. by exporting the search results or sending the search results to PDF. The search results shall be presented instantly as thumbnail images:
 1. Sequence Search: Search in recording sequences on one or more cameras.
 2. Motion Search: Search for sequences with motion, or Smart Search for motion in selected areas on one or more cameras.
 3. Bookmark Search: Search for bookmark headlines or descriptions.
 4. Alarms and Events Search: Search for alarms and events, with the ability to apply filters to refine the search results.
 5. Vehicle license plate search: Search for license plates, with the ability to apply filters to refine the search results.
 6. Third-party Systems Search: Search for metadata from integrated third-party systems.
 7. Save Search: The ability to save searches for reuse:
 - a. Save searches.
 - b. Search for and open saved searches.

- c. Edit saved searches.
 - d. Delete saved searches.
 - 8. Navigation: Ability to jump to search results through a clickable timeline, or the ability to scroll through the search results.
 - 9. Preview: Selected sequence previews with auto play and direct export support.
- M. Video Export and Documentation: Full viewing client options for video export and documentation include, but are not limited to:
 - 1. Snapshot: Produce instant visual documentation of a camera by saving the camera image to a file.
 - 2. Print: Produce instant visual documentation of a camera by sending it directly to a printer.
 - 3. Storyboarding: The storyboarding function makes it possible to include video sequences from different or overlapping time intervals from different cameras in the one and the same export.
 - 4. Export Database Format: Export in database format; including the standalone Full Viewing Client – Player application for simple instant viewing by authorities.
 - 5. Export Preview: Review video just prior to export, with looped playback option.
 - 6. Export Other Formats: Create evidence material in media player format (AVI files), MKV format, or still image format (JPEG images).
 - 7. Re-Export: Re-Export allows an authorized individual to export a digitally signed selection from the original video exported. Option to disable re-export, during initial export to database format, prevents undesirable re-distribution of sensitive video recordings.
 - 8. Bulk Export: In a single step, export in multiple formats to multiple destinations, including direct export to optical media, to ensure consistency across exported video sequences in various formats, and reduce human error possibilities.
 - 9. Export of Comments: Two video formats support inclusion of comments in exported video:
 - a. Database Format: Include general and/or camera-specific comments to a video export file.
 - b. Media Player Format: Include comments as pre/post slides.
 - 10. Video Incident Report Printing: Utilize still images rather than clips to print incident reports including images, surveillance details and free-text user comments.

2.10. MAPS

- A. Maps: Provide multi-layered physical overview of surveillance video coverage, with interactive access to and control of the VMS and related devices, including the following elements:
 - 1. Map Images: Illustrated maps or photographs. Supported image file formats are: BMP, GIF, JPEG, JPG, PNG, TIF, TIFF, and WMP.

2. Camera Icons: Indicate camera locations on the map. Fixed camera icons show camera view as colored angle radiating from the camera. PTZ camera icons show preset camera views as colored angles radiating from the camera.
 - a. Live Preview: Hover mouse pointer over camera icon to display a live preview in a resizable window.
 - b. PTZ Preset Navigation: Click on PTZ preset view zone moves camera to the preset position.
 3. Microphone Icons: Microphone icons show microphone locations on the map.
 - a. Live Listening: Place mouse over microphone icon; press and hold left mouse button to listen to incoming audio from microphone.
 4. Speaker Icons: Indicate speaker locations on the map.
 - a. Live Speaking: Place mouse over speaker icon; press and hold left mouse button to talk through speaker.
 5. Control Icons: Icons to use for control of objects such as doors, gates, and lights.
 6. Hot Zones: Hot zones to provide vertical navigation through a hierarchy of maps by clicking on a hot zone.
 7. Map Overview Window: Navigable overview of map hierarchy set up in full viewing client.
 8. Video Wall Integration: Drag-and-drop integration of maps with video wall.
 9. Map Image Updates: When map images are replaced by an updated version of the map image of the same scale, map icons and other elements are kept in their original locations.
 10. Map Display Information: Information display options include but are not limited to:
 - a. Real-time status monitoring indication from all system components including cameras, I/O devices and system servers.
 - b. Graphical visualization of the system status through color coding.
 - c. Hierarchical propagation of status indications to higher ordered maps.
 - d. Different levels of status indications available (alarm, warning and errors).
 - e. System performance data for cameras and servers including camera resolution, FPS, network use and disk space.
 - f. Ability to suppress status indications (such as alarms and operational status) for a given device.
 - g. Editable device names in map and map-specific names and references assignable to devices in Map, subject to user permissions.
- B. Smart Maps: Provide a geographic information system to accurately reflect geography in the real world, enabling video view and cameras access at multiple locations around the world in a geographically correct way. Differentiate from Maps, which utilize a different map for each location, by providing the complete picture in a single view, with seamless drilldown across different map layers. Include the following capabilities:
1. GIS Map Services: Supported services shall include Bing, Google and OpenStreetMap map services. Geo-referenced GIS Maps, such as shapefiles, and geo-referenced CAD

- drawings and building maps with multiple floor levels, such as dwg and dxf files, are supported.
- a. Offline OpenStreetMap Map Service: Support the use of owner-provided OpenStreetMap server for offline use.
 2. Default World Map: Standard world geographic background containing geo-reference data but not containing geographic reference features such as county boundaries, and cities.
 3. Map Layers: Map data layers whose display may be toggled on and off, including but not limited to: Camera name and field of view, quick links, street names, and building and business names.
 4. Camera Selection: Capabilities include:
 - a. Instant one-click camera preview in floating view of up to 25 cameras.
 - b. Easy multi-camera selection within camera preview.
 - c. Easy drag-and-drop and point-and-click definition of: cameras, camera field of view. Changing cameras placement, direction and field of view automatically update camera position information.
 - d. Selection of 10 different camera icons.
 - e. Depiction of camera field of view on map.
 5. Camera Aggregation: Camera object aggregation that preserves the overview when multiple cameras are closely located.
 6. Device Naming: Administrators may name edit devices in a map and assign map-specific names and references to devices in a map.
 7. Navigation: Easy drag-and-drop and point-and-click definition of:
 - a. Location Links: Location links shall enable quick navigation across different sites and locations.
 - b. Quick Links: Quick links shall enable drilldown to existing classic Smart Client maps.
 - c. Quick Links: Quick links shall enable drilldown to existing classic full viewing client maps.
 - d. Building Navigation: Navigation between different floors in buildings with multiple levels, where only camera related to the specific floor level are presented.

