Specification for:

Bastian Agricultural Center
Arena Building

Utah State University

South Jordan, Utah

REVIEWED FOR
CODE COMPLIANCE
Thomas W Peterson
04/03/2025
DIVISION OF FACILITIES
CONSTRUCTION AND
MANAGEMENT

Construction Documents Submittal
February 20, 2025

Method Studio Project #: 24.0170
DFCM Project #: 25401770

Prepared by:

method studio

360 West Aspen Ave.
salt lake city, utah 84101

TABLE OF CONTENTS

DIVISION 00 – PROJECT DOCUMENTS
GEOTECHNICAL REPORT
DFCM GENERAL CONDITIONS
DIVISION 01 - GENERAL REQUIREMENTS
011000 SUMMARY
012000 PRICE AND PAYMENT PROCEDURES
012200 UNIT PRICES
012300 ALTERNATES
012500 SUBSTITUTION PROCEDURES
012600 CONTRACT MODIFICATION PROCEDURES
013000 ADMINISTRATIVE REQUIREMENTS
013200 CONSTRUCTION PROGRESS DOCUMENTATION
013216 CONSTRUCTION PROGRESS SCHEDULE
013233 PHOTOGRAPHIC DOCUMENTATION
014000 QUALITY REQUIREMENTS
014200 REFERENCES
015000 TEMPORARY FACILITIES AND CONTROLS
015100 TEMPORARY UTILITIES
015213 FIELD OFFICES AND SHEDS
015500 VEHICULAR ACCESS AND PARKING
016000 PRODUCT REQUIREMENTS
017000 EXECUTION AND CLOSEOUT REQUIREMENTS
017419 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL
017800 CLOSEOUT SUBMITTALS
017839 PROJECT RECORD DOCUMENTS
017900 DEMONSTRATION AND TRAINING
DIVISION 02 - EXISTING CONDITIONS
024100 DEMOLITION
DIVISION 03 - CONCRETE
033000 CAST-IN-PLACE CONCRETE
033511 SEALED CONCRETE FLOOR FINISHES
DIVISION 07 - THERMAL AND MOISTURE PROTECTION
071113 BITUMINOUS DAMPPROOFING
072119 FOAMED-IN-PLACE INSULATION
074213 METAL WALL PANELS
079200 JOINT SEALANTS
DIVISION 08 - OPENINGS
083323 OVERHEAD COILING DOORS
084313 ALUMINUM-FRAMED STOREFRONTS
088000 GLAZING

088300 MIRRORS
DIVISION 09 - FINISHES
092116 GYPSUM BOARD ASSEMBLIES
099123 INTERIOR PAINTING
DIVISION 10 - SPECIALTIES
102800 TOILET, BATH, AND LAUNDRY ACCESSORIES
104416 FIRE EXTINGUISHERS
DIVISION 22 - PLUMBING
220500 COMMON WORK RESULTS FOR PLUMBING
220523 GENERAL-DUTY VALVES FOR PLUMBING PIPING
220529 HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT
220548 VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT
220548.13 VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT
220553 IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT
220593 TESTING, ADJUSTING, AND BALANCING FOR PLUMBING
220716 PLUMBING EQUIPMENT INSULATION
220719 PLUMBING PIPING INSULATION
220800 COMMISSIONING OF PLUMBING
221123.21 INLINE, DOMESTIC-WATER PUMPS
221316 SANITARY WASTE AND VENT PIPING
221319.13 SANITARY DRAINS
223300 ELECTRIC, DOMESTIC-WATER HEATERS
224200 COMMERCIAL PLUMBING FIXTURES
224700 DRINKING FOUNTAINS AND WATER COOLERS
DIVISION 23 – MECHANICAL
230500 COMMON WORK RESULTS FOR HVAC
230529 HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT
230546 COATINGS FOR HVAC
230548 VIBRATION AND SEISMIC CONTROLS FOR HVAC
230548.13 VIBRATION CONTROLS FOR HVAC
230553 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
230593 TESTING, ADJUSTING, AND BALANCING FOR HVAC
230713 DUCT INSULATION
230716 HVAC EQUIPMENT INSULATION
230800 COMMISSIONING OF HVAC
233113 METAL DUCTS
233300 AIR DUCT ACCESSORIES
233400 HVAC FANS
233413 AXIAL HVAC FANS
233416 CENTRIFUGAL HVAC FANS
233423 HVAC POWER VENTILATORS

233439 HIGH-VOLUME, LOW-SPEED FANS
233713.13 AIR DIFFUSERS
233713.23 REGISTERS AND GRILLES
238236 FINNED-TUBE RADIATION HEATERS
238239.19 WALL AND CEILING UNIT HEATERS
DIVISION 26 – ELECTRICAL
260519 LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
260523 CONTROL VOLTAGE ELECTRICAL POWER CABLES
260526 GROUNDING & BONDING FOR ELECTRICAL SYSTEMS
260529 HANGERS & SUPPORTS FOR ELECTRICAL SYSTEMS
260533 RACEWAYS & BOXES FOR ELECTRICAL SYSTEMS
260536 CABLE TRAYS FOR ELECTRICAL SYSTEMS
260543 UNDERGROUND DUCTS & RACEWAYS FOR ELECTRICAL SYSTEMS
260544 SLEEVES & SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING
260548.16 SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS
260553 IDENTIFICATION FOR ELECTRICAL SYSTEMS
260573.13 SHORT CIRCUIT STUDIES
260573.16 COORDINATION STUDIES
260573.19 ARC FLASH HAZARD ANALYSIS
260923 LIGHTING CONTROL DEVICES
262213 LOW-VOLTAGE DISTRIBUTION TRANSFORMERS
262413 SWITCHBOARDS
262416 PANELBOARDS
262726 WIRING DEVICES
262813 FUSES
265119 LED INTERIOR LIGHTING
265213 EMERGENCY AND EXIT LIGHTING
265619 LED EXTERIOR LIGHTING
271100 COMMUNICATIONS PATHWAYS AND SPACES
271300 COMMUNICATIONS BACKBONE CABLING
271500 COMMUNICATIONS HORIZONTAL CABLING
284621.11 ADDRESSABLE FIRE-ALARM SYSTEMS
DIVISION 31 - EARTHWORK
311000 SITE CLEARING
312200 GRADING
312316 EXCAVATION
312323 FILL
DIVISION 33 - UTILITIES
331416 SITE WATER UTILITY DISTRIBUTION PIPING
333113 SITE SANITARY SEWERAGE GRAVITY PIPING
334211 STORMWATER GRAVITY PIPING

GORDON
GEOTECHNICAL
ENGINEERING, INC.

REPORT
GEOTECHNICAL STUDY
PROPOSED
BASTIAN AG CENTER IMPROVEMENTS
2100 WEST 11400 SOUTH
SOUTH JORDAN, UTAH
DFCM PROJECT NO. 25401770
DFCM CONTRACT NO. 2570118

December 18, 2024

Job No. 003-054-24

Prepared for:
DFCM
P.O. Box 141160
Salt Lake City, Utah 84129

Prepared by:
Gordon Geotechnical Engineering, Inc.
4426 South Century Drive, Suite 100
Salt Lake City, Utah 84123
Tel: 801-327-9600
Fax: 801-327-9601
www.gordongeotech.com

December 18, 2024
Job No. 003-054-24

DFCM
P.O. Box 141160
Salt Lake City, Utah 84129

Attention: Mr. Brad DeMond

Ladies and Gentlemen:

Re: Report
Geotechnical Study
Proposed Bastian Ag Center Improvements
2100 West 11400 South
South Jordan, Utah
DFCM Project No. 25401770
DFCM Contract No. 2570118

1. INTRODUCTION

1.1 GENERAL

This report presents the results of our geotechnical study performed at the site of the proposed Bastian Ag Center Improvements which is located 2100 West 11400 South in South Jordan, Utah. The general location of the site with respect to major topographic features and existing facilities, as of 1999, is presented on Figure 1, Vicinity Map. A detailed location of the site showing existing roadways and surrounding facilities, on an air photograph base, is presented on Figure 2, Area Map. The locations and alignments of photographs taken of the site during the field portion of study are also shown on Figure 2. A more detailed layout of the site showing the proposed locations of structure and roadways, and existing facilities is presented on Figure 3, Site Plan. The locations of the test pits excavated in conjunction with this study are also presented on Figure 3.

Gordon Geotechnical Engineering, Inc. (G^2) presented a letter dated December 5, 2024[1] for the site. The letter was incorporated with this study.

[1] "Preliminary Geotechnical Design Criteria, Proposed Bastian Ag Center Improvements, 2100 West 11400 South, South Jordan, Utah," G^2 Job No. 003-054-24, Dated December 5, 2024.

1.2 OBJECTIVES AND SCOPE

The objectives and scope of our study were planned in discussions between Mr. Brad DeMond of DFCM and Mr. Patrick Emery of G^2.

In general, the objectives of this study were to:

1. Accurately define and evaluate the subsurface soil and groundwater conditions across the site.

2. Provide appropriate foundation, earthwork, pavement, and geoseismic recommendations to be utilized in the design and construction of the proposed development.

In accomplishing these objectives, our scope has included the following:

1. A field program consisting of the excavating, logging, and sampling of six test pits.

2. A laboratory testing program.

3. An office program consisting of the correlation of available data, engineering analyses, and the preparation of this summary report.

1.3 AUTHORIZATION

Authorization was provided by returning a signed copy of our Professional Services Agreement No. 24-0415 dated September 24, 2024 and authorized on November 12, 2024 by DFCM Contract No. 2570118.

1.4 PROFESSIONAL STATEMENTS

Supporting data upon which our recommendations are based are presented in subsequent sections of this report. Recommendations presented herein are governed by the physical properties of the soils encountered in the exploration test pits, measured and projected groundwater conditions, and the layout and design data discussed in Section 2., Proposed Construction, of this report. If subsurface conditions other than those described in this report are encountered and/or if design and layout changes are implemented, G^2 must be informed so that our recommendations can be reviewed and amended, if necessary.

Our professional services have been performed, our findings developed, and our recommendations prepared in accordance with generally accepted engineering principles and practices in this area at this time.

2. PROPOSED CONSTRUCTION

A pre-fabricated metal building arena is planned for the Bastian Agricultural Center. The proposed structure will be one-extended level in height and of light-gauge steel construction established slab-on-grade.

It is anticipated that the maximum anticipated column and wall loads will be in the range of 90 to 120 kips and 3 to 5 kips per lineal foot, respectively.

Site development will require a minor amount of earthwork in the form of site grading. It is estimated that maximum cuts and fills to achieve design grades will be on the order of two to three feet.

Paved surface parking areas will also be part of the overall development. Traffic over the pavements will consist of a light to moderately light volume of automobiles and light trucks, and some medium-weight trucks. In roadways, the traffic will be somewhat higher.

3. INVESTIGATIONS

3.1 FIELD PROGRAM

In order to define and evaluate the subsurface soil and groundwater conditions across the site, 6 test pits were excavated to depths ranging from 15.0 to 15.5 feet below existing grade. Locations of the test pits are presented on Figure 3.

The field portion of our study was under the direct control and continual supervision of an experienced member of our geotechnical staff. During the course of the excavation operations, a continuous log of the subsurface conditions encountered was maintained. In addition, relatively undisturbed and small disturbed samples of the typical soils encountered were obtained for subsequent laboratory testing and examination. The soils were classified in the field based upon visual and textural examination. These classifications have been supplemented by subsequent inspection and testing in our laboratory. Detailed graphical representation of the subsurface conditions encountered is presented on Figures 4A through 4F, Log of Test Pits. Soils were classified in accordance with the nomenclature described on Figure 5, Unified Soil Classification System.

Disturbed bag samples were collected from the soils brought up by the backhoe bucket.

Following completion of excavating and logging, each test pit was backfilled. Although an effort was made to compact the backfill with the backhoe, backfill was not placed in uniform lifts and compacted to a specific density. Consequently, settlement of the backfill with time is likely to occur.

Following completion of excavating operations, one and one-quarter-inch diameter slotted PVC pipe was installed in Test Pits TP-1, TP-2, and TP-5 in order to provide a means of monitoring the groundwater fluctuations.

3.2 LABORATORY TESTING

3.2.1 General

In order to provide data necessary for our engineering analyses, a laboratory testing program was performed. The program included moisture and density, Atterberg limits, partial gradation, and consolidation tests. The following paragraphs describe the tests and summarize the test data.

3.2.2 Moisture and Density Tests

To aid in classifying the soils and to help correlate other test data, moisture and density tests were performed on selected undisturbed samples. The results of these tests are presented on the test pit logs, Figures 4A through 4F.

3.2.3 Atterberg Limits Tests

To further aid in classifying the site soils, an Atterberg limits test was performed on one selected sample. Results of the tests are tabulated below:

Test Pit No.	Depth (feet)	Liquid Limit (percent)	Plastic Limit (percent)	Plasticity Index (percent)	Soil Classification
TP-6	6.0	49	19	30	CL

3.2.4 Partial Gradation Tests

To aid in classifying the soils and to provide general index parameters, a partial gradation test was performed upon four representative samples of the soils encountered in the exploration test pits. The results of the tests are tabulated below:

Test Pit No.	Depth (feet)	Percent Passing No. 4 Sieve	Percent Passing No. 200 Sieve	Soil Classification
TP-1	11.0	-	98.3	CL
TP-2	9.0	-	97.4	CL
TP-2	15.0	53.6	21.2	SM/GM
TP-6	6.0	-	98.8	CL

3.2.5 Consolidation Tests

To provide data necessary for our settlement analyses, a consolidation test was performed on three representative samples of the fine-grained soils encountered in the exploration test pits. The data available indicates that the soils are moderately over-consolidated and when loaded below the over-consolidated pressure the soils will exhibit moderate compressibility characteristics. Detailed results of the tests are maintained within our files and can be transmitted to you, at your request.

4. SITE CONDITIONS

4.1 SURFACE

The site consists of a square-shaped parcel of mostly undeveloped land. The site is mostly covered by surficial fills.

The site is bordered by the Salt Lake County fairgrounds in all directions. Fairground structures and pavement areas were observed in all directions.

The topography of the site slopes down to the east with an overall relief on the order of 5 to 10 feet across the site. The site grade is at approximately the same elevation as the grade of the adjacent streets.

Representative photographs of the site area are shown on Figure 6, Photographs.

4.2 SUBSURFACE SOIL

The soil conditions encountered in each of the test pits, to the depths excavated, were relatively similar. From the surface and extending to depths of one to two feet in Test Pits TP-3 through TP-6, non-engineered fill consisting of silty sand and gravel was encountered. The fills were likely placed in a somewhat controlled manner during construction of the area; however, unless compaction testing reports can be provided, they must be considered a non-engineered fill. Non-engineered fill will exhibit variable and, in most cases, poor engineering characteristics.

In general, from the ground surface in Test Pits TP-1 and TP-2 and underlying the fills in Test Pits TP-3 through TP-6 and extending to depths of 10.0 to 14.0 feet consisted of natural silty clay. The clay is soft to stiff, slightly moist, brown to light brown in color, and anticipated to exhibit moderate strength and compressibility characteristics under the anticipated loading range.

Underlying the clay and extending to the depths explored of 15.0 to 15.5 in Test Pits TP-1 through TP-6, silty sand and gravel was encountered. The sand and gravel is medium dense,

moist, light brown in color, and will exhibit high strength and low compressibility characteristics under the anticipated loading range.

The lines designating the interface between soil types on the test pit logs generally represent approximate boundaries. In-situ, the transition between soil types may be gradual.

4.3 GROUNDWATER

Immediately following excavating operations, the groundwater was measured in each test pit. On December 12, 2024, the groundwater was measured within the piezometers placed in Test Pits TP-1 and TP-2. Groundwater measurements are tabulated below:

Test Pit No.	Groundwater Depth (feet)	
	December 2, 2024	December 12, 2024
TP-1	NGWE*	NGWE at 15.0’
TP-2	NGWE*	NGWE at 15.5’
TP-3	NGWE*	No PVC installed.
TP-4	NGWE*	No PVC installed.
TP-5	NGWE*	NGWE at 15.0’
TP-6	NGWE*	No PVC installed.

* During excavating; not stabilized

NGWE No groundwater encountered.

Seasonal and longer-term groundwater fluctuations on the order of one to two feet are projected, with the highest seasonal levels generally occurring during the late spring and early summer months.

Seasonal and longer-term groundwater fluctuations of one to two feet should be anticipated. The highest seasonal levels will generally occur during the late spring and summer months.

5. DISCUSSIONS AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

The proposed structure may be supported upon conventional spread and continuous wall foundations over suitable natural soils and/or structural fill extending to suitable natural soils.

The most significant geotechnical aspect of the site is the non-engineered fills encountered to depths of one to two feet below surrounding grades in Test Pits TP-3 through TP-6. Unless compaction testing reports can be provided, the fill must be considered non-engineered fill. Non-engineered fills must be completely removed from below the building footprint and rigid pavement areas.

Non-engineered fills must be completely removed from beneath the building footprint and rigid pavement areas.

Due to the variable nature of the non-engineered fills encountered, a qualified geotechnical engineer from our staff must aid in verifying that all non-engineered fills have been completely removed prior to the placement of structural site grading fills, floor slabs, footings, or foundations.

Detailed discussions pertaining to earthwork, foundations, floor slabs, lateral resistance, pavement, and the geoseismic setting of the site are discussed in the following sections.

5.2 EARTHWORK

5.2.1 Site Preparation

Initial preparation of the site must consist of the removal of any existing structures and pavements, debris, and any associated non-engineered fills. In proposed flexible pavement areas, the existing asphalt concrete and fills may remain provided that they do not interfere with the final grade. The asphalt concrete should be perforated to facilitate drainage and proofrolled.

Further preparation of the site must consist of the removal of all non-engineered fills, loose surficial soils, topsoil, debris, and other deleterious materials from beneath an area extending at least three feet beyond the perimeter of the proposed building, rigid pavement, and exterior flatwork areas.

The non-engineered fills may remain in flexible pavement areas as long as they are properly prepared. Proper preparation will consist of scarifying and moisture conditioning the upper eight inches and recompacting to the requirements of structural fill. However, it should be noted that compaction of fine-grained soils (clays and silts, if utilized) as structural site grading fill will be very difficult, if not impossible, during wet and cold periods of the year. As an option for proper preparation and recompaction, the upper eight inches of the non-engineered fills may be removed and replaced with granular subbase over proofrolled subgrade. Even with proper preparation, flexible pavements established on non-engineered fills may experience some long-term movements. If the possibility of these movements is not acceptable, these non-engineered fills must be completely removed.

Subsequent to the above operations and prior to the placement of footings, structural site grading fill, or floor slabs, the exposed natural subgrade must be proofrolled by passing moderate-weight rubber tire-mounted construction equipment over the surface at least twice. If any loose, soft, or disturbed zones are encountered, they must be completely removed in footing and floor slab areas and replaced with granular structural fill. If removal depth required is greater than two feet, G^2 must be notified to provide further recommendations. In pavement areas, unsuitable soils encountered during recompaction and proofrolling must be removed to a maximum depth of two feet and replaced with compacted granular structural fill.

5.2.2 Temporary Excavations

Temporary construction excavations in cohesive soil, not exceeding four feet in depth, may be constructed with near-vertical sideslopes. Temporary excavations up to eight feet deep in granular soils (sands and gravels) may be constructed with sideslopes no steeper than one horizontal to one vertical (1.0H:1.0V). Temporary excavations up to eight feet deep in fine-grained cohesive soils may be constructed with sideslopes no steeper than one-half horizontal to one vertical (0.5H:1.0V).

Excavations must follow Occupational Safety and Health (OSHA) guidelines.

To minimize disturbance to the underlying soils, it is our recommendation that footings be excavated with a backhoe equipped with a smooth-lip bucket.

All excavations must be inspected periodically by qualified personnel. If any signs of instability or excessive sloughing are noted, immediate remedial action must be initiated.

5.2.3 Structural Fill

Structural fill is defined as all fill which will ultimately be subjected to structural loadings, such as imposed by footings, floor slabs, pavements, etc. Structural fill will be required as backfill over foundations and utilities, as site grading fill, and in some areas, as replacement fill below footings. All structural fill must be free of sod, rubbish, topsoil, frozen soil, and other deleterious materials. Structural site grading fill is defined as fill placed over fairly large open areas to raise the overall site grade. For structural site grading fill, the maximum particle size should generally not exceed four inches; although, occasional larger particles, not exceeding six inches in diameter may be incorporated if placed randomly in a manner such that “honeycombing” does not occur and the desired degree of compaction can be achieved. The maximum particle size within structural fill placed within confined areas should generally be restricted to two inches.