2.11. MEDIA STORAGE MANAGEMENT

- A. Provide multiple media storage containers definable with the following characteristics:
 1. Container: Each container consists of a live database and optionally one or more archive databases, with container-specific archiving and grooming schemes and retention times. Archive database can reside on the same disk as the live database or on secondary disks or network drives.
 2. Capacity: Maximum recording capacity shall be limited only by available disk space or configured container storage limit.

3. Device Assignment: Recording of each device is assigned to a specific storage container. The assigned storage container for a device or group of devices may be changed from one container to another.
 4. Archiving: Recorded video data may be automatically moved from a container's live database storage to its archived storage. Archived data is still online and available to client software.
 5. Grooming: Video data grooming possibility to enable reduction of video recording data size by reducing the frame rate of the video data when archiving.
 6. Maximum Recording Times: Maximum recording times may be set for manual recordings, with VMS deleting older video to free up storage for newer video.
- B. Edge Video Storage: Provide utilization of camera-based storage including the following capabilities:
1. Video and Audio Retrieval: Retrieving video and audio recordings across low-bandwidth connections based on time profiles, events or manual requests.
 2. Video and Audio Consolidation: Consolidating video and audio from multiple storage mechanisms:
 - a. Seamless merging of video and audio stored centrally in media database, and video and audio retrieved from associated camera edge storage, or from an interconnected system.
 - b. Optionally consolidate pre-event images recorded locally in camera or video encoder.
 3. Scalable Video Quality Recording (SVQR): Capability to record high quality video using edge storage and record low quality video centrally, to minimize network bandwidth utilization, using the capabilities described above. High quality video can be retrieved when needed, on an event-driven, scheduled or manual basis.
- C. Evidence Lock: Provide capabilities for assuring the availability of recorded video selected for evidentiary use, including:
1. Extension of Video Retention: Manual extension of video retention time for a selected set of cameras, and its related devices, in a given time interval, where the operator selects an extended retention time from a pre-defined set of retention time options.
 2. Video Sequence Metadata: Users may add headline and comments information to locked video sequences to enhance their manageability.
 3. Management of Locked Video Sequences: Search, filter and listing functions including editing comments, modifying extended retention time and removing an evidence lock.
 4. Locked Video Export: Locked video may be exported through a single step operation.

2.12. MOBILE SERVER

- A. User Authentication: Facilitate the following methods of user authentication:
1. Basic Authentication: Basic user VMS account.

2. Windows Authentication: Via Active Directory or local Windows user account. Possible to use current Windows user to facilitate single sign-on.
 3. Two-Step Verification: In addition to login capabilities, provide two-step authentication via a verification code transmitted to the user's registered email address, with a five-minute timeout for verification code expiration, and a user login block for exceeding the maximum number of failed code entry attempts, which defaults to three but may be adjusted.
- B. Dynamic Bandwidth Optimization: Optimize camera video stream from server to client to make optimum use of bandwidth.
- C. Smart Connect: Easy configuration of internet access to the mobile server by automatic configuration of firewalls and internet routers via UPnP, with verification of configuration and operation of internet connection, with option to email connection details to mobile client users. Includes automatic mobile server on LAN via UPnP.

2.13. WEB CLIENT

- A. Provide the following browser-based capabilities:
1. User Authentication:
 - a. Require only username and password.
 - b. Support two-step verification.
 - c. User authentication and authorization is handled by mobile server.
 2. Inherit System Views: Automatically obtain the user's private and shared views configuration from the system.
 3. All-Camera View: Automatically generate a view for all cameras when no views are set up.
 4. Two-Way Audio: Audio from cameras with built-in or attached microphones can be configured for listening. Camera built-in or attached speakers can be configured for use to talk to individuals near speakers. Audio playback shall be available for investigations, video exports and alarms. Additional capabilities include:
 - a. Broadcast: Broad announcements can be made by selecting a microphone icon on the view level when talking.
 - b. Use the Push-to-talk (PTT) Feature: Communicate via the VMS system, through a PC microphone and while watching live video from one camera, with people near a video camera with audio equipment. Push-to-talk (PTT) is also available in Actions.
 5. Live Video Monitoring: View live video with PTZ control including use of presets, video playback, and triggering of camera-related outputs and events from within the camera's view.
 6. Search: Search function to find cameras, types of camera, cameras with related microphones, cameras with related speakers and camera views.

7. Video Export: Provide video export, with the option to preview and store exported video on the server, and make it available for later usage or download, for example, when a higher-bandwidth connection is in use.
8. Still Image Export: Provide camera view JPEG image export.
9. Investigations: Ability to export the recordings, download and share them with authorities at a later stage:
 - a. Create AVI, MKV or database export files.
 - b. Option to include audio in the export package.
 - c. Export on the server to avoid moving large video files back and forth.
 - d. Store video recordings for a period that is longer than the retention time.
 - e. Play back the recordings even if the recordings have already been deleted from the media database.
 - f. Only download needed files or save them for downloading when on a faster connection.
 - g. Preview exports on the server without downloading them.
10. Secure Connection: Connect to mobile server through trusted CA certificates for HTTPS encryption..
11. Supported Browsers:
 - a. Microsoft Internet Explorer
 - b. Microsoft Edge
 - c. Safari
 - d. Google Chrome
 - e. Mozilla Firefox
12. Browser Plug-Ins or Extensions: No plug-ins or extensions to be installed.

2.14. MOBILE CLIENT

- A. Provide the following native-app mobile client capabilities:
 1. User Authentication:
 - a. Require only user name and password.
 - b. Support two-step verification.
 - c. User authentication and authorization is handled by mobile server.
 2. Multiple Server Profiles: Select between multiple server profiles to facilitate easily switching between sites or different connection addresses.
 3. Inherit System Views: Automatically obtain the user's private and shared views from the system to be use as camera lists.
 4. All-Camera View: Automatically generate a view for all cameras when no views are set up.
 5. Two-Way Audio: Audio from cameras with built-in or attached microphones can be configured for listening. Camera built-in or attached speakers can be configured for

- use to talk to individuals near speakers. Audio playback shall be available for investigations and alarms. Additional capabilities include:
- a. Use the Push-to-talk (PTT) Feature: Communicate via the VMS system, through the microphone of the mobile device and while watching live video from one camera, with people near a video camera with audio equipment. Push-to-talk (PTT) is also available in access control.
6. Full-Screen View: Display cameras in full screen to take better advantage of the mobile device's screen, with camera view navigation in full screen by swiping left or right.
 7. Pinch-To-Zoom: Digital pinch-to-zoom shall enable mobile users to enlarge a part of the image for closer review and conduct detailed investigation of video.
 8. Picture-In-Picture: Provide the following functionality for Picture-In-Picture:
 - a. Display a live picture-in-picture frame of the same camera when in playback mode.
 - b. The picture-in-picture shall be movable by dragging.
 - c. Double-tapping and will return to live view.
 - d. Hide live picture-in-picture frame.
 9. Search: Search function to find cameras, types of camera, cameras with related microphones, cameras with related speakers, and camera views.
 10. Mobile Video Push: Provide mobile client capability for mobile device users to use their mobile device cameras as cameras in the VMS, including the following characteristics.
 - a. No Mobile Setup: No mobile device setup shall be required for mobile video push. Provide central server-side configuration.
 - b. Metadata Support: Mobile users shall be able to include metadata in the video submitted.
 - c. Audio: Mobile users shall be able to include audio in the video submitted.
 11. Investigation: Provide access to investigations created in the web client.
 12. Secure Connection: Connect to XProtect Mobile server through trusted CA certificates for HTTPS encryption.
 13. Supported Mobile Operating Systems:
 - a. Android
 - b. iOS

2.15. SDK-BASED INTEGRATION

- A. Provide an SDK for integration with third-party systems including, but not limited to:
 1. Seamless integration of video analytics algorithms and other third-party applications in full viewing client and management client.
 2. Support for displaying MIP SDK plug-in items on smart map.
 3. Support for displaying SDK plug-in items on smart map.
 4. Functionality for external applications to make changes to the system's configuration.

5. Compatibility with XProtect Transact and XProtect Retail, which integrate video surveillance with automatic teller machines (ATM), point-of-sale (POS) and enterprise resource planning (ERP) systems for managing loss prevention and fraud.
 6. Compatibility with XProtect LPR for automatic reading and tracking of vehicle license plates.
 7. Event integration via a simple message-based socket communication interface enabling external applications to trigger events in the VMS.
 8. Functionality for external applications to trigger user-defined events in the VMS.
- B. Implement the SDK via integration in the following system components:
1. Full viewing client.
 2. Management client.
 3. Event server.

2.16. COMPUTER EQUIPMENT

- A. Computer Requirements: Consult with VMS manufacturer to determine current computer requirements appropriate for system design, intended use and desired level of performance. Optimize server computer count, and server application distribution across servers, to account for likely system expansion. The following are minimum requirements.
1. Computer Running Management Server and Service Channel:
 - a. CPU: Intel® Core™ i3 or better.
 - b. RAM: 8 GB or more.
 - c. Network: Ethernet 100 Mbit or better.
 - d. Graphics Adapter: Onboard GFX, AGP or PCI-Express, minimum 1024×768, 16-bit color or better.
 - e. Hard Disk Space: 50 GB free or more (depends on number of servers, devices, rules, and logging settings).
 - f. Operating System:
 - 1) For Individual Servers:
 - a) Microsoft Windows 8.1 Pro (64 bit).
 - b) Microsoft Windows 8.1 Enterprise (64 bit).
 - c) Microsoft Windows 10 Pro (64 bit).
 - d) Microsoft Windows 10 Enterprise (64 bit).
 - e) Microsoft Windows 10 Enterprise LTSB (Long-Term Servicing Branch) 2016 (version 1607 or later).
 - f) Microsoft Windows 10 IoT Enterprise, version 1803 or later (64 bit), IoT Core.
 - g) Microsoft Windows Server 2012 (64 bit): Standard and Datacenter.
 - h) Microsoft Windows Server 2012 R2 (64 bit): Standard and Datacenter.
 - i) Microsoft Windows Server 2016 (64 bit): Essentials, Standard and Datacenter.

- j) Microsoft Windows Server 2019 (64 bit): Essentials, Standard or Datacenter.
 - 2) To Run Clustering/Failover Management Server:
 - a) Microsoft Windows Server 2012/2012 R2 (64 bit) Standard or Datacenter.
 - b) Microsoft Windows Server 2016 (64 bit) Essentials, Standard or Datacenter.
 - c) Microsoft Windows Server 2019 (64 bit) Essentials, Standard or Datacenter.
 - g. Software:
 - 1) Microsoft .NET 3.5 SP1 and .NET 4.7 Framework.
 - 2) 300 Cameras or less: SQL Server Express Edition.
 - 3) For larger systems or to support frequent database backups, run a licensed version of Microsoft SQL Server on its own server.
 - 2. Computer Running Microsoft SQL Server (if not running Microsoft SQL Server Express Edition on Management Server computer):
 - a. CPU: Intel® Core™ i3 or better.
 - b. RAM: 8 GB or more.
 - c. Network: Ethernet 100 Mbit or better.
 - d. Graphics Adapter: Onboard GFX, AGP or PCI-Express, minimum 1024×768, 16-bit color or better.
 - e. Hard Disk Space: 100 GB free or more (depends on number of servers, devices, rules, and logging settings).
 - f. Operating System:
 - 1) Microsoft Windows Server 2012 (64 bit): Standard and Datacenter.
 - 2) Microsoft Windows Server 2012 R2 (64 bit): Standard and Datacenter.
 - 3) Microsoft Windows Server 2016 (64 bit): Essentials, Standard and Datacenter.
 - g. Software:
 - 1) Microsoft .NET 4.7 Framework.
 - 2) Microsoft SQL Server:
 - a) Microsoft SQL Server 2012 SP1.
 - b) Microsoft SQL Server 2014.
 - c) Microsoft SQL Server 2016.
 - 3. Computer Running Recording Server, Failover Recording Server, Event Server or Log Server:
 - a. CPU: Intel® Core™ i3 or better.
 - b. RAM: 8 GB or more.
 - c. Network: Ethernet 100 Mbit or better.
 - d. Graphics Adapter: Onboard GFX, AGP or PCI-Express, minimum 1024×768, 16-bit color or better.