The on-site natural soils (including non-engineered fills) may be utilized as structural site grading fill. It should be noted that unless moisture control is maintained, utilization of natural on-site clayey soils as structural site grading fill <u>will be very difficult, if not impossible</u>, during wet

and cold periods of the year. Only granular soils are recommended as structural fill in confined areas, such as around foundations and within utility trenches.

To stabilize soft subgrade conditions or where structural fill is required to be placed below a level one foot above the water table at the time of construction, a mixture of coarse gravels and cobbles and/or one and one-half- to two-inch gravel (stabilizing fill) should be utilized.

Non-structural site grading fill is defined as all fill material not designated as structural fill and may consist of any cohesive or granular soils not containing excessive amounts of degradable material.

5.2.4 Fill Placement and Compaction

Structural fill shall be placed in lifts not exceeding eight inches in loose thickness. Structural fills shall be compacted in accordance with the percent of the maximum dry density as determined by the AASHTO[2] T-180 (ASTM[3] D-1557) compaction criteria in accordance with the following table:

Location	Total Fill Thickness (feet)	Minimum Percentage of Maximum Dry Density
Beneath an area extending at least 3 feet beyond the perimeter of the structure	0 to 8	95
Outside area defined above	0 to 6	90
Outside area defined above	6 to 8	92
Road base	-	96

Structural fills greater than eight feet thick are not anticipated at the site.

Subsequent to stripping and prior to the placement of structural site grading fill, the subgrade must be prepared as discussed in Section 5.2.1, Site Preparation, of this report. In confined areas, subgrade preparation should consist of the removal of all loose or disturbed soils.

Non-structural fill may be placed in lifts not exceeding 12 inches in loose thickness and compacted by passing construction, spreading, or hauling equipment over the surface at least twice.

---

2 American Association of State Highway and Transportation Officials
3 American Society for Testing and Materials

Coarse gravel and cobble mixtures (stabilizing fill), if utilized, shall be end-dumped, spread to a maximum loose lift thickness of 15 inches, and compacted by dropping a backhoe bucket onto the surface continuously at least twice. As an alternative, the fill may be compacted by passing moderately heavy construction equipment or large self-propelled compaction equipment over the surface at least twice. Subsequent fill material placed over the coarse gravels and cobbles shall be adequately placed so that the “fines” are “worked into” the voids in the underlying coarser gravels and cobbles.

5.2.5 Utility Trenches

All utility trench backfill material below structurally loaded facilities (flatwork, floor slabs, roads, etc.) should be placed at the same density requirements established for structural fill. If the surface of the backfill becomes disturbed during the course of construction, the backfill should be proofrolled and/or properly compacted prior to the construction of any exterior flatwork over a backfilled trench. Proofrolling may be performed by passing moderately loaded rubber tire-mounted construction equipment uniformly over the surface at least twice. If excessively loose or soft areas are encountered during proofrolling, they should be removed to a maximum depth of two feet below design finish grade and replaced with structural fill.

Most utility companies and City-County governments are now requiring that Type A-1 or A-1-a (AASHTO Designation – basically granular soils with limited fines) soils be used as backfill over utilities. These organizations are also requiring that in public roadways the backfill over major utilities be compacted over the full depth of fill to at least 96 percent of the maximum dry density as determined by the AASHTO T-180 (ASTM D-1557) method of compaction. We recommend that as the major utilities continue onto the site that these compaction specifications are followed.

The natural fine-grained cohesive soils are not recommended for use as trench backfill. Some of the natural sand and gravel may be suitable for use as trench backfill.

5.2.6 Areal Settlements

Areal settlements resulting from site grading fills as much as four to five feet should be less than one-half of an inch. These settlements are in addition to settlements induced by foundation and floor slab loads. To reduce the total settlement that the structure will realize, site grading fill must be placed as far in advance of other construction as possible. The majority of this settlement will occur during placement.

5.3 SPREAD AND CONTINUOUS WALL FOUNDATIONS

5.3.1 Design Data

The proposed structure may be supported upon conventional spread and continuous wall foundations established upon suitable natural soils and/or structural fill extending to suitable natural soils. Under no circumstances shall footings be placed overlying non-engineered fills.

For design, the following parameters are provided with respect to the projected loading discussed in Section 2., Proposed Construction, of this report:

Minimum Recommended Depth of Embedment for Frost Protection	- 30 inches
Minimum Recommended Depth of Embedment for Non-frost Conditions	- 15 inches
Recommended Minimum Width for Continuous Wall Footings	- 18 inches
Minimum Recommended Width for Isolated Spread Footings	- 24 inches
Recommended Net Bearing Pressure for Real Load Conditions	
For footings on suitable natural soils and/or structural fill extending to suitable natural soils	- 2,500 pounds per square foot
Bearing Pressure Increase for Seismic Loading	- 50 percent*

* Not applicable for edge bearing pressure when the footings are established upon granular soil. Use 25 percent for overturning or other inclined loading.

The term “net bearing pressure” refers to the pressure imposed by the portion of the structure located above lowest adjacent final grade. Therefore, the weight of the footing and backfill to the lowest adjacent final grade need not be considered. Real loads are defined as the total of all dead plus frequently applied live loads. Total load includes all dead and live loads, including seismic and wind.

5.3.2 Installation

Under no circumstances shall the footings be established upon non-engineered fills, loose or disturbed soils, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water. If unsuitable soils are encountered, they must be completely removed and replaced with compacted structural fill.

The width of structural replacement fill below footings should be equal to the width of the footing plus one foot for each foot of fill thickness.

5.3.3 Settlements

Settlements of foundations designed and installed in accordance with the above recommendations and supporting maximum projected structural loads are anticipated to be less than one inch. Settlements are expected to occur rapidly with approximately 60 to 70 percent of the settlements occurring during construction.

5.4 LATERAL RESISTANCE

Lateral loads imposed upon foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footings and the supporting soils. In determining frictional resistance on fine-grained soils, a coefficient of 0.40 should be utilized. In determining frictional resistance on granular soils, a coefficient of 0.45 should be utilized. Passive resistance provided by properly placed and compacted granular structural fill above the water table may be considered equivalent to a fluid with a density of 300 pounds per cubic foot. Below the water table, this granular soil should be considered equivalent to a fluid with a density of 150 pounds per cubic foot.

A combination of passive earth resistance and friction may be utilized provided that the friction component of the total is divided by 1.5.

5.5 LATERAL PRESSURES

The lateral pressure parameters as presented within this section, assume that the backfill will consist of a drained granular soil placed and compacted in accordance with the recommendations presented herein. The lateral pressures imposed upon subgrade facilities will, therefore, be basically dependent upon the relative rigidity and movement of the backfilled structure. For active walls, such as retaining walls which can move outward (away from the backfill), granular backfill may be considered equivalent to a fluid with a density of 35 pounds per cubic foot in computing lateral pressures. For more rigid basement walls that are not more than 10 inches thick and 12 feet or less in height, granular backfill may be considered equivalent to a fluid with a density of 45 pounds per cubic foot. For very rigid non-yielding walls, granular backfill should be considered equivalent to a fluid with a density of at least 60 pounds per cubic

foot. The above values assume that the surface of the soils slope behind the wall is horizontal, that the granular fill has been placed and lightly compacted, not as a structural fill. If the fill is placed as a structural fill, the values should be increased to 45 pounds per cubic foot, 60 pounds per cubic foot, and 120 pounds per cubic foot, respectively. If the slope behind the wall is two horizontal to one vertical the values for purely active walls and basement walls should increase to 57 pounds per cubic foot and 67 pounds per cubic foot, respectively.

Recommended average lateral uniform pressure for various height walls are tabulated below and assume a granular wall backfill with a horizontal grade above the wall. It should be noted that the lateral pressures as quoted assume that the backfill materials will not become saturated. If the backfill becomes saturated, the above values may be decreased by one-half; however, full hydrostatic water pressures will have to be included.

Wall Height (feet)	Uniform Seismic Lateral Pressure* (psf)
4	67

* Maximum short-term pressures, they are not sustained loads.

Note that the pressures presented in this section do not include surcharge loadings, such as floor slabs, adjacent footings, etc.

5.6 FLOOR SLABS

Floor slabs may be established upon suitable undisturbed natural soils, and/or upon structural fill extending to suitable natural soils or properly prepared existing surface soils. Non-engineered fills, and topsoil are not considered suitable. To provide a capillary break, it is recommended that floor slabs be directly underlain by at least four inches of “free-draining” fill, such as “pea” gravel or three-quarters- to one-inch minus clean gap-graded gravel. Settlements of lightly to moderately loaded floor slabs are anticipated to be minor.

5.7 PAVEMENTS

The properly prepared non-engineered fills will exhibit poor engineering characteristics when saturated or nearly saturated. Non-engineered fills may remain in flexible pavement areas if properly prepared, as stated previously in this report. Rigid pavements shall not be placed overlying non-engineered fills, even if properly prepared. Considering the existing non-engineered soils as the subgrade soils and the projected traffic, the pavement sections on the following pages are recommended.

Parking Areas

(Light Volume of Automobiles and Light Trucks,
Occasional Medium-Weight Trucks,
and No Heavy-Weight Trucks)
[1 equivalent 18-kip axle load per day]

Flexible:

2.5 inches	Asphalt concrete
8.0 inches	Aggregate base
Over	Properly prepared natural soils, properly prepared non-engineered fills, and/or structural site grading fill extending to suitable stabilized natural soils.

Rigid:

5.0 inches	Portland cement concrete (non-reinforced)
4.0 inches	Aggregate base
Over	Properly prepared natural soils, and/or structural site grading fill extending to suitable stabilized natural soils.*

* Rigid pavements shall not be placed over non-engineered fills, even if properly prepared.

Primary Roadway Areas

(Moderate Volume of Automobiles and Light Trucks,
Light Volume of Medium-Weight Trucks,
and Occasional Heavy-Weight Trucks)
[5 equivalent 18-kip axle loads per day]

Flexible:

3.0 inches	Asphalt concrete
8.0 inches	Aggregate base
Over	Properly prepared natural soils, properly prepared non-engineered fills, and/or structural site grading fill extending to suitable stabilized natural soils.

Rigid:

5.5 inches	Portland cement concrete (non-reinforced)
5.0 inches	Aggregate base
Over	Properly prepared natural soils, and/or structural site grading fill extending to suitable stabilized natural soils.*

* Rigid pavements shall not be placed over non-engineered fills, even if properly prepared.

For dumpster pads, we recommend a pavement section consisting of six and one-half inches of Portland cement concrete, four inches of aggregate base, over properly prepared natural stabilized subgrade or site grading structural fills.

These above rigid pavement sections are for non-reinforced Portland cement concrete. Concrete should be designed in accordance with the American Concrete Institute (ACI) and joint details should conform to the Portland Cement Association (PCA) guidelines. The concrete should have a minimum 28-day unconfined compressive strength of 4,000 pounds per square inch and contain 6 percent ±1 percent air-entrainment.

5.8 GEOSEISMIC SETTING

5.8.1 General

In July 2023, the State of Utah adopted the 2021 International Building Code (IBC). The IBC 2021 code determines the seismic hazard for a site based upon 2014 mapping of bedrock accelerations prepared by the United States Geologic Survey (USGS) and the soil site class. The USGS values are presented on maps incorporated into the IBC code and are also available based on latitude and longitude coordinates (grid points).

The structure must be designed in accordance with the procedure presented in Section 1613, Earthquake Loads, of the IBC 2021 edition.

5.8.2 Faulting

Based on our review of available literature, no active faults pass through or immediately adjacent to the site.

5.8.3 Soil Class

Based on the soils encountered and our review of nearby shear wave velocity profiles in the USGS database, we recommend that Site Class D - Stiff Soil Profile as defined in Table 20.3-1, Site Classification, of ASCE 7-16 be utilized for dynamic structural analysis.

5.8.4 Ground Motions

The IBC 2021 code is based on 2014 USGS mapping, which provides values of short and long period accelerations for the Site Class B boundary for the Maximum Considered Earthquake (MCE). This Site Class B boundary represents a hypothetical sandstone bedrock surface and must be corrected for local soil conditions. The following table summarizes the peak ground and short and long period accelerations for a MCE event and incorporates a soil amplification factor for a Site Class D soil profile in the second column. Based on the site latitude and longitude (40.5489 degrees north and -111.9460 degrees west, respectively), the values for this site are tabulated on the following page.

Spectral Acceleration Value, T Seconds	Site Class B-C Boundary [mapped values] (% g)	Site Class D [adjusted for site class effects] (% g)
Peak Ground Acceleration (Geo-Mean)	54.1	59.5
0.2 Seconds (Short Period Acceleration)	S_S = 121.9	S_{MS} = 123.4
1.0 Seconds (Long Period Acceleration)	S_1 = 43.5	S_{M1} = *

* See Section 11.4.8 for requirements on site-specific ground motion studies. Please contact us for a proposal, if needed.

5.8.5 Liquefaction

The site is located in an area that has been identified by the Utah Geological Survey as having "very low" liquefaction potential. Liquefaction is defined as the condition when saturated, loose, finer-grained sand-type soils lose their support capabilities because of excessive pore water pressure which develops during a seismic event.

Due to absence of groundwater to the depths explored, our analysis indicates that the soils encountered will not liquefy during the design seismic event.

Calculations were performed using the procedures described in the 2008 Soil Liquefaction During Earthquakes Monograph by Idriss and Boulanger[4].

5.9 SITE OBSERVATIONS

As stated previously, due to the variable nature of the non-engineered fills encountered, a qualified geotechnical engineer from our staff must aid in verifying that all non-engineered fills have been completely removed prior to the placement of structural site grading fills, footings, or foundations.

[4] Idriss, I. M., and Boulanger, R. W. (2008), Soil liquefaction during earthquakes: Monograph MNO-12, Earthquake Engineering Research Institute, Oakland, CA, 261 pp.

GORDON GEOTECHNICAL ENGINEERING, INC.

We appreciate the opportunity of providing this service for you. If you have any questions or require additional information, please do not hesitate to contact us.

Gordon Geotechnical Engineering, Inc.

Joshua M. Whitney, State of Utah No. 6252902
Senior Engineer

JMW/PRE:sn

Reviewed by:

Patrick R. Emery, State of Utah No. 7941710
Senior Engineer

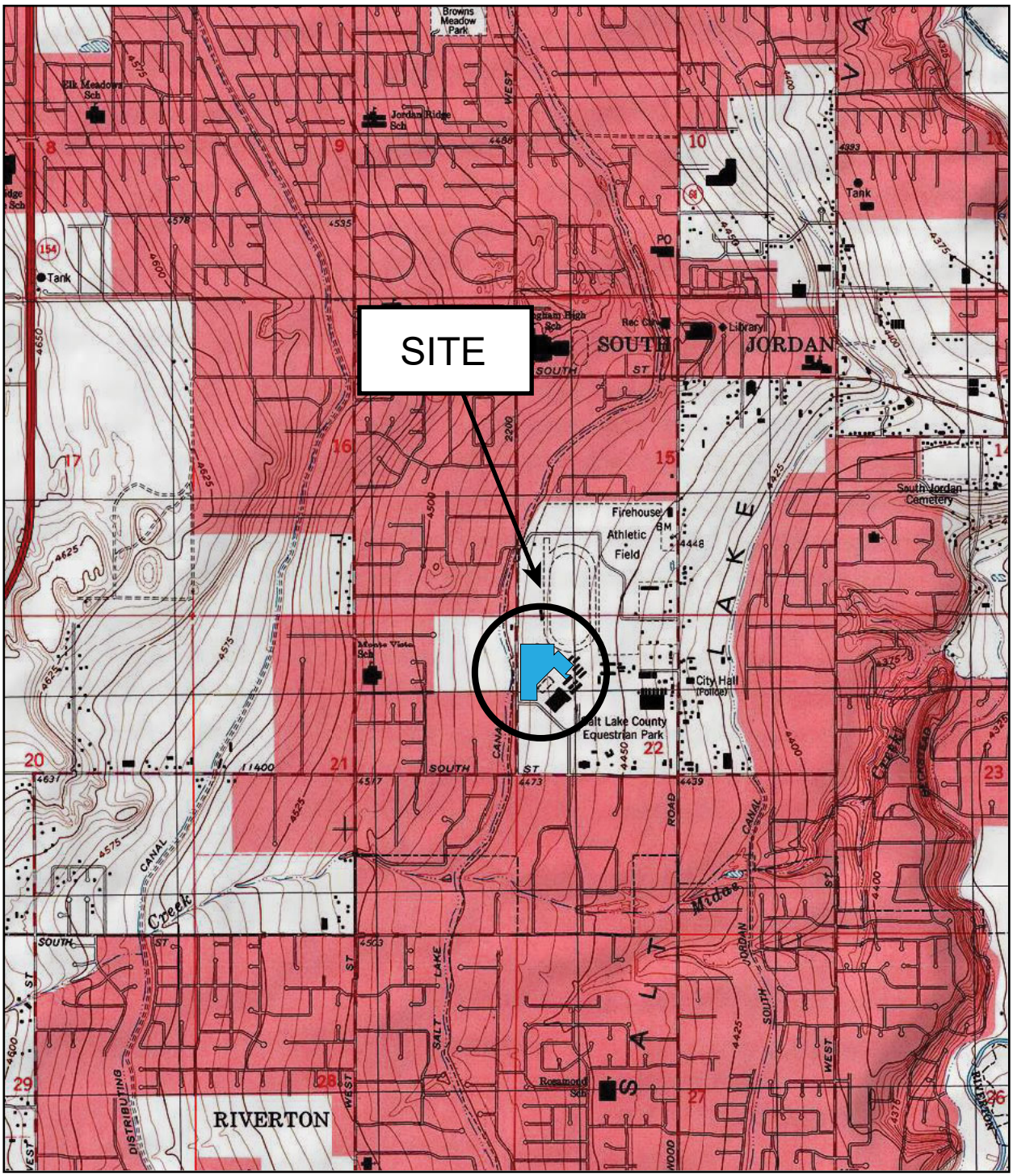
Encl. Figure 1, Vicinity Map
Figure 2, Area Map
Figure 3, Site Plan
Figures 4A through 4F, Log of Test Pits
Figure 5, Unified Soil Classification System
Figure 6, Photographs

Addressee (email only)

PROFESSIONAL ENGINEER
7941710
PATRICK R. EMERY
12-18-24
STATE OF UTAH

DFCM
JOB NO. 003-054-24

GORDON GEOTECHNICAL ENGINEERING, INC.



SCALE IN FEET

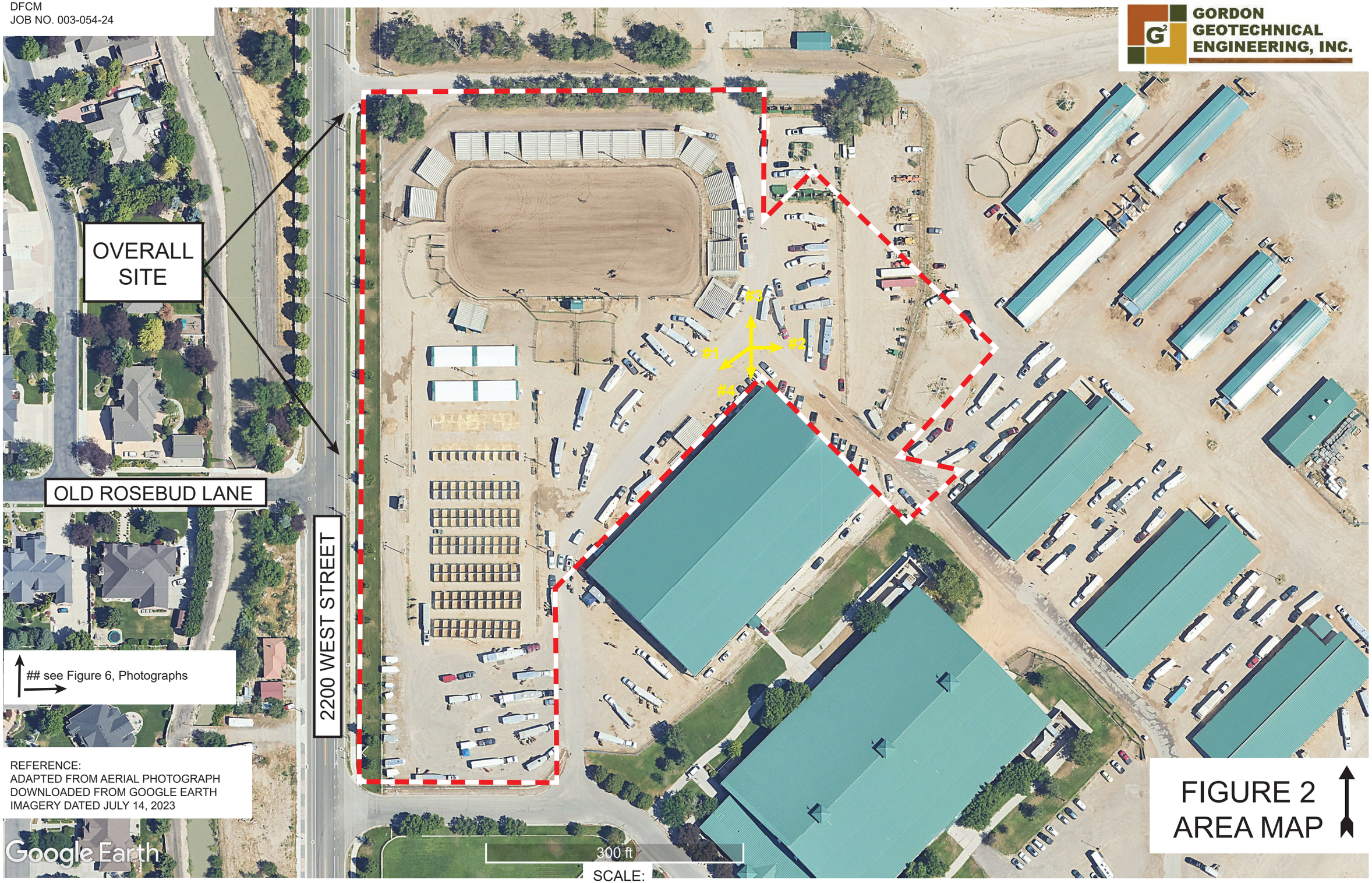
1000 0 1000 2000

FIGURE 1
VICINITY MAP

REFERENCE:
USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE MAP
TITLED "MIDVALE, UTAH", DATED 1999

DFCM
JOB NO. 003-054-24

GORDON GEOTECHNICAL ENGINEERING, INC.