- e. Hard Disk Space: 10 GB free or more (depends on number of devices and recording settings).
- f. Operating System:
 - 1) For Individual Servers:
 - a) Microsoft Windows 8.1 Pro (64 bit).
 - b) Microsoft Windows 8.1 Enterprise (64 bit).
 - c) Microsoft Windows 10 Pro (64 bit).
 - d) Microsoft Windows 10 Enterprise (64 bit).
 - e) Microsoft Windows Server 2012 (64 bit): Standard and Datacenter.
 - f) Microsoft Windows Server 2012 R2 (64 bit): Standard and Datacenter.
 - g) Microsoft Windows Server 2016 (64 bit): Essentials, Standard and Datacenter.
 - g. Software: Microsoft .NET 4.7 Framework.
- 4. Computer Running Management Client:
 - a. CPU: Intel® Core™ i3 or better.
 - b. RAM: 4 GB or more.
 - c. Network: Ethernet 100 Mbit or better.
 - d. Graphics Adapter: Onboard GFX, AGP or PCI-Express, minimum 1024×768, 16-bit color or better.
 - e. Hard Disk Space: 1 GB free or more.
 - f. Operating System:
 - 1) Microsoft Windows 8.1 Pro (64 bit).
 - 2) Microsoft Windows 8.1 Enterprise (64 bit).
 - 3) Microsoft Windows 10 Pro (64 bit).
 - 4) Microsoft Windows 10 Enterprise (64 bit).
 - 5) Microsoft Windows Server 2012 (64 bit): Standard and Datacenter.
 - 6) Microsoft Windows Server 2012 R2 (64 bit): Standard and Datacenter.
 - 7) Microsoft Windows Server 2016 (64 bit): Essentials, Standard and Datacenter.
 - g. Software:
 - 1) Microsoft .NET 4.7 Framework.
 - 2) DirectX 11 or newer.
- 5. Computer Running Full Viewing Client or Accessing Remote Client:
 - a. CPU: Intel® Core™ i3 or better.
 - b. RAM: 1 GB or more.
 - c. Network: Ethernet 100 Mbit or better.
 - d. Graphics Adapter: Onboard GFX, AGP or PCI-Express, minimum 1024×768, 16-bit color or better.
 - e. Hard Disk Space: 500 MB free or more.
 - f. Operating System:

- 1) Microsoft Windows 8.1 Pro.
 - 2) Microsoft Windows 8.1 Enterprise.
 - 3) Microsoft Windows 10 Pro.
 - 4) Microsoft Windows 10 Enterprise.
 - 5) Microsoft Windows 10 Enterprise LTSC (Long-Term Servicing Branch) 2016 (version 1607 or later).
 - 6) Microsoft Windows 10 Enterprise, version 1803 or later (64 bit), IoT Core.
 - 7) Microsoft Windows Server 2012: Standard and Datacenter.
 - 8) Microsoft Windows Server 2012 R2: Standard and Datacenter.
 - 9) Microsoft Windows Server 2016: Essentials, Standard and Datacenter.
 - 10) Microsoft Windows Server 2019: Essentials, Standard and Datacenter.
- g. Software:
- 1) Microsoft .NET 4.7 Framework.
 - 2) DirectX 11.0 or newer.

2.17. LICENSING

- A. License Activation: VMS shall offer easy-to-use automatic or manual online activation via the Internet and alternatively, offline activation via email and web for closed surveillance networks.
- B. Server Base License:
1. Require one mandatory server base license for installing the product.
 2. Server base license shall permit the following deployments within the legal entity purchasing the base license:
 - a. Unrestricted number of Management Server services.
 - b. Unrestricted number of Recording Server services.
 - c. Unrestricted number of management servers.
 - d. Unrestricted number of recording servers.
 - e. Unrestricted number of XProtect Smart Client, XProtect Web Client and XProtect Mobile client applications.
 - f. Unrestricted number of full viewing client, web client and mobile client applications.
- C. Video Wall License:
1. Video wall license shall permit connection of an unrestricted number of video wall instances (including physical displays) and camera feeds.
- D. Hardware Device License:
1. Require one license per hardware IP address to connect:
 - a. Cameras.
 - b. Audio devices.
 - c. Video encoders.

- d. Other devices.
- 2. Support an unlimited number of hardware device licenses.
- E. Licensing of Milestone Interconnect:
 - 1. Require one Milestone Interconnect device license per camera in an interconnected site that is enabled in the central XProtect Corporate system.
 - 2. Interconnect license shall be tied to the parent XProtect Corporate system showing the interconnected devices.
- F. Licensing of Interconnect Functionality:
 - 1. Require one interconnect device license per camera in an interconnected site that is enabled in the central system.
 - 2. Interconnect license shall be tied to the parent system showing the interconnected devices.
- G. Licensing of Milestone Federated Architecture:
 - 1. The use of Milestone Federated Architecture is free and not subject to licensing. This implies that unrestricted sites and licensed cameras can be included in the federated hierarchy, without the need for additional or special licenses.
- H. Licensing of Federated Architecture:
 - 1. The use of federated architecture is free and not subject to licensing. This implies that unrestricted sites and licensed cameras can be included in the federated hierarchy, without the need for additional or special licenses.
- I. License Overview Information: License overview shall include add-on products.
- J. License Administration: Provide expanded license information for multi-site installations where both the total used licenses for the common base license is presented along with the license use in the specific site.
- K. Changes Without Activation: A “Changes without activation” function shall allow additions and replacements of limited number of devices without requiring license device activation or reactivation.

2.18. CAMERAS, MOUNTS & ACCESSORIES

- A. Client has standardized on Axis cameras and will provide model information.
- B. Cameras

2.19. Baseline Camera Features

- a. Listed by a national recognized safety testing laboratory (UL or equivalent)
- b. 10/100/1000 Mbps Ethernet output for transmission of video over IP network
- c. Lens Vari-focal
 - 1) Auto-iris / P-Iris lens

- B. Motorized auto focus
 - a. Camera settings shall be remotely configurable via IP communications
- C. CMOS sensor type imaging device
- D. Backside illumination
- E. Scalable resolution
 - a. Scalable bandwidth
 - b. Light Sensitivity
- F. 0.3 (color)/0.04 (BW), 0 Lux with IR illuminator on, measured with DSS off at 30 IRE
- G. Capable of transmitting 30-progressive frames of video per second at the full native resolution of the camera
 - a. Commercial grade camera
 - b. Auto gain control
- H. Auto white balance
 - a. Wide dynamic range
- I. True or digital WDR
 - a. Support for powering via Power Over Ethernet (POE) enabled input, and local power.
 - b. Support for one or more of the following standards-based encoding algorithms: MJPEG, MPEG-4, 14.264 and 14.265 (HEVC).
 - c. Capable of simultaneously transmitting 2 or more streams at varying rates
 - d. Latest ONVIF profile compatible
- 2. Additional baseline features of cameras used outdoors
 - a. Dual modes of operation — Color during normal lighting conditions; black-and-white during low light conditions
 - b. Physical auto switching removal of the infrared filter for increased sensitivity in lowlight conditions.
 - c. Backlight compensation.
- J. Install transient voltage surge suppression protection devices in line with cables connecting outdoor equipment with indoor equipment. Protection device shall provide a margin of protection of outdoor equipment against surges originating within the building and margin of protection of indoor equipment originating from electrical surges outside the building.
- K. Install protection devices in each conductive circuit that interconnects outdoor equipment to indoor equipment. This includes power, video and control circuits.
- L. Protection devices shall be installed within an Ingress Protection (IP65 minimum) rated enclosure installed within 10 cable feet of cable entrance into the building. Enclosure shall be installed above accessible ceiling and sized to accommodate the fully connectorized TVSS equipment.

- M. See Labeling for additional requirements.
 - 1. Additional features for pole-mounted cameras
 - a. Dynamic Image stabilization feature for reduction of the visual effects of minor pole swaying movement.
 - 2. Pan Tilt Zoom Cameras
- N. PTZ control shall be available to operator via Video Management Software or through outboard dedicated PTZ Joystick type of operator control

2.20. Mounts

- 1. Provide commercial grade mounts heavy duty mounts and mounting hardware for cameras.
- 2. Outdoor mounts shall be designed for outdoor mounting and exposure to the elements
- 3. Refer to drawings and camera matrix for mounting form-factors of individual camera locations.

PART 3 EXECUTION

3.1. EXAMINATION

- A. Verification of Conditions:
 - 1. Visit site and verify that site conditions are in agreement with design package. Report all changes to the site or conditions which will affect performance of the system to the Owner. Do not take any corrective action without written permission from the Owner.
 - 2. General:
 - a. Verify that existing site conditions are acceptable for product installation in accordance with manufacturer's instructions.
 - b. Verify that wire runs, related items, and conditions are ready to receive work of this Section.
 - 3. Cable and Wiring:
 - a. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
 - b. Examine roughing-in for LAN and control cable conduit systems to PCs and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
 - 4. LAN / WAN:
 - a. Verify LAN connections for server and workstation computers.
 - b. Provide access to the internet for the mobile server.
 - 5. Power Connections:

- a. Verify power circuits which are existing or have been previously installed under other sections are acceptable for product installation in accordance with manufacturer's instructions.

3.2. PREPARATION

- A. Review configurable features of the VMS with the Owner's Representative and document the results of the meeting in the Project planning documents. The following configuration topics shall be resolved prior to configuring equipment and services:
 1. Internet Service Provider, firewall, and IP schema for VMS devices.
 2. Time server synchronization scheme for overall security system.
 3. Plan for system testing, startup, and demonstration.
 4. Acceptance test concept and, on approval, develop specifics of the test.
 5. List of default user IDs and passwords (factory defaults) for VMS application, servers and workstations.
 6. Prepare root certificate and necessary child certificates for secure connection between system components.
- B. Provide a schedule with a list of participants to attend monthly coordination and progress update meeting until job completion. Attendees shall include:
 1. Owner's Representative of Facilities Management, Information Services, Security Management.
 2. Contractor Project Manager.
 3. Manufacturer(s) Employed Representative.
 4. Architect / Engineer / Security Consultant.
- C. At all coordination meetings with Owner's Representative, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.
- D. Owner's Representative and Owner shall assist in establishing procedural guidelines and in defining terminology and conditions unique to the Owner's operation.
- E. Supervise installation to appraise ongoing progress of other trades and contracts, make allowances for all ongoing work, and coordinate the requirements of the installation of the VMS.
- F. Coordinate Owner installation or update of workstation operating system software and web browser software to a version as specified by the VMS provider.
- G. Coordinate Owner-managed computer and network security practices as specified by the VMS provider.

3.3. INSTALLATION

- A. Deploy VMS in accordance with manufacturer's Deployment Best Practice Guide, including workstation and integration instructions and requirements.
- B. Collaborate with Owner's Representative on the application of manufacturer's hardening guide recommendations.
- C. Supervise installation to appraise ongoing progress of other trades and contracts, make allowances for all ongoing work, and coordinate the requirements of the VMS installation.
- D. Drawings and Diagrams:
 - 1. System devices identified on building drawings are intended to generally indicate areas where such devices are to be located. Determine final location of these devices in accordance with Owner's requirements.
 - 2. Riser diagrams are schematic and do not show every conduit, wire box, fitting, or other accessories. Provide such materials as necessary for a complete and functioning installation.
 - 3. Comply with manufacturer's written data, including product technical bulletins, product catalog installation instructions and product carton installation instructions.
 - 4. All firmware in products shall be the latest and most up-to-date provided by the manufacturer, or of a version as specified by the provider of the VMS to ensure approved integration compatibility.
 - 5. Install, configure, and test VMS for complete and proper operation.

3.4. SITE QUALITY CONTROL

- A. Site Tests and Inspections:
 - 1. Submit documented test plan to Owner at least 14 days in advance of final acceptance test, inspection and check-off.
 - 2. Perform acceptance reviews with Owner's representative of device and system configurations and their documentation.
 - 3. Perform final acceptance testing in the presence of Owner's representative, executing a point by point inspection against a documented test plan that demonstrates compliance with system requirements as designed and specified, including response times for control actions and sequences, and rules-based actions. Tests shall demonstrate the functionality of each individual device control item, including as camera alarm outputs and control relays.
 - 4. Conduct acceptance tests in presence of Owner's representative, verifying that each device point and sequence is operating correctly and properly reporting back to control panel and control center, and provide Owner's Representative with written report of test results.
 - 5. Specific tests shall be witnessed by Authorities Having Jurisdiction if necessary.
 - 6. Consider VMS accepted only after all acceptance test items have been successfully checked-off.
 - a. Beneficial use of part or all of the system shall not be considered as acceptance.