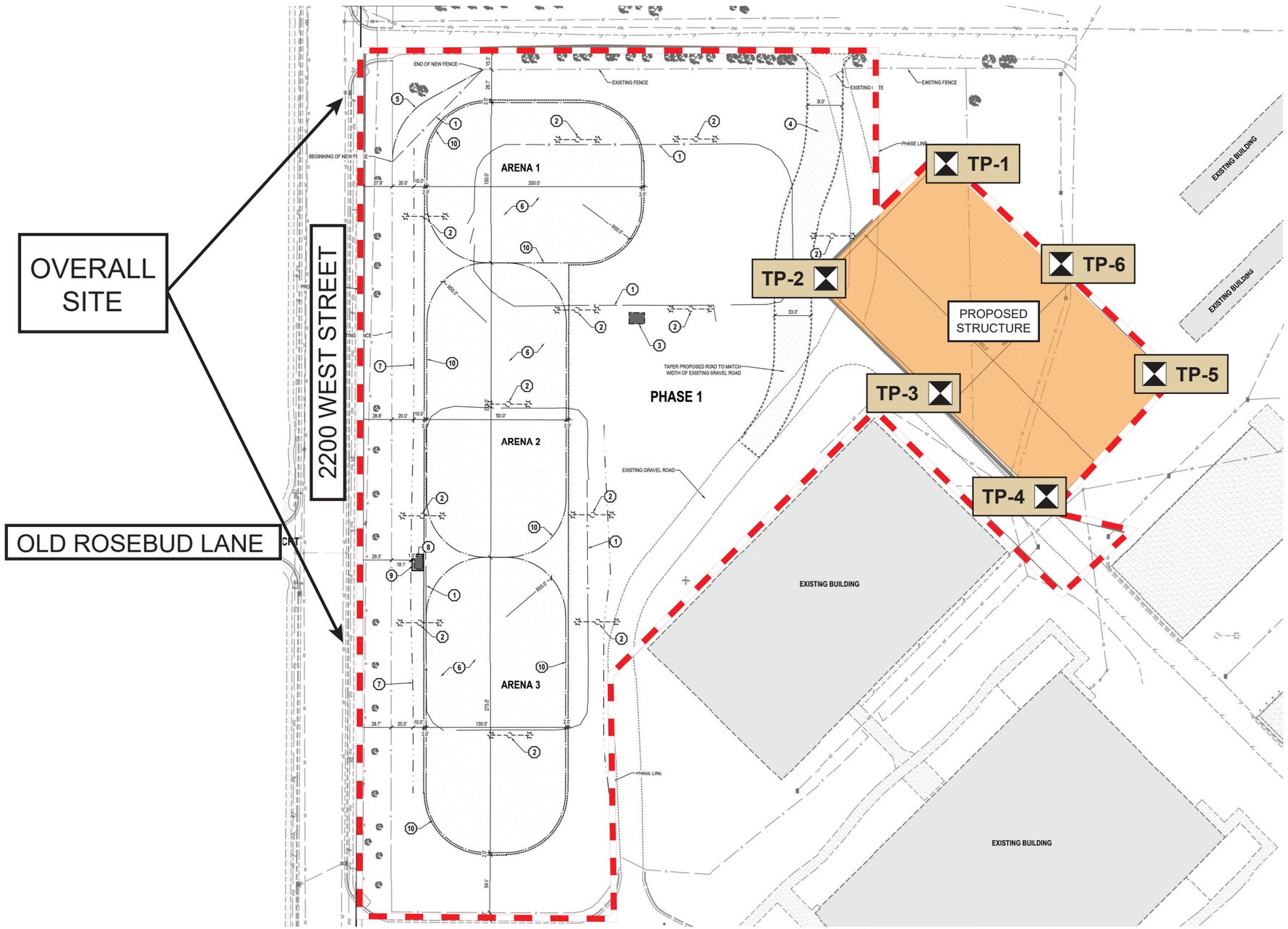


REFERENCE:
ADAPTED FROM AERIAL PHOTOGRAPH
DOWNLOADED FROM GOOGLE EARTH
IMAGERY DATED JULY 14, 2023

FIGURE 2
AREA MAP

DFCM
JOB NO. 003-054-24

GORDON GEOTECHNICAL ENGINEERING, INC.



REFERENCE:
ADAPTED FROM DRAWING ENTITLED
"SITE PLAN - PHASE 1"
BY ENSIGN , DATED JANUARY 19, 2024

NOT TO SCALE

FIGURE 3
SITE PLAN

Gordon Geotechnical Engineering, Inc.
4426 South Century Drive, Suite 100
Salt Lake City, Utah 84123

TEST PIT TP-1

Project Name: Proposed Bastian Ag Center Improvements
Project No.: 003-054-24
Location: 2100 West 11400 South, South Jordan, Utah
Client: DFCM
Excavating Method: Hitachi
Date Excavated: 12-02-24
Elevation: ---
Water Level: No groundwater encountered. (12-02-24 & 12-12-24)
Remarks:

DESCRIPTION	GRAPHIC LOG	WATER LEVEL	DEPTH (FT.)	SAMPLE SYMBOL	SAMPLE TYPE	BLOWS/FT.	MOISTURE (%)	DRY DENSITY (PCF)	%PASSING 200	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	REMARKS
Ground Surface			0									
SILTY CLAY with trace fine to coarse sand; brown (CL)												slightly moist "soft"
					TW		24.3	86				
grades with trace fine sand; brown			5									
					B							
grades light brown			10									
					B		29.9		98.3			
grades with some fine sand												
SILTY FINE TO COARSE SAND with some fine and coarse gravel; light brown/rust (SM)			15									moist "medium dense"
Stopped excavating at 15.0'.												
No groundwater encountered at time of excavating.												
No significant sidewall caving.												
Installed slotted PVC pipe to 15.0'.			20									
			25									

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for proper understanding of the nature of the subsurface material.

FIGURE 4A

Gordon Geotechnical Engineering, Inc.
4426 South Century Drive, Suite 100
Salt Lake City, Utah 84123

TEST PIT TP-2

Project Name: Proposed Bastian Ag Center Improvements
Project No.: 003-054-24
Location: 2100 West 11400 South, South Jordan, Utah
Client: DFCM
Excavating Method: Hitachi
Date Excavated: 12-02-24
Elevation: ---
Water Level: No groundwater encountered. (12-02-24 & 12-12-24)
Remarks:

DESCRIPTION	GRAPHIC LOG	WATER LEVEL	DEPTH (FT.)	SAMPLE SYMBOL	SAMPLE TYPE	BLOWS/FT.	MOISTURE (%)	DRY DENSITY (PCF)	%PASSING 200	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	REMARKS
Ground Surface			0									
SILTY CLAY with trace fine to coarse sand; brown (CL)												slightly moist "soft"
					TW							
grades with trace fine sand; brown			5		B							
grades gray					B		46.8		97.4			
			10									moist
SILTY FINE TO COARSE SAND AND FINE AND COARSE GRAVEL with cobbles and boulders; light brown/rust (SM/GM)												moist "medium dense"
			15		B		8.6		21.2			
Stopped excavating at 15.5'.												
No groundwater encountered at time of excavating.												
No significant sidewall caving.			20									
Installed slotted PVC pipe to 15.0'.												
			25									

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for proper understanding of the nature of the subsurface material.

FIGURE 4B

Gordon Geotechnical Engineering, Inc.
4426 South Century Drive, Suite 100
Salt Lake City, Utah 84123

TEST PIT TP-3

Project Name: Proposed Bastian Ag Center Improvements
Project No.: 003-054-24
Location: 2100 West 11400 South, South Jordan, Utah
Client: DFCM
Excavating Method: Hitachi
Date Excavated: 12-02-24
Elevation: ---
Water Level: No groundwater encountered. (12-02-24)
Remarks:

DESCRIPTION	GRAPHIC LOG	WATER LEVEL	DEPTH (FT.)	SAMPLE SYMBOL	SAMPLE TYPE	BLOWS/FT.	MOISTURE (%)	DRY DENSITY (PCF)	%PASSING 200	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	REMARKS
Ground Surface			0									
SILTY FINE AND COARSE GRAVEL, FILL with fine to coarse sand; dark brown (GM-FILL)												
SILTY CLAY with trace fine sand; brown (CL)												slightly moist "soft"
					TW							
			5									
					B							
grades gray												
			10		B							
grades with some fine to coarse sand; light brown/rust												slightly moist "medium dense"
					B							
FINE TO COARSE SANDY FINE AND COARSE GRAVEL with silt, cobbles, and boulders; light brown/rust (GM)												
			15		B							
Stopped excavating at 15.5'.												
No groundwater encountered at time of excavating.												
No significant sidewall caving.			20									
			25									

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for proper understanding of the nature of the subsurface material.

FIGURE 4C

Gordon Geotechnical Engineering, Inc.
4426 South Century Drive, Suite 100
Salt Lake City, Utah 84123

TEST PIT TP-4

Project Name: Proposed Bastian Ag Center Improvements
Project No.: 003-054-24
Location: 2100 West 11400 South, South Jordan, Utah
Client: DFCM
Excavating Method: Hitachi
Date Excavated: 12-02-24
Elevation: ---
Water Level: No groundwater encountered. (12-02-24)
Remarks:

DESCRIPTION	GRAPHIC LOG	WATER LEVEL	DEPTH (FT.)	SAMPLE SYMBOL	SAMPLE TYPE	BLOWS/FT.	MOISTURE (%)	DRY DENSITY (PCF)	%PASSING 200	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	REMARKS
Ground Surface			0									
FINE AND COARSE GRAVEL, FILL with fine to coarse sand and cobbles; brown (GP-FILL)												
SILTY CLAY with trace fine sand; gray (CL)												slightly moist "soft"
			5		TW		25.0	83				
grades light brown/rust					B							moist
			10									
SILTY FINE TO COARSE SAND with some fine and coarse gravel; light brown (SM)					B							moist "medium dense"
grades with cobbles												
FINE TO COARSE SANDY FINE AND COARSE GRAVEL with silt, cobbles, and boulders; light brown (GM)			15		B							miost "medium dense"
Stopped excavating at 15.5'. No groundwater encountered at time of excavating. No significant sidewall caving.			20 25									

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for proper understanding of the nature of the subsurface material.

FIGURE 4D

Gordon Geotechnical Engineering, Inc.
4426 South Century Drive, Suite 100
Salt Lake City, Utah 84123

TEST PIT TP-5

Project Name: Proposed Bastian Ag Center Improvements
Project No.: 003-054-24
Location: 2100 West 11400 South, South Jordan, Utah
Client: DFCM
Excavating Method: Hitachi
Date Excavated: 12-02-24
Elevation: ---
Water Level: No groundwater encountered. (12-02-24 & 12-12-24)
Remarks:

DESCRIPTION	GRAPHIC LOG	WATER LEVEL	DEPTH (FT.)	SAMPLE SYMBOL	SAMPLE TYPE	BLOWS/FT.	MOISTURE (%)	DRY DENSITY (PCF)	%PASSING 200	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	REMARKS
Ground Surface			0									
FINE TO COARSE SANDY FINE GRAVEL, FILL with bricks and debris; brown (GP-FILL)												
SILTY CLAY with trace fine sand; brown (CL)					TW							slightly moist "soft"
			5									
					B							
grades with trace fine gravel; light brown												moist
SILTY FINE TO MEDIUM SAND light brown (SM)			10		B							moist "loose"
grades with some fine gravel					B							
			15									
Stopped excavating at 15.0'.												
No groundwater encountered at time of excavating.												
No significant sidewall caving.			20									
Installed slotted PVC pipe to 15.0'.												
			25									

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for proper understanding of the nature of the subsurface material.

FIGURE 4E

Gordon Geotechnical Engineering, Inc.
4426 South Century Drive, Suite 100
Salt Lake City, Utah 84123

TEST PIT TP-6

Project Name: Proposed Bastian Ag Center Improvements
Project No.: 003-054-24
Location: 2100 West 11400 South, South Jordan, Utah
Client: DFCM
Excavating Method: Hitachi
Date Excavated: 12-02-24
Elevation: ---
Water Level: No groundwater encountered. (12-02-24)
Remarks:

DESCRIPTION	GRAPHIC LOG	WATER LEVEL	DEPTH (FT.)	SAMPLE SYMBOL	SAMPLE TYPE	BLOWS/FT.	MOISTURE (%)	DRY DENSITY (PCF)	%PASSING 200	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	REMARKS
Ground Surface			0									
SILTY CLAY, FILL with brick/cement and debris; brown (CL-FILL)												
SILTY CLAY with some fine sand; root holes; brown (CL)					TW							slightly moist "medium stiff"
			5									
					B		22.7		98.8	49	19	
			10									
					B							
grades with some fine to medium sand and trace fine and coarse gravel; light brown/rust/gray												
grades with some fine to medium sand; brown/gray			15		B							
Stopped excavating at 15.5'. No groundwater encountered at time of excavating. No significant sidewall caving.			20									
			25									

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for proper understanding of the nature of the subsurface material.

FIGURE 4F

GORDON GEOTECHNICAL ENGINEERING, INC.

UNIFIED SOIL CLASSIFICATION SYSTEM

FIELD IDENTIFICATION PROCEDURES				GRAPH SYMBOL	LETTER SYMBOL [1]	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS More than half of material is larger than No. 200 sieve size. [2] (The No. 200 sieve size is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than No. 4 sieve size. (For visual classifications, the 1/4" size may be used as equivalent to the No. 4 sieve size.)	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.		GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			Predominantly one size or a range of sizes with some intermediate sizes missing.		GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
		GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).		GM	Silty gravels, poorly graded gravel-sand-silt mixtures.
			Plastic fines (for identification procedures see CL below).		GC	Clayey gravels, poorly graded gravel-sand-clay mixtures.
	SANDS More than half of coarse fraction is smaller than No. 4 sieve size. (For visual classifications, the 1/4" size may be used as equivalent to the No. 4 sieve size.)	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.		SW	Well graded sands, gravelly sands, little or no fines.
			Predominantly one size or a range of sizes with some intermediate sizes missing.		SP	Poorly graded sands, gravelly sands, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).		SM	Silty sands, poorly graded sand-silt mixtures.
			Plastic fines (for identification procedures see CL below).		SC	Clayey sands, poorly graded sand-clay mixtures.

IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN No. 40 SIEVE SIZE		DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)	TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)	GRAPH SYMBOL	LETTER SYMBOL [1]	TYPICAL DESCRIPTIONS
FINE GRAINED SOILS More than half of material is smaller than No. 200 sieve size. (The No. 200 sieve size is about the smallest particle visible to the naked eye)	SILTS AND CLAYS Liquid limit less than 50	None to slight	Quick to slow	None		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sand with slight plasticity.
		Medium to high	None to very slow	Medium		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		Slight to medium	Slow	Slight		OL	Organic silts and organic silt-clays of low plasticity.
	SILTS AND CLAYS Liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		High to very high	None	High		CH	Inorganic clays of high plasticity, fat clays.
		Medium to high	None to very slow	Slight to medium		OH	Organic clays of medium to high plasticity.
HIGHLY ORGANIC SOILS		Readily identified by color, odor, spongy feel and frequently by fibrous texture.				Pt	Peat and other highly organic soils.

[1] Boundary classifications: –Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW–GC, well graded gravel–sand mixture with clay binder.
[2] All sieve sizes on this chart are U.S. standard.

GENERAL NOTES

1. In general, Unified Soil Classification Designations presented on the logs were evaluated by visual methods only. There rore, actual designations (based on laboratory testing) may differ.

2. Lines seperating strata on the logs represent approximate boundaries only Actual transitions may be gradual.

3. Logs represent general soil conditions observed at teh point of exploration onthe date indicated.

4. No warranty is provided as to the continuity of soil conditions between individual sample locations.

FINE - GRAINED SOIL

CONSISTENCY	SPT (blows/ft)	TORVANE UNDRAINED SHEAR STRENGTH (tsf)	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH (tsf)	FIELD TEST
Very Soft	<2	<0.125	<0.25	Easily penetrated several inches by Thumb. Squeezes through fingers.
Soft	2 - 4	0.125 - 0.25	0.25 - 0.5	Easily penetrated 1 " by Thumb . Molded by light finger pressure.
Medium Stiff	4 - 8	0.25 - 0.5	0.5 - 1.0	Penetrated over 1/2 " by Thumb with moerate effort. Molded by strong finger pressure.
Stiff	8 - 15	0.5 - 1.0	1.0 - 2.0	Indented about 1/2 " by Thumb but penetrated only with great effort
Very Stiff	15 - 30	1.0 - 2.0	2.0 - 4.0	Readily indented by Thumbnail
Hard	>30	>2.0	>4.0	Indented with difficulty by Thumbnail

LOG KEY SYMBOLS

- Bulk / Bag Sample
- Standard Penetration Split Spoon Sampler
- Rock Core
- Water Level
- Thin Wall
- No Recovery
- 3-3/4" ID D&M Sampler
- 3" ID D&M Sampler
- California Sampler

COARSE -GRAINDE SOIL

APPERENT DENSITY	SPT (blows/ft)	RELATIVE DENSITY (%)	FIELD TEST
Very Loose	<4	0 - 15	Easily penetrated with 1/2 " reinforcing rod pushed by hand
Loose	4 - 10	15 - 35	Difficult to penetrated with 1/2 " reinforcing rod pushed by hand
Medium Dense	10 - 30	35 - 65	Easily penetrated a foot with 1/2 " reinforcing rod driven with 5-lb hammer
Dense	30 - 50	65 - 85	Difficult to penetrated a foot with 1/2 " reinforcing rod driven with 5-lb hammer
Very Dense	>50	85 - 100	Penetrated only a few inches with 1/2 " reinforcing rod driven with 5-lb hammer

STRATIFICATION

DESCRIPTION	THICKNESS
SEAM	1/16 - 1/2 "
LAYER	1/2 - 12 "

DESCRIPTION	THICKNESS
Occasional	One or less per foot of thickness
Frequent	More than on per foot of thichness

CEMENTATION

DESCRIPTION	DESCRIPTION
Weakely	Crumbles or breaks with handling of slight finger pressure
Moderately	Crumbles or breaks with considerable finger pressure
Strongly	Will not crumbles or breaks with finger pressure

MODIFIERS

DESCRIPTION	%
Trace	<5
Some	5 - 12
With	>12

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible water, usually soil below Water Table

FIGURE 5

DFCM
JOB NO. 003-054-24

GORDON GEOTECHNICAL ENGINEERING, INC.

#1 Looking southwest.

#2 Looking east.

#3 Looking north.

#4 Looking south.

Locations and direction, see Figure 2, Area Map

FIGURE 6
PHOTOGRAPHS

GENERAL CONDITIONS

August 31, 2020

Table of Contents

ARTICLE 1. GENERAL PROVISIONS

1.1 Definitions *(see revision page 8)*

ARTICLE 2. DFCM

2.1 Information and Services Required of DFCM
- 2.1.1 DFCM's Representative
- 2.1.2 Specialists and Inspectors
- 2.1.3 Surveys and Legal Description
- 2.1.4 Prompt Information and Services
- 2.1.5 Copies of Contract Documents

2.2 Construction By DFCM or By Separate Contractors
- 2.2.1 DFCM's Right To Perform Construction and to Award Separate Contracts
- 2.2.2 Coordination of the Work
- 2.2.3 Coordination of Schedules
- 2.2.4 Reporting Problems to DFCM
- 2.2.5 Contractor Remedial Work

ARTICLE 3. A/E

3.1 A/E's Administration of the Contract
- 3.1.1 In General
- 3.1.2 Site Visits
- 3.1.3 Communications Facilitating Contract Administration
- 3.1.4 A/E May Reject Work, Order Inspection, Tests
- 3.1.5 A/E Review Contractor's Submittals

3.2 Ownership and Use of A/E's Drawings, Specifications, and Other Documents

ARTICLE 4. CONTRACTOR

4.1 Review of Contract Documents and Field Conditions By Contractor
- 4.1.1 Reviewing Contract Documents, Information, Reporting Errors, Inconsistencies or Omissions
- 4.1.2 Review of Field Conditions
- 4.1.3 Subsurface Investigations
- 4.1.4 Perform in Accordance with Contract Documents and Submittals
- 4.1.5 Performance to Produce the Complete System and Intended Results
- 4.1.6 Intent and Hierarchy
- 4.1.7 Dividing Work and Contractor Representation
- 4.1.8 Planning and Priority

4.2 Supervision and Representatives
- 4.2.1 Supervision and Control
- 4.2.2 Persons Performing Work
- 4.2.3 Designated Representatives
- 4.2.4 Discipline and Competence
- 4.2.5 Responsibility
- 4.2.6 Not Relieved of Obligations
- 4.2.7 Inspections and Approvals

4.3 Payment by Contractor

4.4 Taxes and Other Payments to Government

4.5 Permits, Fees, Notices, Labor and Materials
- 4.5.1 Permits and Fees
- 4.5.2 Compliance, Notices
- 4.5.3 Correlation of Contract Documents and Laws
- 4.5.4 Failure to Give Notice

4.6 Time and Contractor's Construction Schedules
- 4.6.1 Progress and Completion
- 4.6.2 Schedule Preparation
- 4.6.3 Schedule Submittal
- 4.6.4 Schedule Content Requirements
- 4.6.5 Interim Completion Dates and Milestones
- 4.6.6 Float Time
- 4.6.7 Updates
- 4.6.8 Schedule of Submittals
- 4.6.9 Schedule Recovery
- 4.6.10 Schedule Changes and Modifications
- 4.6.11 Excusable Delay
- 4.6.12 Compensable Delay, Suspension or Interruption.
- 4.6.13 Time Extension Requests
- 4.6.14 Liquidated Damages

4.7 Documents and Samples at the Site, Certifying "As-Builts"

4.8 Shop Drawings, Product Data and Samples
- 4.8.1 Not Contract Documents
- 4.8.2 Promptness
- 4.8.3 Not Perform Until A/E Approves

4.8.4 Representations by Contractor
4.8.5 Contractor's Liability
4.8.6 Direct Specific Attention to Revisions
4.8.7 Informational Submittals
4.8.8 Professional Services
4.9 Use of Site
4.9.1 In General
4.9.2 Access to Neighboring Properties
4.10 Access to Work
4.11 Intellectual Property Licenses
4.12 Indemnification
4.12.1 Not Exclusive
4.12.2 Not Limited

ARTICLE 5. SUBCONTRACTORS

5.1 Award of Subcontracts and Other Contracts For Portions of the Work
5.1.1 Subcontracting Work Permitted; Conditions
5.1.2 Subsequent Changes
5.1.3 Business and Licensing Requirements
5.1.4 Bonding of Subcontractors
5.1.5 Subcontractor Default Insurance
5.2 Subcontractor Relations
5.2.1 Contractor Fully Responsible
5.2.2 Comply with Contact Documents
5.2.3 Rights
5.2.4 Sub-Subcontractors
5.2.5 Document Copies
5.3 Contingent Assignment of Subcontracts

ARTICLE 6. PROTECTION OF PERSONS AND PROPERTY

6.1 Safety of Persons and Property
6.1.1 Contractor Responsibility
6.1.2 Safety Program, Precautions
6.1.3 Compliance with Laws
6.1.4 Erect and Maintain Safeguards
6.1.5 Utmost Care
6.1.6 Prompt Remedy
6.1.7 Safety Designee
6.1.8 Load Safety
6.1.9 Off-Site Responsibility
6.1.10 Emergencies
6.2 Hazardous Materials
6.3 Historical and Archeological Considerations
6.4 Contractor Liability

ARTICLE 7. MODIFICATIONS, PRs & PCOs, PRE AND CLAIMS PROCESS

7.1 Modifications: In General
7.1.1 Types of Modifications and Limitations
7.1.2 By Whom Issued
7.1.3 Contractor to Proceed Unless Otherwise Stated
7.1.4 Adjusting Unit Prices
7.1.5 Concealed or Unknown Conditions
7.1.6 Increase in Contract Time
7.1.7 Allowances
7.2 Contractor Initiated Requests
7.2.1 The Request for Information, RFI, Process and Time to File
7.2.2 Proposed Change Order ("PCO")
7.2.3 Substitutions
7.3 Proposal Request Initiated by DFCM
7.3.1 If Agreement, Change Order Issued
7.3.2 If Disagreement
7.4 Change Orders
7.4.1 Adjusting Price Based Upon Agreement
7.4.2 DFCM Resolution of Price in the Absence of an Agreement Under Paragraph 7.4.1
7.4.3 Credits
7.4.4 Effect of a Change Order
7.5 Construction Change Directives
7.5.1 When Used and Contractor's Right to Challenge
7.5.2 Proceed with Work
7.5.3 Interim Payments by DFCM
7.6 ASI
7.7 Procedure for Preliminary Resolution Efforts
7.7.1 Request for Preliminary Resolution Effort (PRE)
7.7.2 Time for Filing
7.7.3 Content Requirement
7.7.4 Supplementation
7.7.5 Subcontractors
7.7.6 Information and Meetings
7.7.7 Contractor Required to Continue Performance
7.7.8 Decision
7.7.9 Decision Final Unless Claim Submitted
7.7.10 Extension Requires Mutual Agreement
7.7.11 If Decision Not Issued
7.7.12 Payment for Performance
7.8 Resolution of Claim
7.8.1 Claim
7.8.2 Subcontractors
7.8.3 Time for Filing
7.8.4 Content Requirement
7.8.5 Extension of Time to Submit Documentation
7.8.6 Contractor Required to Continue Performance
7.8.7 Agreement of Claimant on Method and Person(s) Evaluating the Claim
7.8.8 The Evaluation Process, Timeframes of Evaluator(s), Director's Determination, Administrative Appeal to the Executive Director and Judicial Review
7.8.9 Appeal Process Prerequisite for Further Consideration or Judicial Review

7.8.10 Payment of Claim
7.8.11 Allocation of Costs of Claim Resolution Process.
7.8.12 Alternative Procedures
7.8.13 Impact on Future Selections
7.8.14 DFCM's Right to Have Issues, Disputes or Claims Considered *(see revision page 41)*

ARTICLE 8. PAYMENTS AND COMPLETION

8.1 Schedule of Values
8.2 Applications for Payment
8.2.1 In General
8.2.2 Payment for Material and Equipment
8.2.3 Warranty of Title
8.2.4 Holdback by DFCM
8.3 Certificates for Payment
8.3.1 Issued by A/E
8.3.2 A/E's Representations
8.4 Decisions to Withhold Certification
8.4.1 When Withheld
8.4.2 Certification Issued When Reasons For Withholding Removed
8.4.3 Continue Work Even if Contractor Disputes A/E's Determination
8.4.4 DFCM Not in Breach
8.5 Progress Payments
8.5.1 In General, Interest on Late Payments
8.5.2 Contractor and Subcontractor Responsibility
8.5.3 Information Furnished by A/E or DFCM to Subcontractor
8.5.4 DFCM and A/E Not Liable
8.5.5 Certificate, Payment or Use Not Acceptance of Improper Work
8.6 Payment Upon Substantial Completion
8.7 Partial Occupancy or Use
8.7.1 In General
8.7.2 Inspection
8.7.3 Not Constitute Acceptance
8.7.4 Insurance
8.8 Final Payment
8.8.1 Certificate for Payment
8.8.2 Conditions for Final Payment
8.8.3 Waiver of Claims: Final Payment
8.8.4 Delays Not Contractor's Fault
8.8.5 Waiver by Accepting Final Payment

ARTICLE 9. TESTS AND INSPECTIONS, SUBSTANTIAL AND FINAL COMPLETION, UNCOVERING, CORRECTION OF WORK AND GUARANTY PERIOD

9.1 Tests and Inspections
9.1.1 In General
9.1.2 Failure of an Inspector to Appear
9.1.3 Nonconforming Work
9.1.4 Certificates
9.1.5 A/E Observing
9.1.6 Promptness
9.2 Uncovering of Work
9.2.1 Uncover Uninspected Work
9.2.2 Observation Prior to Covering
9.2.3 When an Inspector Fails to Appear or A/E or DFCM Did Not Make Prior Request
9.3 Inspections: Substantial and Final
9.3.1 Substantial Completion Inspection
9.3.2 Final Completion Inspection
9.3.3 Punchlist Completion
9.4 Correction of Work and Guaranty Period
9.4.1 Contractor Correct the Work
9.4.2 Guaranty and Correction After Substantial Completion
9.4.3 Removal of Work
9.4.4 Not Limit Other Obligations
9.5 Additional Warranties
9.5.1 In General
9.5.2 Exclusion
9.5.3 Furnish Evidence on Request
9.6 Acceptance of Nonconforming Work

ARTICLE 10. INSURANCE AND BONDS

10.1 Contractor's Liability Insurance
10.1.1 In General
10.1.2 Coverage
10.1.3 Endorsements
10.1.4 Terms
10.1.5 Failure to Provide
10.1.6 Certificates
10.1.7 No Limitation
10.2 "Builder's Risk" Insurance
10.2.1 In General
10.2.2 Deductible
10.2.3 Waiver of Subrogation
10.2.4 Special Hazards
10.2.5 Non-Eligible Projects
10.3 Performance Bond and Payment Bond

ARTICLE 11. MISCELLANEOUS PROVISIONS

11.1 A/E's Responsibilities
11.2 Successors and Assigns
11.3 Written Notice
11.3.1 Personal Delivery and Registered or Certified Mail
11.3.2 E-mail
11.4 Rights and Remedies
11.4.1 Not Limit
11.4.2 No Waiver
11.5 No Discrimination, No Sexual Harassment
11.6 Applicable Laws and Enforcement
11.7 Interpretation
11.8 Venue
11.9 Severability
11.10 Construction of Words
11.11 No Third-Party Rights

ARTICLE 12. TERMINATION OR SUSPENSION OF THE CONTRACT

12.1 Termination by Contractor for Cause
12.1.1 In General
12.1.2 Notice
12.2 Termination by DFCM for Cause
12.2.1 In General
12.2.2 DFCM's Right to Carry Out the Work Upon Termination for Cause
12.2.3 Items Required to Be Transferred or Delivered
12.2.4 Payment
12.2.5 DFCM Protection if Lienable
12.2.6 Credits and Deficits
12.2.7 If Contractor Found Not in Default or Excusable
12.2.8 Rights and Remedies Not Exclusive
12.2.9 Time Period for Claims
12.3 Termination for Convenience of DFCM
12.3.1 In General
12.3.2 Contractor Obligations
12.3.3 Termination Claim
12.3.4 Agreed Upon Payment
12.3.5 Payment Not Agreed Upon
12.3.6 Deductions
12.3.7 Partial Termination
12.3.8 Partial Payments
12.3.9 Preserve and Make Available Records
12.3.10 Suspension, Delay or Interruption of Work by DFCM for Convenience
12.4 DFCM's Right to Stop the Work

GENERAL CONDITIONS

August 31, 2020

THESE GENERAL CONDITIONS ("General Conditions") are part of and subject to the Contractor's Agreement (defined below) between DFCM (defined below) and Contractor (defined below).

ARTICLE 1. GENERAL PROVISIONS.

1.1 DEFINITIONS.

ARCHITECT/ENGINEER OR A/E. "Architect / Engineer" or "A/E" means the person or entity practicing as a design professional, including architect, engineer, interior designer, and/or landscape architect, retained under separate agreement with DFCM to act on behalf of DFCM according to the Contract Documents (defined below) and the A/E's employees, representatives and consultants. For Work (defined below) where there is no A/E hired by DFCM, references in these General Conditions to A/E shall be deemed to refer to DFCM's Representative.

ADDENDA. "Addenda" means the written or graphic instruments issued prior to the execution of the Contractor's Agreement (defined below) that clarify, correct, or change the bidding documents or the Contract Documents.

A/E's SUPPLEMENTAL INSTRUCTION OR ASI. "A/E's Supplemental Instruction" or "ASI" means a supplemental instruction issued by the A/E to Contractor that results in a clarification, correction, or minor change in the Work and does not affect the Contract Time (defined below) or the Contract Price (defined below).

AMENDMENT. "Amendment" means any document or communication that changes (or purports to change) the terms of Contractor's Agreement and/or the General Conditions, except as to: (1) scope of the Work; (2) Contract Price; and/or (3) Contract Time. With the exception of Supplemental General Conditions (defined below), no Amendment shall be valid and/or binding on DFCM unless: (1) the Amendment is set forth in a separate document, clearly titled "Amendment"; and (2) the Amendment is specifically and expressly accepted in writing by the Director (defined below).

BID. "Bid" means the offer or proposal of the bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

BONDS. "Bonds" means collectively the bid bond, performance bond, payment bond, and any other instruments of security.

CHANGE ORDER. "Change Order" means a written instrument signed by both DFCM and Contractor, issued after the execution of the Contractor's Agreement on DFCM's form, authorizing: (1) a change in the Work; (2) an adjustment of the Contract Price; and/or (3) an adjustment of the Contract Time.

CLAIM. "Claim" means a dispute, demand, assertion or other matter submitted by Contractor, including a subcontractor at any tier, subject to the provisions of these General Conditions. The claimant may seek, as a matter of right, modification, adjustment or interpretation of Contract terms, payment of money, extension of time or other relief with respect to the terms of the Contract. A request for Preliminary Resolution Effort ("PRE") (defined below) shall not be considered a "Claim". A request for an amendment of the Contract Documents, requested Change Order or a Construction Change Directive ("CCD") (defined below) is not a PRE or Claim unless agreement cannot be reached, and the procedures of these General Conditions are followed.

CONSTRUCTION CHANGE DIRECTIVE. "Construction Change Directive" means a written order signed by DFCM, issued after execution of the Contractor's Agreement, directing Contractor to perform a change in the Work and stating a proposed basis for adjustment, if any, in the Contract Price and/or Contract Time.

CONTRACT DOCUMENTS. "Contract Documents" means collectively Contractor's Agreement, these General Conditions of Contractor's Agreement, applicable Supplemental General Conditions, Drawings (defined below), Specifications (defined below), Addenda, other documents listed in the Contractor's Agreement, authorized Amendments and Supplementary Conditions and Modifications (defined below) issued after execution of the Contractor's Agreement. The Contract Documents shall also include the bidding/proposal documents, including the Instructions to Bidders/Proposers, Notice to Contractors and the Bid/Proposal Form, to the extent not in conflict with the other above-stated Contract Documents and other documents and oral representations which are memorialized in writing and documented as an attachment to the Contractor's Agreement.

CONTRACT PRICE. "Contract Price" means the total amount payable by DFCM to Contractor for performance of the Work, including any authorized changes in the Work.

CONTRACT TIME. "Contract Time" means the time within which Contractor shall complete the Work, including any authorized changes in the Work

CONTRACTOR. "Contractor" means the person or entity identified as such in the Contractor's Agreement. As used in the Contract Documents, "Contractor" includes Contractor's employees, agents, representatives, subcontractors at any tier, and any other third party hired by Contractor to perform a portion of the Work and is referred to throughout the Contract Documents as if singular in number.

CONTRACTOR'S AGREEMENT. "Contractor's Agreement" means, unless the context requires otherwise, the agreement executed by the Contractor and DFCM for the Work.

DAY. "Day" or "days" means calendar day unless otherwise specifically defined.

DEFECTIVE. "Defective" is an adjective which when modifying the word "Work" refers to Work that does not conform to the Contract Documents, or does not meet the requirements of any inspection, referenced standard, code, test or approval referred to in the Contract Documents, or which fails to meet generally accepted craft standards, or which has been damaged.

DIRECTOR. "Director" means the Director of the Division of Facilities Construction and Management, unless the context requires otherwise. Director may include a designee selected by the Director for a particular function described in the Contract Documents.

DFCM. "DFCM" means the State of Utah, Division of Facilities Construction and Management. Unless the context requires otherwise, DFCM is the "Owner" as that term is commonly understood in the construction industry.

DRAWINGS. "Drawings" means the graphic and pictorial portions of the Contract Documents, wherever located and whenever issued, showing the design, location, and dimensions of the Work and generally includes drawings, elevations, sections, details, schedules, and diagrams, including electronic copies.

EXECUTIVE DIRECTOR. "Executive Director" means the Executive Director of the Utah Department of Administrative Services, including unless otherwise stated, the Executive Director's duly authorized designee.

FINAL COMPLETION. "Final Completion" means the date when all Work to be performed by Contractor has been completed and accepted in writing by DFCM.

INSPECTION. "Inspection" or its derivatives means a review of the Work, including but not limited to a visual review of the Work completed to date to ascertain if the Work is in accordance with the Contract Documents, including all applicable building codes and construction standards.

MODIFICATION. "Modification" means: (1) a Change Order; (2) a Construction Change Directive; or (3) an ASI. Contractor's Agreement may be amended or modified only by: (1) an authorized Amendment; or (2) a Modification.

NOTICE TO PROCEED. "Notice to Proceed" means a document prepared by DFCM that authorizes Contractor to commence Work. It shall be deemed issued upon being sent by DFCM to Contractor's address specified in Contractor's Bid.

PRELIMINARY RESOLUTION EFFORT OR PRE. "Preliminary Resolution Effort" or "PRE" means the processing of a request for preliminary resolution or any similar notice about an issue that could potentially lead to a Claim and is prior to reaching the status of a Claim.

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

PROPOSAL REQUEST OR PR. "Proposal Request" or "PR" means a request made by DFCM to Contractor requesting a proposal to resolve an issue as part of the Change Order process.

PROPOSED CHANGE ORDER OR PCO. "Proposed Change Order" or "PCO" means a request by Contractor submitted to the DFCM Representative to commence the Change Order process. It shall not be considered a "PRE" or a "Claim". The PCO may be related to any potential or actual delay, disruption, unforeseen condition or any other matter for which Contractor intends to seek an increase in the Contract Price and/or extension of the Contract Time.

REQUEST FOR INFORMATION OR RFI. "Request for Information" or "RFI" means a written request from Contractor to the A/E seeking information, direction, or clarification related to the Contract Documents, including Drawings and/or Specifications.

RULE. "Rule", unless the context requires otherwise, means a rule of the Utah Administrative Code.

SALES TAX AND/OR USE TAX. "Sales Tax" and/or "Use Tax", unless the context requires otherwise, means the sales tax and/or use tax collected or to be collected by the Utah State Tax Commission and shall

include any sales and/or use tax that the Utah State Tax Commission collects on behalf of any special district, local government, or political subdivision.

SAMPLES. "Samples" mean physical examples that illustrate materials, equipment or workmanship and establish standards by which the Work shall be judged.

SHOP DRAWINGS. "Shop Drawings" means drawings, diagrams, schedules and other data specially prepared for the Work by Contractor, or a subcontractor at any tier, manufacturer, supplier or distributor to illustrate some portion of the Work.

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

SUBCONTRACTOR. "Subcontractor" means any person or entity under contract with Contractor to provide services or labor for the Work. "Subcontractor" includes a trade contractor or specialty contractor. "Subcontractor" does not include suppliers who provide only materials, equipment or supplies to Contractor or a Subcontractor. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Subcontractor or authorized representative of the Subcontractor. The term "Sub-subcontractor" means a person or entity that has a contract with a Subcontractor to provide services or labor for the Work and also includes all lower tier sub-subcontractors. The terms "Subcontractor" and "Sub-subcontractor" do not include a separate contractor retained by DFCM or subcontractors or sub-subcontractors of a separate contractor retained by DFCM.