7. As required to sufficiently demonstrate the VMS functionality, request the console operator on duty and his/her superior to perform certain daily operations using the VMS.
8. Complete all required training prior to initiation of the final acceptance test.
9. Inspect the installation of all field computers and devices.
 - a. Point out general neatness and quality of installation, test the full functionality of each individual device, and show that mounting, backbox and conduit meet compliance requirements.
10. Owner's Representative shall, upon successful completion of the final acceptance test (or subsequent punch list retest), issue a letter of final acceptance.
11. Owner's Representative retains right to suspend and/or terminate testing at any time when the system fails to perform as specified.
 - a. Collaborate with Owner's Representative prior to start of testing, to establish criteria pass/fail criteria and classification of test execution problems, such as:
 - 1) Pass/fail: Criteria determining what constitutes a test pass or failure.
 - 2) Suspension and resumption: Criteria determining when testing must be suspended and resulted later.
 - 3) Show Stopper: Stop test, fix problem and restart test from beginning.
 - 4) Major Problem: Fix problem before test can be resumed or concluded.
 - 5) Minor Problem: Add problem to "punch list", complete test.
 - 6) Special Issue: Investigate to determine which problem category above category applies.
 - b. If it becomes necessary to suspend testing or inspections, work diligently to complete/repair all outstanding items to the condition specified in Specification and as indicated on related drawings.
 - c. Supply Owner's Representative with detailed completion schedule outlining phase by phase completion dates and a tentative date for a subsequent punch list retest.
 - d. During final acceptance test, make no adjustments, repairs or modifications to system without permission of Owner's Representative.

3.5. ADJUSTING

- A. Perform field software changes after the initial programming session to "fine tune" operating parameters and sequence of operations based on any revisions to the Owner's operating requirements.
- B. Installer/Factory User Accounts:
 1. Remove all default, installer, or temporary user accounts and passwords used during installation that are not part of End-user's final operational requirements.
 2. Assign new passwords that are substantially different from factory default passwords to user accounts that match factory-default user accounts.
 3. Apply appropriate measures from manufacturer's system hardening guide.

3.6. CLOSEOUT ACTIVITIES

- A. Training:
 - 1. General:
 - a. Submit training plans and instructor qualifications to Owner's Representative for approval.
 - b. Coordinate with Owner's Representative to accommodate owner shift schedules to reduce impact to regular operations.
- B. Provide training as scheduled.
- C. Deliver printed or electronic reference materials that cover the entire training presentation.

3.7. PROTECTION

- A. Maintain strict site security during the installation of equipment and software.
 - 1. Equipment Rooms: Lock and secure rooms housing accessible equipment that has been powered up.
 - 2. Dedicated Workstations: Shut down, lock and secure rooms containing workstations during periods when a qualified operator in Contractor's employ is not present.
- B. Protect installed work of other trades when working in the same location, protecting all completed work prior to acceptance by Owner, unless Owner has specifically relieved Contractor from this responsibility.
- C. Incremental and As-built Configuration Backup:
 - 1. Perform full back-up of all configuration settings and system data from VMS at the completion of critical installation milestones, immediately prior to start of acceptance testing, and immediately after acceptance testing is completed.
 - 2. Deliver instructions for restoration of the VMS backups upon completion of acceptance testing.

3.8. MAINTENANCE

- A. Provide maintenance updates by VMS manufacturer per agreed schedule.

END OF SECTION 281302.00

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SECTION 32 3119
DECORATIVE METAL FENCES AND GATES

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. Decorative aluminum fences.
2. Swing gates.
3. Horizontal-slide gates.
4. Gate operators, including controls.

B. Related Requirements:

1. Section 03 3000 "Cast-in-Place Concrete" for concrete bases for gate operators, drives, and controls.
2. Division 26 Sections for electrical service and connections for system disconnect switches and powered devices including, but not limited to, motor operators, controls, and limit switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fencing and gates.

1. Include plans, elevations, sections, gate locations, post spacing, and mounting attachment details, and grounding details.
2. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
3. Wiring Diagrams: Include diagrams for power, signal, and control wiring.

C. Samples: For each fence material and for each color specified.

1. Provide Samples 12 inches in length for linear materials.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Product Test Reports: For decorative metallic-coated-steel tubular picket fences, including finish, indicating compliance with referenced standard and other specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For gate operators to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. ASTM B221 – Standard specification for aluminum and aluminum-alloy extruded bars, rods and tubes.

1.7 PRODUCT WARRANTY

- A. All structural fence components shall be warranted within specified limitations, by the manufacturer for a period of 20 years from date of original purchase. Warranty shall cover any defects in material finish, including cracking, peeling, chipping, blistering or corroding.

PART 2 - PRODUCTS

2.1 DECORATIVE ALUMINUM FENCES

- A. Decorative Aluminum Fences: Fences made from aluminum extrusions.
 - 1. Ameristar Fence Products – Basis of Design.
 - a. Fence System – Echelon Plus/Majestic Type.
 - b. Approved equal.
 - c. Fence Height: 6'-0".
- B. Post Caps: Aluminum castings that cover entire top of posts.
- C. Rails: Extruded-aluminum channels: 3-Rail.
- D. Pickets: Extruded-aluminum tubes: Standard 3/4" square.
- E. Fasteners: Manufacturer's standard concealed fastening system.

- F. Fasteners: Manufacturer's standard corrosion-resistant, color-coated fasteners matching fence components with resilient polymer washers.
- G. Fabrication: Assemble fences into sections by fastening pickets to rails.
 - 1. Fabricate sections with clips welded to rails for field fastening to posts.
- H. Finish exposed welds to comply with NOMMA Guideline 1.
- I. Finish: Powder coating.