SUBSTANTIAL COMPLETION. "Substantial Completion" and its derivatives means the date certified in accordance with *Section 9.3** when the Work, or a designated portion thereof, is sufficiently complete, and any lack of completion or performance does not materially interfere with DFCM's intended use of the Work, in accordance with the Contract Documents, so that DFCM can occupy and use the Work for its intended use. DFCM's "intended use" or "occupy" as used in this definition, shall include any intended use or occupation by any agency or entity that DFCM intends to use or occupy the Work.
**Revised numbering from 'Section 9.2' to 'Section 9.3' as of 07122023.*

SUPPLEMENTAL GENERAL CONDITIONS. "Supplemental General Conditions" means the Supplemental General Conditions identified on DFCM's website, dfcm.utah.gov, applicable to the Work, if any, that supplements these General Conditions. Supplemental General Conditions are authorized Amendments.

SUPPLEMENTARY CONDITIONS. "Supplementary Conditions" means the part of the Contract Documents, if any, that amends or supplements these General Conditions and/or applicable Supplemental General Conditions. Supplementary Conditions, if authorized, are an Amendment.

WORK. "Work" means the construction, services, supervision, labor, tools, equipment, materials, products and transportation, to be furnished by Contractor, so as to fulfill the Contractor's obligations as required by the Contract Documents.

ARTICLE 2. DFCM.

2.1 INFORMATION AND SERVICES REQUIRED OF DFCM.

2.1.1 DFCM'S REPRESENTATIVE. DFCM shall designate a representative authorized to act on behalf of DFCM with respect to the Work ("DFCM's Representative"). Unless the context requires otherwise, "DFCM's Representative" is the "Owner's representative" as that term is commonly understood in the construction industry. DFCM's Representative shall have authority to review and approve the Work, including

the time schedule for completion, and the authority (but not a duty) to stop the Work for any reason, including, without limitation, unsafe conditions, or to direct Contractor to remedy, repair, or replace any Work, if necessary, to ensure its proper execution. DFCM and DFCM's Representative shall endeavor to render decisions pertaining to documents submitted by the A/E and/or Contractor to avoid a delay in the orderly and sequential progress of the Work. Contractor shall be responsible for time lost and the cost of correcting Work that in DFCM's judgment was executed improperly. DFCM shall be the final interpreter of the Contract Documents; the decision of DFCM in the absence of arbitrary or capricious conduct shall be conclusive. Notwithstanding anything to the contrary in the Contract Documents, DFCM's approval shall not relieve Contractor of Contractor's sole responsibility for the Work.

2.1.2 SPECIALISTS AND INSPECTORS. DFCM shall provide building inspection services in accordance with the applicable building codes, including routine and special inspections unless otherwise noted in the Contract Documents. DFCM may assign an inspector or specialist to note deviations from, or necessary adjustments to, the Contract Documents or to report deficiencies or defects in the Work. The inspector's or specialist's activities in no way relieve Contractor from the responsibilities set forth in the Contract Documents.

2.1.3 SURVEYS AND LEGAL DESCRIPTION. Except to the extent not applicable to the type of Work to be performed pursuant to Contractor's Agreement, DFCM shall furnish surveys describing physical characteristics, legal limitations and utility locations for the Work site, and a legal description of the Work site. The Contractor shall be entitled to rely on the accuracy of such survey information furnished by DFCM but shall exercise proper precautions relating to the safe performance of the Work. The Contractor recognizes that the exact location of underground or hidden utilities, plumbing and electrical runs may be somewhat different from the location indicated on such surveys furnished by DFCM or in the Contract Documents. The Contractor shall exercise reasonable skill and care to locate underground or hidden utilities, plumbing and electrical runs that are to remain to prevent damage thereto. The Contractor shall review the survey information provided by DFCM and shall promptly provide written notice to DFCM of any survey information that Contractor knows or discovers to be inaccurate.

2.1.4 PROMPT INFORMATION AND SERVICES. Upon receipt of a written request from Contractor, DFCM shall endeavor to furnish information or services under DFCM's control with reasonable promptness to avoid delay in the orderly progress of the Work.

2.1.5 COPIES OF CONTRACT DOCUMENTS. Unless otherwise provided in the Contract Documents, DFCM shall provide or make available to Contractor, free of charge, paper or electronic copies of Contract Documents, as determined by DFCM, as are reasonably necessary for execution of the Work. DFCM's website may also provide Contract Documents for the Work.

2.2 CONSTRUCTION BY DFCM OR BY SEPARATE CONTRACTORS.

2.2.1 DFCM'S RIGHT TO PERFORM CONSTRUCTION AND TO AWARD SEPARATE CONTRACTS. DFCM reserves the right to enter into contracts with third parties in connection with the Work and to perform construction or other activities itself on or about the Work site.

2.2.2 COORDINATION OF WORK. Contractor shall afford DFCM and the separate contractors or subcontractors retained by DFCM adequate opportunity for the introduction and storage of their materials and equipment and the execution of their work. Contractor shall properly connect and coordinate the Work with the work of DFCM and separate contractors or subcontractors.

2.2.3 COORDINATION OF SCHEDULES. Contractor shall cooperate with DFCM and any separate contractors and subcontractors hired by DFCM in performing the Work so that all portions of the Work may be completed in the shortest possible time within normal working hours. Contractor shall furnish separate contractors and subcontractors full information regarding time schedules for Contractor's Work. Contractor

shall coordinate the Work with the workers who may be retained by DFCM, all separate contractors and subcontractors, and their activities in the vicinity of the Work site.

2.2.4 REPORTING PROBLEMS TO DFCM. If part of Contractor's Work depends on work by DFCM or a separate contractor, Contractor shall, prior to proceeding with that portion of the Work, promptly report in writing to DFCM any apparent defects in workmanship of the work of DFCM and/or such separate contractor that would render it unsuitable for proper execution of the Work. Failure of Contractor to report defects shall constitute an acknowledgment that DFCM's or the separate contractor's completed or partially completed work is fit and proper to receive Contractor's Work, except as to defects in workmanship not then reasonably discoverable.

2.2.5 CONTRACTOR REMEDIAL WORK. If Contractor causes damage to the work of DFCM or any separate contractors or subcontractors, Contractor shall promptly remedy such damage and shall use all reasonable efforts to promptly negotiate a settlement with DFCM and such separate contractors and subcontractors.

ARTICLE 3. A/E.

3.1 A/E'S ADMINISTRATION OF THE CONTRACT.

3.1.1 IN GENERAL. The A/E shall assist DFCM in administering the Contract in accordance with the Contract Documents. The A/E shall have authority to act on behalf of DFCM, but only to the extent provided in the Contract Documents and/or A/E's agreement with DFCM.

3.1.2 SITE VISITS.

3.1.2.1 Site visits or inspections by the A/E or DFCM shall in no way limit or affect Contractor's responsibility to comply with all the requirements and the overall design concept of the Contract Documents as well as all federal, state, and local laws, rules, regulations, ordinances and orders of public authorities applicable to the Work.

3.1.2.2 The A/E shall promptly submit to DFCM a written report subsequent to each site visit detailing the visit.

3.1.3 COMMUNICATIONS FACILITATING CONTRACT ADMINISTRATION. Except as authorized by DFCM or as otherwise provided in the Contract Documents, including these General Conditions, the A/E and Contractor shall communicate through DFCM on issues regarding the timing of the Work, cost of the Work, and scope of the Work. Communications by and with the A/E's consultants shall be through the A/E. Communications by and with Subcontractors shall ordinarily be through Contractor. Communications by and with separate contractors shall be through DFCM.

3.1.4 A/E MAY REJECT WORK, ORDER INSPECTIONS, TESTS. The A/E shall have the authority to reject Work which, based upon the A/E's knowledge or what may be reasonably inferred from the A/E's site observations and review of data, does not conform to the Contract Documents. Whenever the A/E considers it necessary or advisable for implementation of the intent of the Contract Documents, the A/E shall have the authority to require additional inspections or testing of the Work in accordance with the provisions of the Contract Documents, whether or not such Work is fabricated, installed, or completed; however, the A/E must obtain DFCM's prior written approval of any such additional inspections or testing. Neither this authority of the A/E nor a decision made in good faith either to exercise or not to exercise such authority shall give rise to a duty or responsibility of the A/E to Contractor, Subcontractors, their agents or employees or other persons performing portions of the Work, including separate contractors. If Contractor disputes the rejection of any

Work and the correction thereof shall involve additional cost or time, it shall be DFCM's option to accept such Work whether it shall be conforming or nonconforming.

3.1.5 A/E REVIEW OF CONTRACTOR'S SUBMITTALS.

3.1.5.1 Contractor shall submit Shop Drawings, Product Data, and Samples and other submittals required by the Contract Documents to the A/E as required by the approved submittal schedule.

3.1.5.2 The A/E shall review and take appropriate action upon Contractor's submittals such as Shop Drawings, Product Data, and Samples, but only for the purpose of checking for conformance with the information and design concepts expressed in the Contract Documents. A/E action taken on a submittal shall not constitute a Modification.

3.1.5.3 The A/E's action shall be taken no later than fourteen (14) days following A/E's receipt of the submittal, unless agreed to otherwise by Contractor and DFCM, in order to avoid a delay in the Work of Contractor or of separate contractors while allowing sufficient time in the A/E's professional judgment to permit adequate review.

3.1.5.4 Review of such submittals shall not be conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of Contractor as required by the Contract Documents.

3.1.5.5 The A/E's review of Contractor's submittals shall not relieve Contractor of Contractor's obligations under the Contract Documents.

3.1.5.6 The A/E's review shall not constitute approval of safety precautions or, unless otherwise specifically stated by the A/E, of any construction means, methods, techniques, sequences, or procedures.

3.1.5.7 The A/E's approval of a specific item shall not indicate approval of an assembly of which the item is a component.

3.1.5.8 When professional certification of performance characteristics of materials, systems, or equipment is the responsibility of the Contractor under the Contract Documents, the A/E shall be entitled to rely upon such certifications to establish that the materials, systems or equipment shall meet the performance criteria required by the Contract Documents.

3.2 OWNERSHIP AND USE OF A/E'S DRAWINGS, SPECIFICATIONS AND OTHER DOCUMENTS. All Drawings, Specifications, and other documents prepared by the A/E for the Work are and shall remain the property of DFCM, and DFCM shall retain all common law, statutory, and other reserved rights with respect thereto. Said documents are intended for use as an integrated set for the Work. Neither Contractor nor A/E shall modify or use Contract Documents on any other project without the prior written consent of DFCM. Any such non-permissive use or modification by Contractor, Contractor's Subcontractors at any tier, or anyone else for whose acts Contractor is liable, shall be at Contractor's sole risk. To the fullest extent permitted by law, Contractor shall release, indemnify, hold harmless, and defend DFCM, and require all Subcontractors to release, indemnify, hold harmless, and defend DFCM, from and against any and all liabilities, claims, demands, actions, damages, losses, and expenses, including but not limited to attorney fees and costs of litigation, arising out of such non-permissive use or modification by Contractor or its Subcontractors. Contractor, including its Subcontractors, are granted a limited license to use and reproduce applicable portions of the Drawings, Specifications, and other documents prepared by the A/E appropriate to and for use in the execution of the Work. Contractor shall preserve the copyright notice, if any, shown on the Drawings, Specifications and other documents prepared by the A/E for the Work, on all copies. Submittals or distributions

necessary to meet official regulatory requirements or for other purposes relating to the Work shall not be construed as a publication in derogation of DFCM's copyright or other reserved rights.

ARTICLE 4. CONTRACTOR.

4.1 REVIEW OF CONTRACT DOCUMENTS AND FIELD CONDITIONS BY CONTRACTOR.

4.1.1 REVIEW OF DOCUMENTS. Contractor shall carefully study and compare the Contract Documents with each other and with information furnished by DFCM and shall at once report to DFCM and A/E all errors, omissions, inconsistencies and/or ambiguities discovered. Contractor shall not be liable to DFCM or A/E for damage resulting from errors, omissions, inconsistencies and/or ambiguities in the Contract Documents unless Contractor recognized such error, omission, inconsistency and/or ambiguity or a contractor of ordinary skill and expertise for the type of Work involved would have readily so recognized such error, omission, inconsistency and/or ambiguity, and Contractor failed to report such to DFCM and A/E. If Contractor performs any Work without such notice to DFCM and A/E and prior to resolution of the error, omission, inconsistency and/or ambiguity, Contractor shall be responsible for such performance and shall bear the costs for correction.

4.1.2 REVIEW OF FIELD CONDITIONS. Contractor shall take field measurements, verify field conditions and carefully compare such field measurements and conditions and other information known to Contractor, or information that a contractor of ordinary skill and expertise for the type of Work involved would have known, before commencing Work. Contractor shall immediately report to DFCM and A/E all errors, omissions, inconsistencies and/or ambiguities discovered. If Contractor performs any Work without such notice to DFCM and A/E and prior to resolution of the error, omission, inconsistency and/or ambiguity, Contractor shall be responsible for such performance and shall bear the costs for correction.

4.1.3 SUBSURFACE INVESTIGATIONS. If DFCM has provided the Contractor with reports of subsurface investigations and/or tests of soils at the Work site ("Geotechnical Report") as part of the Contract Documents, the Contractor may rely upon the accuracy of the technical data contained in such Geotechnical Report at the locations where the data was obtained and to the depth indicated. However, Contractor acknowledges that the conditions indicated in any Geotechnical Report of any subsurface investigations and/or tests of soils at the Work site may not be representative of conditions existing at locations and/or at depths other than where data was obtained or that conditions different than those indicated by such Geotechnical Report may exist at the Work site. Contractor shall not be entitled to any increase in the Contract Price and/or increase in the Contract Time based on any data, opinion and/or recommendation in any Geotechnical Report and/or any inaccuracy, incompleteness, mistake and/or error in any Geotechnical Report except to the extent that Contractor is entitled to an increase in the Contract Price and/or extension of the Contract Time for a concealed or unknown condition as provided in Section 7.1.5.

4.1.4 PERFORM IN ACCORDANCE WITH CONTRACT DOCUMENTS AND SUBMITTALS. Contractor shall perform the Work in accordance with the Contract Documents and submittals to which no exception has been taken in accordance with the Contract Documents.

4.1.5 PERFORMANCE TO PRODUCE THE COMPLETE SYSTEM AND INTENDED RESULTS. The Contract Documents shall be read as a whole and wherever possible, the provisions shall be construed in order that all provisions are operable. The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by Contractor, whether or not specifically set forth in the Contract Documents, for the Contract Price and within the Contract Time. Performance by Contractor shall be required to the extent consistent with and reasonably inferable from the Contract Documents as being necessary to allow the Work to function for its intended use.

4.1.6 INTENT AND HIERARCHY. The Contract Documents are complimentary, and what is required by one Contract Document or provisions thereof, shall be as binding as if required by all the Contract

Documents or provisions thereof. In case of an irreconcilable conflict between provisions within a Contract Document or between Contract Documents, the following priorities shall govern as listed below:

4.1.6.1 A Modification or authorized Amendment (including authorized Supplementary Conditions) shall govern over all Contract Documents listed in Sections 4.1.6.2 – 4.1.6.6 or previous Modifications or authorized Amendments (including authorized Supplementary Conditions).

4.1.6.2 The Contractor's Agreement shall govern over all Contract Documents listed in Sections 4.1.6.3 - 4.1.6.6**.**

4.1.6.3 Supplemental General Conditions shall govern over all Contract Documents listed in Sections 4.1.6.4 – 4.6.1.6.

4.1.6.4 These General Conditions shall govern over the Contract Documents listed in Sections 4.1.6.5 – 4.1.6.6.

4.1.6.5 The Drawings and Specifications shall govern over the Contract Documents listed in Section 4.1.6.6.

4.1.6.6 Attachments to the Contractor's Agreement, Contractor's management plan, bidding/proposal documents, including the Instructions to Bidders/Proposers, Notice to Contractors and the Bid/Proposal Form and/or documented interview information, if any, are Contract Documents, binding on Contractor, but are subordinate to the Contract Documents listed in Sections 4.1.6.1 – 4.1.6.5.

4.1.6.7 An Addendum shall govern over all other Contract Documents and any previously issued Addendum.

4.1.6.8 In case of a conflict or ambiguity within the same level of hierarchy of described documents, DFCM reserves the right to revise the documents to select the most stringent requirement unless the preponderance of the Contract Documents indicate a less stringent requirement.

4.1.7 DIVIDING WORK AND CONTRACTOR REPRESENTATION. Organization of the Specifications into divisions, sections and articles, and arrangement of Drawings, shall not control Contractor in dividing the Work among Subcontractors or in establishing the extent of Work to be performed by any trade. Contractor shall ensure that the Subcontractors at any tier, manufacturers and suppliers engaged or to be engaged by Contractor, are and shall be familiar with the requirements for performance by them of their obligations.

4.1.8 PLANNING AND PRIORITY. Contractor shall plan and schedule the Work and shall maintain the schedule to Substantially Complete the Work within the Contract Time.

4.2 SUPERVISION AND REPRESENTATIVES.

4.2.1 SUPERVISION AND CONTROL. Contractor shall supervise and direct the Work using Contractor's best skill and attention to complete the Work within the Contract Time. Contractor shall be solely responsible for and have control over the construction means, methods, techniques, sequences, and procedures and for coordinating all portions of the Work, except to the extent that the Contract Documents specifically and expressly state otherwise.

4.2.2 PERSONS PERFORMING WORK. Contractor shall perform the Work using qualified employees, consultants, and Subcontractors selected and paid for by Contractor, adequately trained in the requirements of their particular jobs, and skilled in the Work assigned to them. Contractor shall use all

reasonable efforts to maintain a stable project team and minimize changes in key members of the team where loss of key members could have an adverse impact on the Contract Time. Any change in key personnel assigned to the Work must be approved by DFCM in writing.

4.2.3 DESIGNATED REPRESENTATIVES. Contractor shall employ a competent superintendent and necessary assistants, fluent in spoken and written English, who shall be at the Work site during performance of the Work. Contractor's superintendent shall maintain communication between DFCM, the A/E, and Contractor and be responsible for the management of Contractor's activities and deliverables described in the Contract Documents, as well as management of any third-party resources hired by Contractor to provide services or products under the Contract Documents. Contractor's superintendent shall represent Contractor, and communications given to the superintendent shall be as binding as if given to Contractor. Important communications shall be confirmed in writing. Other communications shall be similarly confirmed in writing on written request in each case.

4.2.4 DISCIPLINE AND COMPETENCE. Contractor shall enforce safety procedures, strict discipline, and good order among Contractor's employees, Contractor's Subcontractors, agents, representatives and other persons performing the Work under the Contract Documents. If DFCM reasonably determines that a particular person does not follow safety procedures, is unfit or unskilled for the assigned Work, disregards instructions, ignores the environmental restraints of the Work, or jeopardizes the goodwill between DFCM and the public, Contractor shall immediately replace the person upon receipt of DFCM's request to do so and shall not employ the person again on the Work.

4.2.5 RESPONSIBILITY. Contractor shall be responsible to the State of Utah and DFCM for the acts and omissions of Contractor's employees, Subcontractors and their agents and employees and other persons performing portions of the Work under a contract with Contractor or on behalf of Contractor.

4.2.6 NOT RELIEVED OF OBLIGATIONS. Contractor shall not be relieved of obligations to perform the Work in accordance with the Contract Documents either by activities or duties of DFCM or DFCM's agents in DFCM's administration of the Contractor's Agreement, or by tests, inspections, or approvals required or performed by persons other than Contractor or for those that Contractor is liable.

4.2.7 INSPECTIONS AND APPROVALS.

4.2.7.1 All Work performed by Contractor shall be subject to the inspection and approval of DFCM to determine whether the Work is in accordance with the Contract Documents. Contractor shall permit and facilitate inspection of the Work at all times by DFCM, DFCM's representatives and governmental authorities having jurisdiction.

4.2.7.2 Contractor shall be responsible for requesting inspections for various stages and portions of the Work required under the Contract Documents in a timely manner in accordance with the process and document requirements of the applicable inspection authority. In the event Work is not in a condition to be inspected at the time scheduled for the inspection of such Work for causes for which the Contractor is responsible, Contractor shall bear all associated costs and expenses without reimbursement by DFCM.

4.2.7.3 If any of the Work is required to be inspected or approved by the terms of the Contract Documents, Contractor shall timely request such inspection or approval to be performed in accordance with Article 9. Except as provided in Article 9, Work shall not proceed without any required inspection and the associated authorization to proceed. Contractor shall promptly notify DFCM if the inspector fails to appear at the site.

4.2.7.4 Contractor shall work with the inspector to maintain an Open Issues Log and Contractor shall proceed diligently to resolve all open issues.

4.3 PAYMENT BY CONTRACTOR. Except to the extent it is otherwise stated in the Contract Documents, Contractor shall provide and pay for all supervision, labor, tools, equipment, materials and transportation, including, without limitation: construction equipment and machinery; water; heat; utilities; and other facilities, supplies, consumables and services necessary for the proper execution and completion of the Work, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work.

4.4 TAXES AND OTHER PAYMENTS TO GOVERNMENT. Contractor shall pay Sales Tax and/or Use Tax, consumer, employment-related and similar taxes related to the Work or portions thereof provided by Contractor which are legally enacted when bids are received or negotiations concluded, whether or not yet effective or merely scheduled to go into effect. Contractor shall comply with the laws and regulations regarding the payment of Sales Tax and/or Use Tax and any exemptions. The procurement documents may have a provision regarding specific items which are exempt from State of Utah Sales Tax and/or Use Tax. Any such exemption shall be used only for the items and the project specified in the procurement documents. Any such exemption does not apply to taxes levied by the federal government or any taxing entity outside of the State of Utah. If Contractor properly relies upon a provision(s) of the bidding or proposal documents indicating exemption from State of Utah Sales Tax and/or Use Tax, and if State of Utah Sales Tax and/or Use Tax subsequently becomes due, then Contractor shall be paid such tax amount not included in the bid/proposal amount due to the reliance upon such provision.

4.5 PERMITS, FEES, NOTICES, LABOR AND MATERIALS.

4.5.1 PERMITS AND FEES. Unless otherwise required in the Contract Documents, it shall not be necessary for Contractor to obtain or pay for local building permits, plan check fees, electrical permits, plumbing permits, connection fees, or impact fees, nor shall it be necessary to pay fees for inspections pertaining thereto.

4.5.2 COMPLIANCE, NOTICES. Contractor shall comply with and give notices required by all federal, state, and local laws, rules, regulations, ordinances, and orders of public authorities applicable to the Work.

4.5.3 CORRELATION OF CONTRACT DOCUMENTS AND LAW. It is not Contractor's responsibility to ascertain that the Contract Documents are in accordance with applicable federal, state and/or local laws, rules, regulations, ordinances, and/or orders of public authorities having jurisdiction. However, if Contractor observes, or if such would be readily observable to a contractor of ordinary skill and expertise for the type of Work involved, that a portion of the Contract Documents is at variance therewith, Contractor shall promptly notify the A/E and DFCM in writing, and necessary changes shall be accomplished by appropriate Modification and/or Amendment.

4.5.4 FAILURE TO GIVE NOTICE. If Contractor, or any Subcontractor, performs Work without complying with the requirements of this Section 4.5, Contractor shall assume responsibility for such Work and shall bear the appropriate amount of the applicable costs of correction.

4.6 TIME AND CONTRACTOR'S CONSTRUCTION SCHEDULES.

4.6.1 PROGRESS AND COMPLETION.

4.6.1.1 Time is of the essence in this Contract. By executing the Contractor's Agreement, Contractor confirms that the Contract Time is adequate to perform the Work. The Contractor shall proceed expeditiously with adequate forces to achieve Substantial Completion within the Contract Time.

4.6.1.2 Contractor shall commence and complete the Work within the Contract Time and pursuant to the schedule, an initial version of which shall be prepared and provided by Contractor to DFCM and the A/E for approval, as it may be modified with DFCM's consent. Unless and except to the extent that preliminary Work at the Work site is authorized in writing by DFCM, Contractor shall not prematurely commence the Work at the Work site or elsewhere until DFCM issues a Notice to Proceed or prior to the effective date of insurance required by Article 10 to be furnished by Contractor, whichever is later. Contractor shall proceed expeditiously with adequate forces to achieve Substantial Completion within the Contract Time. All other Work shall be completed no later than the date established for Final Completion. Contractor shall notify DFCM when Contractor considers the entire Work to be completed. DFCM shall be entitled to a final inspection to determine whether the Work has been completed in accordance with the Contract Documents. The date of Substantial Completion shall be established by a certificate of Substantial Completion issued by the A/E or a written acknowledgement of Substantial Completion signed by DFCM.

4.6.1.3 **INITIAL CONTRACT TIME**. Unless otherwise specified in the bidding documents, the initial Contract Time shall be the time identified in the Contractor's Agreement.

4.6.2 SCHEDULE PREPARATION.

4.6.2.1 Promptly after being awarded the Work, Contractor shall prepare and submit for DFCM's and the A/E's approval, a planned progress schedule for the Work. Contractor shall plan and schedule the Work to facilitate the Work and shall maintain a schedule to place proper priority to sequence the Work to complete the Work within the Contract Time. Contractor shall commence and complete the Work by the dates set forth in the agreed upon schedule and Contractor's Agreement.

4.6.2.2 The schedule shall include a time-line for procurement, fabrication, construction, and testing activities, including interdependence of items necessary to complete the Work, duration of activities, interim completion dates, milestones, closeout and commissioning, submittals, and critical path.

4.6.2.3 Contractor shall advise and consult with DFCM during progress of the Work and keep DFCM fully informed as to the status of the Work at intervals as required by DFCM. Contractor shall provide DFCM with a daily listing of personnel and equipment used on the Work. If the Work is not on schedule, Contractor shall immediately advise DFCM in writing of Contractor's proposed action to bring it on schedule.

4.6.2.4 DFCM may take reasonable exception to activity duration, activity placement, construction logic, and time frame for any element of the Work to be scheduled and may recommend revisions.

4.6.3 SCHEDULE SUBMITTAL.

4.6.3. Contractor shall develop the CPM schedule using Primavera, MS Project or Phoenix unless otherwise authorized by DFCM. The critical path shall be identified, including the critical paths for interim completion dates and milestones.

4.6.3.2 Contractor shall update the schedule at least once a month and submit the updated schedule with each Application for Payment.

4.6.3.3 No progress payments shall be approved until Contractor has submitted a detailed CPM schedule covering the first ninety (90) days of the Work with a general CPM schedule for the entire Work. The detailed schedule for the entire Work shall be completed prior to the second Application for Payment, unless otherwise authorized in writing by DFCM.

4.6.4 SCHEDULE CONTENT REQUIREMENTS.

4.6.4.1 The schedule shall indicate the duration of activities and order, sequence and interdependence of all items known to be necessary to complete the Work, including construction, procurement, fabrication and delivery of materials and equipment, commissioning, submittals and approvals of submittals or other documents. Work items of DFCM, other contractors, utilities, and other third parties that may affect or be affected by Contractor shall be included.

4.6.4.2 If DFCM is required by the Contract Documents to furnish any materials, equipment, or other items to be incorporated into the Work by Contractor, Contractor shall submit, with the first schedule submittal, a letter clearly indicating the dates that such items are required at the Work site.

4.6.4.3 The schedule shall indicate an early Substantial Completion date for the Work that is no later than the Work's required Substantial Completion date.

4.6.4.4 The schedule, including duration of all activities, shall be given in calendar days and indicate all of the following:

4.6.4.4.1 Interfaces with the Work of outside contractors (e.g., utilities, power, and any separate contractors retained by DFCM);

4.6.4.4.2 Description of activity including activity number/numbers;

4.6.4.4.3 Estimated duration time for each activity and remaining duration;

4.6.4.4.4 Early start, late start, early finish, late finish date, and predecessor/successors including stop-start relationships with lead and lag time for each activity – all activities shall have a predecessor and a successor, except for the start milestone and finish milestone;

4.6.4.4.5 Total Float and Free Float available to each path of activities;

4.6.4.4.6 Actual start date for each activity begun;

4.6.4.4.7 Actual finish date for each activity completed;

4.6.4.4.8 The percentage complete of each activity in progress or completed;

4.6.4.4.9 Identification of all critical path activities;

4.6.4.4.10 The critical path for the Work, with the path of activities being clearly and easily recognizable on the time-scaled network diagram. The path(s) with the least amount of float must be identified. Except as may otherwise be explicitly and specifically provided in the Contract Documents, no more than forty-percent (40%) of all activities may be identified as critical path items. The relationship between non-critical activities and activities on the critical path shall be clearly shown on the network diagram. Near critical path activities shall also be identified;

4.6.4.4.11 Unless otherwise authorized by DFCM, all activities on the schedule representing construction on the site may not have a duration longer than fourteen (14) days. Construction items that require more than fourteen (14) days to complete must be broken into identifiable activities on the schedule with durations less than fourteen (14) days. The sum of these activities represents the total length required to complete that construction item; and

4.6.4.4.12 Additional requirements, if any, as specified in the Supplemental General Conditions and/or authorized Supplementary Conditions.

4.6.5 INTERIM COMPLETION DATES AND MILESTONES. The schedule must include contractually specified interim completion dates and milestones (which completion milestones must have a "finish on or before" soft constraint added). The milestones and completion dates indicated are considered essential to the satisfactory performance of the Contractor's Agreement and to the coordination of all Work. The milestone dates listed are not intended to be a complete listing of all Work or of interfaces with other contractors.

4.6.6 FLOAT TIME. "Total Float" is defined as the amount of time that an activity can be delayed from its early without delaying Substantial Completion. "Free Float" is the amount of time that an activity can be delayed without delaying the early start date of any successor activity. Total Float time and Free Float time shall belong to the project and DFCM and Contractor have the right to use the Total Float time and/or Free Float Time for non-critical path activities until Contractor has reallocated such time on a newly submitted schedule.

4.6.7 UPDATES. Prior to any approval of an Application for Payment, DFCM, A/E, and Contractor shall review Contractor's schedule compared to the Work completed. The amount of Work completed shall be approved by DFCM as supported by the schedule of values and as verified by the determination of Work completed. If necessary, Contractor shall then update and submit to DFCM the schedule with the Application for Payment; all of which shall be in accordance with DFCM's approval. All updates shall be provided in electronic and hard copy formats. At each scheduled meeting with DFCM, Contractor shall provide a four week look ahead, with long lead items identified. If the Work is not on schedule, Contractor shall immediately advise DFCM in writing of Contractor's proposed action to bring it on schedule.

4.6.8 SCHEDULE OF SUBMITTALS. Contractor shall prepare and keep current, for the A/E's and DFCM's review and approval, a schedule of submittals required by the Contract Documents, which shall be coordinated with Contractor's construction schedule and allow the A/E a reasonable time to review the submittals. The submittal schedule shall be included as part of the construction schedule. Submittals requiring expedited review must be clearly identified as such in the schedule of submittals. Contractor shall coordinate and agree upon a submittal schedule with A/E. If a submittal does not pass a second review, then a meeting will be held to determine a path to proceed and expedite approval. Contractor shall notify A/E in writing if expedited review of a submittal is critical.

4.6.9 SCHEDULE RECOVERY. If the Work represented on the critical path falls behind more than seven (7) days, Contractor shall redo the schedule within seven (7) days, showing how the Contractor shall recover the time. Contractor's schedule must have an approved baseline schedule before the schedule may be updated. A narrative that addresses the changes in the schedule from the previously submitted schedule shall be submitted along with the updated schedule in electronic .pdf format and on the written request of DFCM in native electronic copy format of the scheduling software utilized by Contractor. Contractor shall comply with the most recent schedules.

4.6.10 SCHEDULE CHANGES.

4.6.10.1 The Contract Time may only be shortened or extended by a Change Order or Construction Change Directive.

4.6.10.2 Should Contractor, after approval of the complete detailed construction schedule, desire to change Contractor's plan of construction, Contractor shall submit its requested revisions to DFCM and the A/E, along with a written statement of the revisions including a description of the sequence and duration changes for rescheduling the Work, methods of maintaining adherence to intermediate milestones and the completion dates, and the reasons for the revisions. Requested changes to the approved baseline schedule shall include a narrative that addresses the requested changes. If the requested changes are acceptable to DFCM, which acceptance shall not be unreasonably withheld, they shall be incorporated into the schedule in the next reporting period by Contractor. If after Contractor submits a request for change in the schedule, DFCM does not agree with the request, DFCM shall schedule a meeting with Contractor to discuss the differences.

4.6.10.3 The critical path schedule, as the term is used in these General Conditions, shall be based on the current version of Contractor's schedule for the Work and accepted by DFCM just prior to the an asserted change in the Work, asserted delay, suspension, or interruption. If Contractor believes it is entitled to an extension of Contract Time under the Contract Documents, Contractor shall submit a PCO in accordance with Section 7.2 to the A/E and DFCM accompanied by an analysis ("Requested Time Adjustment Schedule") in accordance with the Contract Documents for time extensions. The "Requested Time Adjustment Schedule" shall include "fragnets" that represent the added or changed Work to the schedule. The impact on unchanged activities caused by the changes and/or delays being analyzed shall be included in these fragnets. A "fragnet" as used in these General Conditions and when used in the context of project scheduling is a subset of project activities that are inter-related by predecessor and successor relationships that are tied into the main schedule with identified start and completion points. Each fragnet may or may not be on the critical path. An entire schedule consists of a series of inter-related fragnets.

4.6.11 EXCUSABLE DELAY.

4.6.11.1 If Contractor is unreasonably delayed in the progress of the Work on the critical path schedule by an act or neglect of DFCM; or separate contractors retained by DFCM; or by a Force Majeure Delay (defined below) that DFCM reasonably determines may justify delay beyond the date for Substantial Completion, then the Contract Time shall be extended by Change Order for the period of time caused by such delay. The Contract Price shall not be increased, and the Contract Time shall not be extended for any delays that are concurrent with Contractor delays.

4.6.11.1.1 For purposes of the Contractor's Agreement, a Force Majeure Delay shall mean a delay to the commencement or the progress of the Work by reason of events or causes beyond the control of DFCM, the Contractor, and the Contractor's Subcontractors and Sub-subcontractors of any tier, or anyone directly or indirectly employed by them or anyone for whose acts they may be liable. Notwithstanding anything to the contrary set forth herein, Force Majeure Delays shall not include: (1) labor disputes confined to the Work site or relating solely to the Work that are due to a breach of a collective bargaining agreement by the Contractor or its Subcontractors or Sub-subcontractors of any tier, or anyone directly or indirectly employed by them or anyone for whose acts they may be liable; (2) adverse weather conditions, except as provided in Section 4.6.11.2; (3) a failure of the Contractor or its Subcontractors or Sub-subcontractors of any tier, or anyone directly or indirectly employed by them or anyone for whose acts they may be liable, to comply with any laws, codes or orders of governmental authorities with jurisdiction of the Work; or (4) any financial inability of the Contractor or its Subcontractors or Sub-subcontractors of any tier, or anyone directly or indirectly employed by them, to perform their obligations under the Contract Documents.

4.6.11.1.2 Delays which according to the schedule do not affect any critical path milestone dates or the completion dates shown on the schedule at the time of the delay shall not be the basis for a change in the Contract Time.

4.6.11.1.3 Contractor shall immediately take all steps reasonably possible to lessen the adverse impact of delay. Notwithstanding the foregoing, to the extent any of the causes for delay were caused by Contractor, reasonably foreseeable by Contractor, or avoidable by Contractor, then to such extent the delay shall not be cause for a change in the Contract Price and/or Contract Time. For purposes of this Section, "Contractor" shall include all Subcontractors and others under the responsibility of the Contractor.

4.6.11.1.4 The determination of the total amount of time extension, if any, shall be based upon the current schedule in effect at the inception of the change and/or delay and upon all data relevant to the extension as supported by appropriate substantiating relative data in the project record. Once approved, such data shall be incorporated in the next monthly update of the schedule by Contractor.

4.6.11.2 The Contract Price shall not be increased and the Contract Time shall not be extended for normal bad weather or any weather that is reasonably foreseeable at the time of entering into the Contractor's Agreement. The Contract Time as stated in the Contract Documents includes due allowance for days on which Work cannot be performed out of doors. Contractor acknowledges that Contractor may lose days due to weather conditions. The Contract Time may be extended at no cost to DFCM if all of the following are met, which must be established by Contractor:

4.6.11.2.1 That the weather prevented Work from occurring that is on the critical path for the Work based upon a critical path schedule previously submitted to DFCM and to the extent accepted by DFCM;

4.6.11.2.2 There are no concurrent delays for which Contractor is responsible;

4.6.11.2.3 Contractor took all reasonable steps to alleviate the impact of the weather and made reasonable attempts to prevent the delay and despite such reasonable actions of Contractor, the weather impacted the critical path as described above; and

4.6.11.2.4 In connection with the weather event for which delay is claimed by Contractor, the weather was either exceptionally adverse, such as a tornado, severe wind storm, or severe hail storm, or one of the following occurred:

4.6.11.2.4.1 for any day between November 1 and March 31 for which delay is claimed by Contractor, the recorded minimum temperature at the Work site, as verifiably documented by Contractor, fell below the mean minimum temperature for the station closest to the Work site ("Proximate Station") for the applicable month according to the Western Regional Climate Center Website, http//www.wrcc.dri.edu/summary ("WRCCW"), as shown on the *Average of Minimum Temperature* chart on the WRCCW for the Proximate Station, less the mean extreme minimum temperature for the Proximate Station for the applicable month, as shown on the *Minimum of Minimum Temperature Chart* on the WRCCW for the Proximate Station, divided by Two (2);

4.6.11.2.4.2 for any day between November 1 and March 31 for which delay is claimed by Contractor, the recorded maximum temperature at the Work site, as verifiably documented by Contractor, fell below the mean minimum temperature as shown on the *Average of Minimum Temperature* chart on the WRCCW for the Proximate Station;

4.6.11.2.4.3 for any day for which delay is claimed by Contractor, the recorded precipitation at the Work site, as verifiably documented by Contractor, exceeded seventy-five percent (75%) of the daily extreme for the applicable month as shown on the *POR – Daily Precipitation Average and Extreme* chart on the WRCCW for the Proximate Station;

4.6.11.2.4.4 for any day for which delay is claimed by Contractor, the recorded snowfall at the Work site, as verifiably documented by Contractor, exceeded seventy-five percent (75%) of the daily extreme for the applicable month as shown on the *POR – Daily Snowfall Average and Extreme* chart on the WRCCW for the Proximate Station.

4.6.12 COMPENSABLE DELAY, SUSPENSION OR INTERRUPTION.

4.6.12.1 In addition to the other requirements of the Contract Documents, a compensable delay, suspension, or interruption of the Work occurs only when the following conditions are met:

4.6.12.1.1 The delay is caused by DFCM for a reason not permitted by the Contract Documents; and

4.6.12.1.2 Contractor delivers a written notice to the A/E and DFCM within seven (7) days that Contractor knows or should have known of the condition giving rise to the purported compensable delay, suspension, or interruption, and the condition affects the Contract Time as indicated by the last agreed upon critical path schedule.

4.6.12.2 To the extent of the compensable delay, Contractor's total entitlement for all compensable delay damages is the computed result of the following formula: Contract Price divided by Contract Time (in calendar days); the result of which is then multiplied by 0.05; and the result of which is multiplied by the number of calendar days of compensable days allowed under these General Conditions that are beyond the Contract Time. Notwithstanding any other provision of these General Conditions or the Contract Documents, to the extent Contractor is entitled to receive a markup under Sections 7.4.2.5.1 or 7.4.2.5.2 this provision shall be inapplicable, and the markup shall be deemed to include all the compensable delay damages provided by this Section.

4.6.12.3 The length and extent of compensable delay shall be determined, with the use of the Work's critical path schedule by ascertaining the number of additional days added to the Contract Time are needed in order to perform the Work in accordance with the Contract Documents as a result of the delay, suspension, or interruption after receipt of the written notice received by the A/E and DFCM under Section 4.6.12.1.2.

4.6.12.4 Notwithstanding any other provision of these General Conditions, to the extent a non-compensable delay occurs at the same time as a compensable delay, DFCM shall not be responsible for any compensation to Contractor and the Contract Price shall not be increased for the period of the non-compensable delay.

4.6.13 TIME EXTENSION REQUESTS. Contractor shall notify DFCM within seven (7) days of a potential delay and Contractor shall request any and all Contract Time extensions within twenty-one (21) days after Contractor knew or should have known about the delay. Contractor must support any request for a Contract Time extension with a critical path schedule analysis.

4.6.14 LIQUIDATED DAMAGES.

4.6.14.1 Time is of the essence in the Contract Documents. DFCM will suffer damages that are difficult to ascertain for each calendar day the date for Substantial Completion is delayed. Therefore, as agreed damages and not as a penalty, DFCM may offset from any payments due Contractor the sum stated in the Contractor's Agreement, as augmented in Section 4.6.14.2 in the case of continuing delay, for each day Substantial Completion is delayed beyond the date established for Substantial Completion of the Work by the Contract Documents.