2.2 SWING GATES

- A. Gate Configuration: Double leaf.
- B. Gate Frame Height: 6'-0".
- C. Gate Opening: 12'-0".
 - a. Two (2) gates at 6'-0"/each.
- D. Galvanized-Steel Frames and Bracing: Fabricate members from square tubes.
- E. Steel Frames and Bracing: Fabricate members from square steel tubing.
- F. Aluminum Frames and Bracing: Fabricate members from square extruded-aluminum tubes.
- G. Frame Corner Construction: Assembled with corner fittings.
- H. Additional Rails: Provide as indicated, complying with requirements for fence rails.
- I. Infill: Comply with requirements for adjacent fence.
- J. Picket Size, Configuration, and Spacing: Comply with requirements for adjacent fence.
- K. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet (1.52 m) wide. Provide center gate stops and cane bolts for pairs of gates.
- L. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.
 - 1. Function: 39 - Full surface, triple weight, antifriction bearing.
 - 2. Material: Wrought steel, forged steel, cast steel, or malleable iron; galvanized.
- M. Rim Locks: BHMA A156.5, Grade 1, suitable for exterior use.
 - 1. Function: 621 - Latchbolt by key from outside and by turn from inside. Latchbolt is held retracted by device from inside.

2. Material: Cast, forged, or extruded brass or bronze.
3. Mounting Plate: Configuration necessary for mounting locks. Fabricate from 1/8-inch- (3.2-mm-) thick.

N. Mortise Locks: BHMA A156.13, Grade 1, suitable for exterior use.

O. Finish exposed welds to comply with NOMMA Guideline 1.

P. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.

Q. Metallic-Coated-Steel Finish: High-performance coating.

R. Steel Finish: Primed, high-performance coating.

S. Aluminum Finish: Baked enamel or powder coating.

2.3 HORIZONTAL-SLIDE GATES

A. Gate Configuration: Single leaf.

1. Type: Cantilever slide, with external roller assemblies.

B. Gate Frame Height: 6'-0".

C. Gate Opening Width: 24'-0".

D. Automated vehicular gates shall comply with ASTM F 2200, Class I.

E. Galvanized-Steel Frames and Bracing: Fabricate members from square tubing.

F. Aluminum Frames and Bracing: Fabricate members from square tubing.

1. Frame Members: Extruded-aluminum tubes.
2. Bracing Members: Extruded-aluminum tubes.

G. Frame Corner Construction:

1. Welded frame.

H. Additional Rails: Provide as indicated, complying with requirements for fence rails.

I. Infill: Comply with requirements for adjacent fence.

J. Picket Size, Configuration, and Spacing: Comply with requirements for adjacent fence.

- K. Overhead Track Assembly: Manufacturer's standard track, with overhead framing supports, bracing, and accessories, engineered to support size, weight, width, operation, and design of gate and roller assemblies.
- L. Hardware: Latches permitting operation from both sides of gate.
- M. Finish exposed welds to comply with NOMMA Guideline 1.
- N. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A 123/A 123M. For hardware items, hot-dip galvanize to comply with ASTM A 153/A 153M.
- O. Metallic-Coated-Steel Finish: High-performance coating.
- P. Steel Finish: High-performance coating.
- Q. Aluminum Finish: Baked enamel or powder coating.

2.4 GATE OPERATORS

- A. Gate Operators:
 - 1. Nortek or approved equal.
- B. Provide factory-assembled automatic operating system designed for gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, with remote-control stations, safety devices, and weatherproof enclosures; coordinate electrical requirements with building electrical system.
 - 1. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
 - 2. Provide operator with UL approval.
 - 3. Provide electronic components with built-in troubleshooting diagnostic feature.
 - 4. Provide unit designed and wired for both right-hand/left-hand opening, permitting universal installation.
- C. Comply with NFPA 70.
- D. UL Standard: Manufacturer and label gate operators to comply with UL 325.
- E. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators on gates that must provide emergency access.
- F. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor. Comply with NEMA MG 1 and the following:

1. Voltage: 208/3Phase.
 2. Horsepower: Not less than 1/2.
 3. Enclosure: Totally enclosed.
 4. Duty: Continuous duty at ambient temperature of 105 deg F (40 deg C) and at altitude of 3300 feet (1005 m) above sea level.
 5. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.
 6. Phase: Polyphase.
- G. Gate Operators: Concrete base mounted and as follows:
1. Hydraulic Slide Gate Operators:
 - a. Duty: Heavy duty, commercial/industrial.
 - b. Gate Speed: Minimum 60 feet (18.2 m) per minute.
 - c. Maximum Gate Weight: 800 lb (363 kg).
 - d. Frequency of Use: Continuous duty.
 - a. Operating Type: Wheel-and-rail drive with manual release.
 - b. Hydraulic Fluid: Of viscosity required for gate operation at ambient temperature range for Project.
 - c. Locking: Hydraulic in both directions.
 - a. Heater: Manufacturer's standard track and roller heater with thermostatic control.
- H. Remote Controls: Electric controls separated from gate and motor and drive mechanism, with NEMA ICS 6, Type 4 enclosure for pedestal mounting, and with space for additional optional equipment. Provide the following remote-control device(s):
1. Digital Keypad Entry Unit: Provided by Owner.
 2. Radio Control: Digital system consisting of code-compatible universal receiver for each gate, located where indicated, with remote antenna with coaxial cable and mounting brackets designed to operate gates. Provide 10 programmable transmitter(s) with multiple-code capability permitting validating or voiding of not less than 1000 codes per channel configured for the following functions:
 - a. Transmitters: Single button operated, with open function.
 - b. Channel Settings: 1 independent channel settings controlling separate receivers for operating more than one gate from each transmitter.
- I. Vehicle Loop Detector: System includes automatic closing timer with adjustable time delay, timer cutoff switch, and loop detector designed to hold gate open until traffic clears. System includes electronic detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit a signal activating the gate operator. System includes number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement, as recommended in writing by detection system manufacturer for function indicated, at location indicated on Drawings.