4.6.14.2 For each day subsequent to the fourteenth (14th) day after the date established for Substantial Completion of the Work by the Contract Documents, the liquidated damages amount stated in the Contractor's

Agreement shall be increased by ½ percent (0.5%) of the amount stated in the Contractor's Agreement for each day Substantial Completion is delayed beyond the date established for Substantial Completion of the Work by the Contract Documents.

4.6.14.3 The sum for liquidated damages due DFCM by Contractor has been agreed upon by reason of the inconvenience and added costs of administration, engineering, supervision, and other expenses resulting from Contractor's default.

4.6.14.4 To the extent liquidated damages exceed any amounts that would otherwise be due Contractor, Contractor shall be liable for such excess to DFCM.

4.6.14.5 Notwithstanding any other provision of these General Conditions, the availability of liquidated damages to DFCM shall not limit DFCM's right to seek damages or other remedies available under law or equity to the extent such damages or remedies are not based upon delay.

4.6.15 NO WAIVER OF DFCM'S RIGHTS. Permitting Contractor to continue any part of the Work after the time fixed for completion or beyond any authorized extension thereof shall in no way operate as a waiver or estoppel on the part of DFCM of any of its rights under the Contract Documents, including the right to liquidated damages or any other remedies or compensation.

4.7 DOCUMENTS AND SAMPLES AT THE SITE, CERTIFYING "AS-BUILTS". Contractor shall maintain at the Work site one record copy of the Drawings, Specifications, Addenda, authorized Amendments and Modifications, in good order and marked weekly to record changes and selections made during construction, as well as approved Shop Drawings, Product Data, Samples and similar submittals. These items shall be available to the A/E and shall be delivered to the A/E for submittal to DFCM upon completion of the Work, signed by Contractor, certifying that they show complete and exact "as-built" conditions, stating sizes, kind of materials, piping, conduit locations, and similar matters. All notes of encountered or changed conditions shall be included.

4.8 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

4.8.1 NOT CONTRACT DOCUMENTS. Shop Drawings, Product Data, Samples and other submittals are not Contract Documents. The submittal shall demonstrate, for those portions of the Work for which the submittal is required, the way Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents.

4.8.2 PROMPTNESS. Contractor shall coordinate submittals prepared by Subcontractors and Sub-subcontractors, review, approve, and submit to the A/E, Shop Drawings, Product Data, Samples and other submittals required by the Contract Documents with reasonable promptness and according to an agreed submittal schedule in such sequence as to cause no delay in the Work, or the activities of DFCM, or separate contractors.

4.8.3 NOT PERFORM UNTIL A/E APPROVES. Contractor shall not perform any portion of the Work requiring submittal and review of Shop Drawings, Product Data, Samples, mock-ups where required or other submittals (including deferred submittals) until the applicable submittal has been approved in writing by the A/E. Contractor shall perform the Work in accordance with the approved submittals. Submittals marked "No-exceptions taken" or its equivalent by the A/E are considered approved for purposes of this Section 4.8.3.

4.8.4 REPRESENTATIONS BY CONTRACTOR. By approving and submitting Shop Drawings, Product Data, Samples, and other submittals, Contractor represents that Contractor has determined and verified materials, field measurements, field construction criteria, manufacturer installation instructions and

procurement and delivery dates related thereto and has checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.

4.8.5 CONTRACTOR'S LIABILITY. Contractor shall not be relieved of responsibility for deviations from the requirements of the Contract Documents by the A/E's approval of Shop Drawings, Product Data, Samples, or similar submittals unless Contractor has specifically informed the A/E in writing of such deviation at the time of the submittal and the A/E has given written approval to the specific deviation. Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples, or other submittals by the A/E's review and approval.

4.8.6 DIRECT SPECIFIC ATTENTION TO REVISIONS. Contractor shall direct specific attention in writing to all revisions on resubmitted Shop Drawings, Product Data, Samples, or other submittals, except those requested by the A/E and indicated on previous submittals.

4.8.7 INFORMATIONAL SUBMITTALS. Informational submittals upon which the A/E is not expected to take responsive action may be so identified in the Contract Documents.

4.8.8 PROFESSIONAL SERVICES. The Contractor shall not be required to provide professional services that constitute the practice of architecture or engineering unless such services are specifically required by the Contract Documents for a portion of the Work or unless the Contractor needs to provide such services in order to carry out the Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. The Contractor shall not be required to provide professional services in violation of applicable law. If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of the Contractor by the Contract Documents, DFCM and the A/E will specify performance and design criteria that such services must satisfy. The Contractor shall cause such services or certifications to be provided by a properly licensed Design Professional (as that term is defined in Section 4.8.8.1 of these General Conditions), whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Each Design Professional providing such services shall carry professional errors and omissions insurance in an amount of at least Two Million Dollars ($2,000,000.00) per claim/annual aggregate with a deductible or self-insured retention of not greater than One Hundred Thousand Dollars ($100,000.00), unless different amounts are authorized by DFCM in writing. Shop Drawings and other submittals related to the Work designed or certified by such Design Professional, if prepared by others, shall bear such Design Professional's written approval when submitted to the A/E. DFCM and the A/E shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications and approvals performed or provided by such Design Professional, provided DFCM and A/E have specified to the Contractor performance and design criteria that such services must satisfy. Pursuant to this Section 4.8, the A/E will review, approve or take other appropriate action on submittals only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Contractor shall not be responsible for the adequacy of the performance and design criteria specified in the Contract Documents.

4.8.8.1 A "Design Professional" is any and all employees or independent contractors directly or indirectly employed by the Contractor, a Subcontractor or a Sub-subcontractor of any tier to perform any professional design services required by the Contract Documents. The Contractor or its Subcontractors or Sub-subcontractors of any tier employing the Design Professional shall require the Design Professional to agree in writing to be bound by the terms of the Contract Documents insofar as they apply to the design services of the Design Professional in the performance of the Work.

4.8.8.2 The Contractor hereby assigns to DFCM all common law, statutory and other rights that the Contractor may have in the drawings, specifications and other documents prepared by the Design Professional for the Work (the "Design Documents"), including all copyrights. The Contractor shall endeavor to obtain a similar assignment to DFCM by the Design Professional and by the Subcontractors or Sub-subcontractors of

any tier employing the Design Professional of their common law, statutory and other rights (including copyrights) in the Design Documents. At the date of final payment or upon the earlier termination of the Contractor's Agreement, the Contractor shall promptly deliver to DFCM hardcopy originals of all Design Documents and all Design Documents in reproducible (not read only) electronic media.

4.8.8.3 The Contractor shall require and hereby represents and warrants to DFCM that the Design Professional is appropriately registered with and licensed by the State of Utah to perform the services required by the Contract Documents to be performed by the Design Professional.

4.8.8.4 All services provided by the Design Professional shall be performed consistent with the professional skill and care ordinarily provided by other design professionals: (1) with the same or similar license; and (2) providing the same or similar design professional service (A) in the same or similar locality, (B) at the same or similar time and (C) under the same or similar circumstances, provided that, if the nature of the project reasonably requires specialized design expertise, the Design Professional shall perform design professional services consistent with such specialized design expertise.

4.8.8.5 Notwithstanding any approval of DFCM or A/E of any Design Documents, the Contractor shall be responsible for assuring that all Design Documents (whether prepared by a Design Professional employed by the Contractor, a Subcontractor or a Sub-subcontractor of any tier) are technically adequate and accurate and are in accordance with all laws, ordinances, codes, regulations or other requirements of governmental authorities having jurisdiction of the Work applicable to the Work on the day of the issuance of such documents and on the day of the use of such documents on the Work.

4.8.8.6 The Contractor shall be responsible and liable to DFCM for any and all losses, costs, and/or expenses incurred by DFCM arising out of, related to and/or connected with errors or omissions in the services provided hereunder by the Design Professional, to the extent that such errors or omissions were caused by the failure of the Design Professional to perform services consistent with the requirements of Section 4.8.8.4 or by other fault of the Design Professional, whether or not such losses, costs and/or expenses were caused by any negligence or other fault of the Contractor. This responsibility and liability shall survive completion of the Work or termination of the Contractor's Agreement.

4.8.8.7 The Contractor shall indemnify and hold harmless DFCM and the other Indemnified Parties (as defined in Section 4.12) from and against any and all third-party claims, demands, losses, liabilities, judgments, costs, expenses and/or attorney fees arising of, related to and/or connected with errors or omissions in the services provided hereunder by the Design Professional, to the extent that such errors or omissions were caused by the failure of the Design Professional to perform services consistent with the requirements of Section 4.8.8.4 or by other fault of the Design Professional, whether or not such third-party claims, demands, losses, liabilities, judgments, costs, expenses and/or attorney fees were caused by any negligence or other fault of the Contractor. This indemnity is in addition to the indemnity provided in Section 4.12 and shall survive completion of the Work or termination of the Contractor's Agreement.

4.8.8.8 The Contractor's or its Subcontractor's or Sub-subcontractor of any tier's agreement with the Design Professional for design services in the performance of the Work shall state that DFCM and its successors and assigns are intended third-party beneficiaries of such agreement and such agreement with the Design Professional shall require the Design Professional to deliver to DFCM a separate agreement wherein the Design Professional shall expressly contract with DFCM to provide the Design Professional's professional services consistent with the standard of care established by Section 4.8.8.4.

4.8.8.9 The Contractor shall indemnify, defend and hold harmless DFCM and the other Indemnified Parties (as defined in Section 4.12 of these General Conditions) from and against any and all claims, demands, losses, liabilities, judgments, costs, expenses and/or attorney fees caused by any suits or claims of infringement of any patent rights or copyrights for materials, methods or systems depicted upon or required by Design Documents

prepared by the Design Professional. This indemnity is in addition to the indemnity provided in Sections 4.11 and 4.12 of these General Conditions and shall survive completion of the Work or termination of the Contractor's Agreement.

4.9 USE OF SITE.

4.9.1 IN GENERAL. Contractor shall confine its equipment, the storage of materials, and the operations of its workers at the Work site to areas permitted by the Contract Documents, laws, rules, regulations, ordinances, orders, and permits and shall not unreasonably encumber the Work site with materials or equipment. Contractor shall take all reasonable steps to secure the Work site and protect the Work from any damage. Upon completion of the Work, Contractor shall leave the Work site free and clear of all waste materials, rubbish, tools, equipment, and surplus materials. Contractor shall at all times keep the Work site free from spilled liquids and chemicals, toxic or otherwise. If such a spill occurs while Contractor has control of the Work site, Contractor shall be responsible to clean the affected areas on or about the Work site and pay all associated costs, fines, and penalties. Notwithstanding the foregoing, Contractor shall not be responsible for any damage to the Work site or the Work to the extent caused by DFCM or DFCM's agents.

4.9.2 ACCESS TO NEIGHBORING PROPERTIES.

4.9.2.1 Contractor shall not, except as provided in the Contract Documents or with DFCM's advance written consent when necessary to perform the Work, interfere with access to properties neighboring the Work site by the owners of such properties and their respective tenants, agents, invitees and guests.

4.9.2.2 Various federal, state, and local agencies and private landowners may own or control lands and facilities either crossed by or adjacent to the Work site. DFCM shall secure and pay for all necessary rights of access to the Work site. Contractor shall comply with all stipulations provided by DFCM and shall maintain a cooperative relationship with all agencies and landowners. Contractor shall not retain on the Work site any person who in the judgment of DFCM prejudices or tends to endanger this cooperation. Contractor shall not enter into any agreement with such agencies or landowners related to the Work without prior approval by DFCM.

4.10 ACCESS TO WORK. Contractor shall provide DFCM and the A/E access to the Work in preparation and progress, at all times and wherever located.

4.11 INTELLECTUAL PROPERTY LICENSES. Contractor shall obtain and pay for all royalties and other license fees for all equipment, property, or processes of Contractor used or purchased in connection with performance of the Work. Contractor shall defend suits or claims for infringement of intellectual property rights and shall hold DFCM and the A/E harmless from loss on account thereof but shall not be responsible for such defense or loss when a particular design, process, or product of a particular manufacturer or manufacturers is required by the Contract Documents. However, if Contractor has reason to believe that the required design, process or product is an infringement of any third party's intellectual property right, Contractor shall be responsible for such defense or loss unless such information is promptly furnished to DFCM in writing.

4.12 INDEMNIFICATION. To the fullest extent permitted by law, Contractor shall release, indemnify, hold harmless, and defend the State of Utah, the State of Utah's institutions, agencies (including, but not limited to, DFCM), departments, divisions, authorities, and instrumentalities, boards, commissions, elected or appointed officers, employees, agents and authorized volunteers (collectively "Indemnified Parties") from and against any and all claims, liabilities, demands, actions, damages, losses and expenses of any nature whatsoever, including, but not limited to, attorneys' fees and defense costs (collectively "Liabilities"), and including those events covered under the blanket Contractual Liability Coverage required under the Contract Documents, arising out of, related to, or connected with any act or omission in the performance of the Work, including the Work of all Subcontractors and their employees, provided that any Liabilities are caused in whole or in part by

the negligent, intentional, or other wrongful act or omission of Contractor, any Subcontractor, their employees, or anyone directly or indirectly employed or the agent of any of them or anyone for whose acts any of them may be liable, regardless of whether or not it is caused in part by an Indemnified Party. Without relieving Contractor of any obligation under the Contract, the Indemnified Parties shall have the right, at their option, to fully participate in the investigation, defense and settlement of any Liabilities.

4.12.1 NOT EXCLUSIVE. The foregoing obligations in this Section 4.12 shall not be construed to negate, abridge, or otherwise reduce any other right or obligation of indemnity which would otherwise exist as to any party or person under the Contract Documents.

4.12.2 NOT LIMITED. The foregoing obligations in this Section 4.12 shall not be limited by a limitation on amount or type of damages, compensation or benefits payable by or for the Contractor or Subcontractor under workers' or workmen's compensation acts, disability benefit acts or other employee benefit acts.

ARTICLE 5. SUBCONTRACTORS.

5.1 AWARD OF SUBCONTRACTS AND OTHER CONTRACTS FOR PORTIONS OF THE WORK.

5.1.1 SUBCONTRACTING WORK PERMITTED; CONDITIONS.

5.1.1.1 Contractor may subcontract portions of the Work.

5.1.1.2 DFCM reserves the right to reject on reasonable ground any Subcontractor. Contractor shall not contract with any person or entity to whom DFCM has made reasonable objection. Contractor shall not be required to contract with anyone to whom Contractor has made reasonable and timely objection, provided that any additional costs associated with Contractor replacing a Subcontractor objected to by Contractor with a replacement Subcontractor not objectionable to Contractor shall be at no cost to DFCM.

5.1.2 SUBSEQUENT CHANGES. After execution of Contractor's Agreement Subcontractors listed by Contractor in accordance with Utah Code § 63A-5b-605 and Rule R23-1-615 may be changed by Contractor only in accordance with the requirements of Utah Code § 63A-5b-605 and R23-1-615.

5.1.2.1 DFCM shall pay the additional costs for a DFCM-requested change in Subcontractor if all of the following conditions are met:

5.1.2.1.1 If DFCM in writing requests the change of a Subcontractor;

5.1.2.1.2 The original Subcontractor is a responsible subcontractor that meets the requirements of the Contract Documents; and

5.1.2.1.3 The original Subcontractor did not withdraw as a Subcontractor on the Work.

5.1.2.2 In all other circumstances, Contractor shall pay the additional cost for a change in a Subcontractor.

5.1.3 BUSINESS AND LICENSING REQUIREMENTS. All Subcontractors used by Contractor shall have secured, at their own expense, all necessary professional accreditations, registrations, and licenses in the state of Utah.

5.1.4 BONDING OF SUBCONTRACTORS. Subcontractors, as identified by DFCM in the procurement documents, may be required to submit performance and payment bonds to cover the full extent of

their portion of the Work. This provision does not in any way limit the right of Contractor to have Subcontractors at any tier be required to have a performance and/or payment bond at Contractor's expense.

5.1.5 SUBCONTRACTOR DEFAULT INSURANCE. If the Contract Price includes any amount to compensate the Contractor for Subcontractor Default Insurance ("SDI"), then, notwithstanding anything in the Contract Documents to the contrary:

5.1.5.1 DFCM shall be added to the SDI by a financial interest endorsement reasonably acceptable to DFCM at no cost to DFCM;

5.1.5.2 If the Contract Documents provide for Contractor contingency, no Contractor contingency may be expended for any Subcontractor default or for any expenses and/or losses arising out of, connected with and/or related to any Subcontractor default;

5.1.5.3 Contractor shall in no event be entitled to an increase in the Contract Price and/or extension of the Contract Time for a Subcontractor default or for expense, losses and/or delays arising out of, connected with and/or related in any way to a Subcontractor default; and

5.1.5.4 The cost of SDI is included in Contractor's overhead and profit for purposes of Article 7.

5.2 SUBCONTRACTUAL RELATIONS.

5.2.1 CONTRACTOR FULLY RESPONSIBLE. Subcontracting any portion of the Work shall not relieve Contractor of Contractor's obligations or duties under the Contract Documents, Contractor shall be fully responsible and liable to DFCM for the acts and omissions of all Subcontractors at any tier and their employees and agents and Contractor shall maintain complete control over all Subcontractors. Neither the consent of DFCM to a Subcontractor proposed by Contractor, nor anything contained in the Contract Documents shall be deemed to create a contractual relationship between a Subcontractor at any tier and DFCM.

5.2.2 COMPLY WITH CONTRACT DOCUMENTS. By appropriate enforceable agreement Contractor shall require each Subcontractor to be bound to Contractor by the terms of the Contract Documents, and to assume toward Contractor all the obligations and responsibilities that Contractor, by the Contract Documents, assumes towards DFCM and the A/E.

5.2.3 RIGHTS. Each Subcontractor agreement shall preserve and protect the rights of DFCM under the Contract Documents with respect to that portion of the Work to be performed by the Subcontractor so that subcontracting any portion of the Work shall not prejudice any rights of DFCM under the Contract Documents, and shall allow to the Subcontractor, unless specifically provided otherwise in the Subcontractor agreement, the benefit of all rights and remedies against Contractor that Contractor, by the Contract Documents, has against DFCM.

5.2.4 SUB-SUBCONTRACTORS. Contractor shall require each Subcontractor to enter into similar agreements with Sub-subcontractors and to require such Sub-subcontractors to enter into similar agreements with lower tier Sub-subcontractors that comply with the requirements of Sections 5.2.2 and 5.2.3.

5.2.5 DOCUMENT COPIES. Contractor shall make available to each proposed Subcontractor, prior to execution of the Subcontractor agreement, copies of the Contract Documents to which the Subcontractor shall be bound. Contractor shall require Subcontractors to make copies of applicable portions of the Contract Documents available to their respective proposed Sub-subcontractors.

5.3 CONTINGENT ASSIGNMENT OF SUBCONTRACTS TO DFCM. Contractor contingently assigns each Subcontractor agreement with a Subcontractor for a portion of the Work to DFCM, provided that

the assignment is effective only after termination of the Contractor's Agreement by DFCM for cause pursuant to Section 12.2 or stoppage of the Work by DFCM pursuant to Section 12.5, and only for those Subcontractor agreements that DFCM accepts by notifying the Subcontractor in writing. Contractor shall remain liable for all obligations incurred under assigned Subcontractor agreements prior to DFCM's acceptance of such assignment.

ARTICLE 6. PROTECTION OF PERSONS AND PROPERTY.

6.1 SAFETY OF PERSONS AND PROPERTY.

6.1.1 CONTRACTOR RESPONSIBILITY. Contractor shall be solely responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the performance of the Work. Contractor shall seek to minimize the risk of bodily injury, property damage, and environmental harm by taking all reasonable precautions to protect:

6.1.1.1 All persons at and/or in proximity to the Work site;

6.1.1.2 Materials and equipment to be incorporated in the Work, whether in storage on or off the Work site, under the care, custody, or control of Contractor or a Subcontractor;

6.1.1.3 Property and structures located at the Work site and adjacent to the Work site, whether or not such property and structures are part of the Work, such as trees, shrubs, lawns, walks, pavements, roadways, structures and utilities not designated for removal, relocation or replacement in the course of construction; and

6.1.1.4 The environment.

6.1.2 SAFETY PROGRAM, PRECAUTIONS. Contractor shall institute and provide to DFCM a project specific safety program at the start of the Work to minimize accidents. The program shall continue to the final completion of the Work and conform to applicable laws, rules, and regulations. including without limitation. the Utah Occupational Safety and Health Rules as published by the Utah Labor Commission - UOSH Division at Utah Administrative Code, R614. Contractor shall post signs, erect barriers, and provide those items necessary to implement the safety program. As soon as Contractor proceeds with the Work, Contractor shall have all workers and all visitors on the Work site wear safety hard hats, as well as all other appropriate safety apparel such as safety glasses and shoes, and obey all safety laws, rules, and regulations. Contractor shall post a sign in a conspicuous location indicating the necessity of wearing hard hats, and Contractor shall loan such hard hats to visitors. Contractor shall maintain a clean and orderly Work site.