- J. Vehicle Presence Detector: System includes automatic closing timer with adjustable time delay, timer cutoff switch, and presence detector designed to hold gate open until traffic clears. System includes emitter/receiver detector with adjustable detection zone pattern and sensitivity, designed to detect the presence or transit of a vehicle in gate pathway when infrared beam in zone pattern is interrupted, and to emit a signal activating the gate operator.
- K. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:
 - 1. Action: Stop gate in opening cycle and reverse gate in closing cycle, and hold until clear of obstruction.
 - 2. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
 - 3. Sensor Edge: Contact-pressure-sensitive safety edge, profile, and sensitivity designed for type of gate and component indicated, in locations as follows. Connect to control circuit using gate edge transmitter and operator receiver system.
 - a. Along entire length of gate posts.
 - 4. Photoelectric/Infrared Sensor System: Designed to detect an obstruction in gate's path when infrared beam in the zone pattern is interrupted.
- L. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully retracted and fully extended positions.
- M. Emergency Release Mechanism: Quick-disconnect release of operator drive system of the following type, permitting manual operation if operator fails. Design system so control-circuit power is disconnected during manual operation.
 - 1. Type Mechanical device, key, or crank-activated release.
- N. Operating Features:
 - 1. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features with capability for monitoring and auditing gate activity. Provide unit that is isolated from voltage spikes and surges.
 - 2. System Integration: With controlling circuit board capable of accepting any type of input from external devices.
 - 3. Master/Slave Capability: Control stations designed and wired for gate pair operation.
 - 4. Automatic Closing Timer: With adjustable time delay before closing and timer cutoff switch.
 - 5. Open Override Circuit: Designed to override closing commands.
 - 6. Reversal Time Delay: Designed to protect gate system from shock load on reversal in both directions.
 - 7. Maximum Run Timer: Designed to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.
 - 8. Clock Timer: 24-hour programmable for regular events.
- O. Accessories:
 - 1. Warning Module: Audio, Visual, strobe-light alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving; compliant with the United States Access Board's ADA-ABA Accessibility Guidelines.

2. External electric-powered magnetic lock with delay timer allowing time for lock to release before gate operates.
3. Fire box.
4. Fire strobe sensor.
5. Instructional, Safety, and Warning Labels and Signs: According to UL 325.
6. Retain "Equipment Bases/Pads" Subparagraph below if gate operator, drives, or controls are mounted on precast equipment bases/pads. Pads should extend 6 to 12 inches (150 to 300 mm) below frost line.
7. Equipment Bases/Pads: Precast concrete, depth not less than 12 inches (305 mm), dimensioned and reinforced according to gate operator component manufacturer's written instructions and as indicated on Drawings.

2.6 ALUMINUM

- A. Aluminum, General: Provide alloys and tempers with not less than the strength and durability properties of alloy and temper designated in paragraphs below for each aluminum form required.
- B. Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5.
- C. Tubing: ASTM B 429/B 429M, Alloy 6063-T6.
- D. Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.
- E. Die and Hand Forgings: ASTM B 247 (ASTM B 247M), Alloy 6061-T6.
- F. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.

2.7 COATING MATERIALS

- A. Epoxy Primer for Galvanized Steel: Epoxy primer recommended in writing by topcoat manufacturer.
- B. Intermediate Coat for Uncoated Steel: Epoxy intermediate recommended in writing by primer and topcoat manufacturer.
- C. Acrylic Topcoat: Complying with MPI #72 and compatible with undercoat.
- D. Six Stage Pretreatment/Wash followed by an electrostatic spray application of a 'no-mar' polyester coat finish with a minimum thickness of 2-4 mils.

2.8 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for strength and compatibility in fabricated items.
- B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 03 3000 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi slump, and 1-inch (25-mm) maximum aggregate size.
- C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M and specifically recommended by manufacturer for exterior applications.

2.9 GROUNDING MATERIALS

- A. Comply with requirements of Section 26 0526 "Grounding and Bonding for Electrical Systems."
- B. Grounding Conductors: Size as indicated on Drawings. Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
 1. Material above Finished Grade: Copper.
 2. Material on or below Finished Grade: Copper.
 3. Bonding Jumpers: Braided copper tape, 1-5/8 inch (41 mm) wide and 1/16 inch (1.6 mm) thick, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.
- C. Grounding Connectors and Grounding Rods: Comply with UL 467.
 1. Connectors for Below-Grade Use: Exothermic-welded type.
 2. Grounding Rods: Copper-clad steel.
 - a. Size: 5/8 by 96 inches (16 by 2440 mm).

2.10 ALUMINUM FINISHES

- A. Polyester Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 2 mils (0.05 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
 1. Color and Gloss: As selected by Architect from manufacturer's full range.

2.11 STEEL FINISHES

- A. Primer Application: Apply zinc-rich epoxy primer immediately after cleaning, to provide a minimum dry film thickness of 2 mils per applied coat, to surfaces that are exposed after assembly and installation, and to concealed surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.
- B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 DECORATIVE FENCE INSTALLATION

- A. Install fences according to manufacturer's written instructions.
- B. Install fences by setting posts as indicated and fastening rails to posts.
- C. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 32 inches.
- D. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
 - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 - 2. Concrete Fill: Place concrete around posts and sleeves and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
 - a. Exposed Concrete: Extend 2 inches (51 mm) above grade. Finish and slope top surface to drain water away from post.
 - b. Concealed Concrete: Top below grade to allow covering with surface material. Slope top surface of concrete to drain water away from post.
 - 3. Posts Set in Concrete: Extend post to within 6 inches (150 mm) of specified excavation depth, but not closer than 3 inches to bottom of concrete.

3.4 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.5 GATE OPERATOR INSTALLATION

- A. General: Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.
- B. Excavation for Concrete Bases: Hand-excavate holes for bases in firm, undisturbed soil to dimensions and depths and at locations as required by gate operator component manufacturer's written instructions and as indicated.
- C. Concrete Bases: Cast-in-place or precast concrete, depth not less than 12 inches, dimensioned and reinforced according to gate operator component manufacturer's written instructions.
- D. Vehicle Loop Detector System: Bury and seal wire loop according to manufacturer's written instructions. Connect to equipment operated by detector.
- E. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.

3.6 GROUNDING AND BONDING

- A. Comply with Section 26 0526 "Grounding and Bonding for Electrical Systems."
- B. Fence Grounding: Install at maximum intervals of 1500 feet (450 m) except as follows:
 - 1. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet (225 m).
 - a. Gates and Other Fence Openings: Ground fence on each side of opening.
 - 1) Bond metal gates to gate posts.
- C. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet (45 m) on each side of crossing.
- D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (150 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.
- E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

- F. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in 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.
- G. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.7 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Automatic Gate Operators: Energize circuits to electrical equipment and devices. Adjust operators, controls, safety devices, and limit switches.
- C. Lubricate hardware, gate operators, and other moving parts.

3.8 DEMONSTRATION

- A. Train Owner's personnel to adjust, operate, and maintain gates.

END OF SECTION 32 3119