6.1.3 COMPLIANCE WITH LAWS. Contractor shall give notices and comply with applicable laws, rules, regulations, ordinances, and orders of public authorities applicable to the safety of persons and property and their protection from damage, injury and loss. In particular, Contractor shall comply with all applicable provisions of federal, state and municipal safety laws, rules and regulations, specifically including, without limitation, building codes, to prevent accidents and injury to persons on, about or adjacent to the Work site.

6.1.4 ERECT AND MAINTAIN SAFEGUARDS. As required by existing conditions at the Work site and proper and safe performance of the Work, Contractor shall erect and maintain safeguards for safety and protection, including effective fences, danger signs, barricades and other warnings against hazards. Contractor shall also promulgate safety regulations and notify owners and users of adjacent sites and/or utilities before performing Work that may impact such adjacent sites and/or utilities.

6.1.5 UTMOST CARE. When use or storage of explosives or other dangerous materials or equipment or unusual methods are necessary for execution of the Work, Contractor shall exercise utmost care and carry on such activities under the supervision of properly qualified personnel.

6.1.6 PROMPT REMEDY. Contractor shall promptly remedy any damage and loss (other than damage or loss insured under property insurance required by Section 10.2) to persons, property and/or the environment arising in conjunction with the Work caused in whole or in part by Contractor, Subcontractors, or any person or entity for whose acts Contractor is responsible, without cost or expense to DFCM.

6.1.7 SAFETY DESIGNEE. Contractor shall designate a responsible member of Contractor's organization at the Work site whose duty shall be the prevention of accidents, damage, injury and loss. This person shall be Contractor's superintendent, unless otherwise designated by Contractor in writing to DFCM and the A/E.

6.1.8 LOAD SAFETY. Contractor shall not load or permit any part of the construction or Work site to be loaded so as to endanger its safety and/or the safety of persons at or in the vicinity of the Work site.

6.1.9 OFF-SITE RESPONSIBILITY. In addition to its other obligations under this Article 6, the Contractor shall, at Contractor's sole cost and expense, promptly repair any damage or disturbance to walls, utilities, streets, ways, sidewalks, curbs and the property of the State and third parties (including municipalities and other governmental agencies) resulting from the performance of the Work, whether by Contractor or by Contractor's Subcontractors at any tier. The Contractor shall not cause materials, including soil and debris, to be placed or left on streets or ways.

6.1.10 EMERGENCIES. In an emergency affecting safety of persons or property, Contractor shall act, at Contractor's discretion, to prevent threatened damage, injury or loss. Contractor shall promptly notify DFCM of the action taken.

6.2 HAZARDOUS MATERIALS. In the event Contractor encounters at the Work site material reasonably believed to be asbestos, polychlorinated biphenyl (PCB), or any other hazardous waste or substance that may endanger the health of persons performing Work or being at the Work site that is not part of the Work and/or disclosed by the Contract Documents**,** Contractor shall immediately stop Work in the area affected and immediately report the condition to DFCM and the A/E by phone with a follow-up email. Contractor shall resume the Work in the affected area upon written direction provided by DFCM. Except to the extent provided otherwise in the Contract Documents, or if the presence of hazardous materials is due to the fault of Contractor, Contractor shall not be required to perform, without Contractor's consent, any Work relating to asbestos, polychlorinated biphenyl (PCB), or any other hazardous waste or substance.

6.3 HISTORICAL AND ARCHEOLOGICAL CONSIDERATIONS. In the event Contractor discovers any cultural, historical, or archeological material that is either recognized as an item to be protected under federal, state, or local law or regulation, or is an item of obvious value to the State of Utah, Contractor shall cease any Work that would interfere with such discovery and immediately report the condition to DFCM and the A/E by phone with a follow-up email. Contractor shall resume the Work upon the direction of DFCM. Contractor shall ensure cooperation with any DFCM-recognized archaeologist or other cultural/historical expert.

6.4 CONTRACTOR LIABILITY. If Contractor fails in any of its obligations in Sections 6.2 through 6.3, Contractor shall be liable for any damages to DFCM, the State of Utah, or any third party resulting from such noncompliance. Contractor shall also be liable for any mitigation or restoration effort resulting from such noncompliance. To the extent all the following is met, the presence of hazardous material or cultural, historical, or archeological material at the Work site shall qualify as a concealed or unforeseen condition under Section 7.1.5:

6.4.1 The presence of such material is not reasonably foreseeable given the site conditions that Contractor is or should have been aware of;

6.4.2 The presence of such material is not identified in any part of the Contract Documents;

6.4.3 Contractor has undertaken all proper action to mitigate any impact of the discovery of such material on the Contract Time and/or Contract Price;

6.4.4 The discovery of such material increases the Contract Time and/or Contract Price from what is stated in the Contract Documents; and

6.4.5 The requirements of Section 7.1.5 and the Contract Documents are met.

ARTICLE 7. MODIFICATIONS, PRs & PCOs, PRE AND CLAIM PROCESS.

7.1 MODIFICATIONS: IN GENERAL.

7.1.1 TYPES OF MODIFICATIONS AND LIMITATIONS. Changes in the Work may be accomplished after execution of the Contractor's Agreement, and without invalidating the Contract Documents, by ASI, Change Order or Construction Change Directive, subject to the limitations stated in this Article 7 and elsewhere in the Contract Documents. Contractor must have a written Change Order or Construction Change Directive executed by DFCM under this Article 7 prior to proceeding with any Work for which Contractor intends to request an increase in the Contract Price and/or an extension of the Contract Time.

7.1.2 BY WHOM ISSUED. The A/E or DFCM may issue ASIs not involving an adjustment in the Contract Price or an extension of the Contract Time which are not inconsistent with the intent of the Contract Documents. A Change Order or Construction Change Directive shall be issued by DFCM. The A/E shall prepare Change Orders and Construction Change Directives with specific documentation and data for DFCM's approval and execution in accordance with the Contract Documents.

7.1.3 CONTRACTOR TO PROCEED UNLESS OTHERWISE STATED. Changes in the Work shall be performed under applicable provisions of the Contract Documents, and Contractor shall proceed promptly, unless otherwise provided in the ASI, Change Order or Construction Change Directive.

7.1.4 ADJUSTING UNIT PRICES. If unit prices are stated in the Contract Documents or subsequently agreed upon, and if quantities originally contemplated are so changed in a proposed Change Order or Construction Change Directive that application of such unit prices to quantities of Work proposed shall cause a substantial inequity to DFCM or Contractor, the applicable unit prices may be equitably adjusted.

7.1.5 CONCEALED OR UNKNOWN CONDITIONS. Contractor must file a written notice with DFCM within seven (7) calendar days of the date that Contractor knew or should have known of a site condition described below or Contractor shall be deemed to waive any right to file any PCO, PRE, or Claim for an increase in the Contract Price and/or extension of the Contract Time related to such condition:

7.1.5.1 If Contractor encounters unknown and reasonably unforeseeable subsurface or otherwise concealed physical conditions, including hazardous or historical/cultural/archeological materials under Article 6, which differ materially from those indicated by the Contract Documents or which would have been revealed by a reasonably thorough site inspection; or

7.1.5.2 If Contractor encounters unknown physical conditions of an unusual nature which differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents.

7.1.6 INCREASE IN CONTRACT TIME. To the extent DFCM and/or the State of Utah is damaged by the failure of Contractor to provide the notice required by Section 7.1.5 after the Contractor knows or should

have known of such site condition, Contractor shall be liable for liquidated damages attributable thereto, as well as any damages to the State of Utah and/or DFCM that are allowable in addition to liquidated damages.

7.1.7 ALLOWANCES.

7.1.7.1 The Contractor has included in the Contract Price all allowances stated in the Contract Documents. Items covered by allowances shall be supplied for such amounts and by such persons or entities as DFCM may direct, but the Contractor shall not be required to employ persons or entities to whom the Contractor has reasonable objection.

7.1.7.2 Unless otherwise provided in the Contract Documents:

7.1.7.2.1 Allowances shall cover the cost to the Contractor of materials and equipment delivered at the Work site and all required taxes, less applicable trade discounts;

7.1.7.2.2 Allowances shall cover the Contractor's costs of unloading and handling at the Work site, labor, installation costs and other expenses contemplated for allowance items of the Work, including the Contractor's overhead and profit.

7.1.7.2.3 Whenever costs are more than or less than allowances, the Contract Price for the Work shall be adjusted accordingly by Change Order. The amount of the Change Order shall reflect (1) the difference between actual costs and the allowances under Section 7.1.7.2.1 and (2) changes in Contractor's costs under Section 7.1.7.2.2.

7.1.7.3 Materials and equipment under an allowance shall be selected by DFCM with reasonable promptness.

7.2 CONTRACTOR INITIATED REQUESTS.

7.2.1 THE REQUEST FOR INFORMATION ("RFI") PROCESS AND TIME TO FILE. Contractor may file an RFI with the A/E regarding any question the answer to which will assist Contractor in the proper completion of the Work, including, but not limited to, issues related to the Contract Documents, Drawings, and Specifications. The RFI shall be filed with the A/E in a timely manner so as not to prejudice DFCM as to the quality, time, or cost related to the Work.

7.2.2 PROPOSED CHANGE ORDER ("PCO"). Within seven (7) days after Contractor knows or should know of a situation or condition for which Contractor anticipates requesting an increase in the Contract Price and/or extension of the Contract Time, Contractor must file a Proposed Change Order ("PCO") with DFCM, or Contractor shall be deemed to waive any right to claim an increase in the Contract Price and/or extension of the Contract Time related to such situation or condition. The PCO shall include all documentation supporting the PCO available to Contractor at the time of filing and Contractor shall thereafter diligently pursue the supplementation(s) of such documentation and promptly deliver such supplementation(s) to DFCM.

7.2.2.1 One of the following may occur after a PCO is filed with DFCM:

7.2.2.1.1 DFCM, after considering any input by the A/E, may reach an agreement with Contractor and issue a Change Order.

7.2.2.1.2 DFCM, after considering any input by the A/E, may issue a Construction Change Directive.

7.2.2.1.3 If DFCM, after considering any input by the A/E, disagrees with Contractor's PCO, DFCM may seek additional information or verification from Contractor, the A/E, or other sources, and may negotiate with

Contractor, may issue a Change Order upon such later agreement, may issue or retract an issued PR, or may issue a Construction Change Directive.

7.2.2.2 If a Construction Change Directive is issued which identifies DFCM's position in regard to a Contract Price and/or Contract Time adjustment or if a PCO is denied by DFCM, Contractor must file a PRE no later than twenty-one (21) days after Contractor's receipt of the Construction Change Directive or such denial of the PCO. Failure to timely file a PRE shall be deemed to waive any right to an increase in the Contract Price and/or extension of the Contract Time related to a Construction Change Directive beyond that identified by DFCM in the Construction Change Directive, if any, or denial of the PCO. Such waiver shall entitle DFCM to convert a Construction Change Directive into a Change Order, whether or not executed by Contractor.

7.2.2.3 If a Construction Change Directive leaves open the determination of an increase in the Contract Price and/or extension of the Contract Time related to a change in the Work, then the time period for commencement of filing the PRE shall not accrue until such time as DFCM has conveyed to Contractor DFCM's position as to increase, if any, in the Contract Price and/or extension, if any, of the Contract Time as a result of the change in the Work.

7.2.2.4 The Contractor must continually cooperate with DFCM in providing data, documentation and efforts to resolve any issues related to a PCO.

7.2.3 **SUBSTITUTIONS.** The Contractor may make substitutions only with the consent of DFCM, after evaluation by the A/E and in accordance with a Change Order. Substitutions will be considered after the award of the Contractor's Agreement only when a PCO is submitted by the Contractor to substitute a non-specified product for a product specified in the Contract Documents, under the following conditions:

7.2.3.1 The PCO is accompanied by complete data on the proposed substitution substantiating compliance with the design intent and performance requirements of the Contract Documents, including product identification and description, performance and test data, references and samples where applicable, comparison of the proposed substitution with the products specified or named in the Contract Documents, and the impact of the substitution upon the Contract Time.

7.2.3.2. The PCO is accompanied by accurate cost data on the proposed substitution and comparison with the products specified, whether or not modification of the Contract Price is to be a consideration.

7.2.3.3 The Contractor is responsible for any additional costs for the A/E's additional services caused by the evaluation of the proposed substitution and/or the substitution of products.

7.2.3.4 The PCO for substitution by the Contractor shall constitute a certification by the Contractor that the Contractor has investigated the proposed substitute product and determined that it is equal or superior in all respects to that specified; the cost data presented by the Contractor is complete and includes all related costs under the Contract Documents, including the A/E's additional services; the Contractor waives all claims for additional costs related to the substitution which subsequently become apparent; the Contractor will provide the same guarantee or warranty for the substituted product that the Contractor would have provided for the product specified in the Contract Documents; and the Contractor will coordinate the installation of the accepted substitute, making such changes as may be required for the Work to be properly completed in all respects.

7.2.3.5 Substitutions will not be considered by the A/E or DFCM if they are intended or implied by submittals of Shop Drawings, Product Data or Samples without a PCO for substitution or when for their implementation they require a substantial revision of the Contract Documents in order to accommodate their use.

7.3 PROPOSAL REQUEST INITIATED BY DFCM. DFCM may submit a Proposal Request to Contractor seeking information, data, impact on the Contract Price and/or impact on the Contract Time for a change in the Work or other modification to the Contract Documents. The PR shall provide a time limit for Contractor to file a response with the A/E and DFCM. If a proposal is not timely provided by Contractor, DFCM may calculate a Change Order under Section 7.4.2. Upon timely receipt of a proposal, one of the following shall occur:

7.3.1 IF AGREEMENT, CHANGE ORDER ISSUED. DFCM, after considering any input by the A/E, may reach an agreement with the Contractor and issue a Change Order.

7.3.2 IF DISAGREEMENT. If DFCM disagrees with Contractor's proposal, after considering any input from the A/E, DFCM may seek additional information or verification from Contractor or other sources, may negotiate with Contractor, may issue a Change Order upon such later agreement, may retract the PR, or may issue a Construction Change Directive. If a Construction Change Directive is issued that identifies DFCM's position in regard to the increase, if any in the Contract Price and/or extension, if any, of the Contract Time, Contractor must file a PRE within twenty-one (21) days of Contractor's receipt of the Construction Change Directive, or Contractor shall be deemed to waive any right for an increase in the Contract Price and/or extension of the Contract Time as a result of the issuance of the Construction Change Directive beyond that identified by DFCM in the Construction Change Directive, if any. Such waiver shall entitle DFCM to convert the Construction Change Directive into a Change Order, whether or not executed by Contractor. If the Construction Change Directive leaves open the determination of an increase, if any, in the Contract Price and/or extension, if any, of the Contract Time related to the change in the Work, then the time period for commencement of filing the PRE shall not accrue until such time as DFCM has conveyed to Contractor DFCM's position as to the increase, if any, in the Contract Price and/or extension, if any, of the Contract Time resulting from the change in the Work.

7.4 CHANGE ORDERS.

7.4.1 ADJUSTING PRICE BASED UPON AGREEMENT. If a Change Order provides for an adjustment to the Contract Price, the adjustment shall be based on the mutual agreement of Contractor and DFCM, including any terms mandated by unit price agreements or other terms of the Contract Documents.

7.4.2 DFCM RESOLUTION OF PRICE IN THE ABSENCE OF AN AGREEMENT UNDER SECTION 7.4.1. In the absence of an agreement under Section 7.4.1, the adjustment in Contract Price shall be based on an itemized accounting of costs and savings supported by appropriate data. Unless otherwise provided in the Contract Documents, costs for the purposes of this Section shall be limited to the following:

7.4.2.1 All direct and indirect costs of labor; including workers' compensation insurance, social security, and other federal and state payroll-based taxes, and payroll-based fringe benefits paid by Contractor so long as they are reasonable and no higher than that charged to other clients;

7.4.2.2 Costs of materials, on-site temporary facilities, supplies, and equipment (except hand tools) required for or incorporated into the Work;

7.4.2.3 Rental costs of machinery, equipment, tools (except hand tools), and on-site temporary facilities, whether rented from Contractor or others;

7.4.2.4 Costs of permits and other fees, sales, use or similar taxes related to the Work; and

7.4.2.5 Overhead and profit. The markups stated herein for overhead and profit are intended to cover the Contractor's profit and all indirect costs associated with a change in the Work. Items covered by such markups include, but are not limited to: home office expenses, branch office and field office overhead expense of any

kind; project management; estimating, engineering; coordinating; expediting; purchasing; billing and invoicing; detailing; legal, accounting, data processing or other administrative expenses; computer and telephone costs (including computer and phone allowances); shop drawings; liability insurance premium, auto insurance premium, performance and payment bond premium and SDI; vehicle costs (including vehicle allowances); ESOP related costs; and warranty expense costs. The cost for the use of small tools is also to be considered covered by such markups. Small tools shall be defined as tools and equipment (power or non-power) with an individual purchase cost of less than Seven Hundred Fifty Dollars ($750).

7.4.2.5.1 The maximum markup percentage to be paid to any contractor (regardless of tier) including Contractor, a Subcontractor and/or Sub-subcontractor on self-performed work shall be a single markup percentage not-to-exceed fifteen percent (15%) of the net increased direct cost of: (A) direct labor and allowable labor burden costs applicable to the change in the Work; (B) the net cost of material and installed equipment incorporated into the change in the Work, and (C) net rental cost of major equipment and related fuel costs necessary to complete the change in the Work;

7.4.2.5.2 With respect to pricing the portion of Change Orders involving work performed by lower tier contractors, including Subcontractors and Sub-subcontractors, the maximum markup percentage allowable to the Contractor, Subcontractor or Sub-subcontractor supervising the lower tier contractor's work shall not exceed seven percent (7%) of the net increase of all approved changes in the Work performed by all contractors combined for any particular Change Order.

7.4.2.5.3 Contractor agrees to include these limitations on Change Order pricing in Contractor's subcontracts with Subcontractors and shall likewise require all of Contractor's Subcontractors to include the same provisions in all sub-subcontracts with their respective Sub-subcontractors of any tier.

7.4.3 **CREDITS**. The amount of credit to be allowed by Contractor to DFCM for a deletion or change in the Work which results in a net decrease in the Contract Price shall be actual net cost as confirmed to DFCM based upon corroboration by an appropriate source, provided, however, the application of the markup percentages referenced in Section 7.4.2.5 for overhead and profit will apply only to additive change orders. In those instances where a change in the Work involves both additive and deductive work, the additions and deductions will be netted and the markup percentage adjustments will be applied to the net additive amount, if any.

7.4.4 **EFFECT OF A CHANGE ORDER.** A Change Order signed by the Contractor constitutes the Contractor's agreement that, when implemented by DFCM, the adjustment in the Contract Price, if any, and/or the adjustment in the Contract Time, if any, for the change in the Work shall fully and finally compensate the Contractor and its Subcontractors and Sub-subcontractors of any tier for any and all additional costs, damages or expenses arising directly or indirectly out of the change in the Work described in the Change Order.

7.4.4.1 All Change Orders shall be conclusively presumed to constitute settlement of all Claims for direct or indirect damages of the Contractor, its Subcontractors and their respective Sub-subcontractors of any tier arising out of the change in the Work. This shall include, but is not limited to, any and all so-called "delay," "equitable adjustment," "impact," "cumulative impact," "acceleration," "constructive acceleration," "inefficiency," "interference," "indirect," "ripple" or "consequential" claims, costs or damages and all direct or indirect costs pertaining to the Contractor's home office, branch offices, or field site office and all other costs and effects whatsoever relating to the change in the Work.

7.4.4.2 Any statement unilaterally added by the Contractor to a Change Order or contained in any transmittal or separate correspondence wherein the Contractor unilaterally attempts to reserve rights to seek any further increases in the Contract Price and/or further extensions of the Contract Time for a change in the Work that is the subject of the Change Order and/or arising out of, related to and/or connected with the change in the Work described in the Change Order shall be null and void.

7.5 CONSTRUCTION CHANGE DIRECTIVES.

7.5.1 WHEN USED AND CONTRACTOR'S RIGHT TO CHALLENGE. Without invalidating the Contractor's Agreement, DFCM reserves the right to unilaterally issue, in DFCM's sole discretion, a Construction Change Directive that requires Contractor to proceed with a change in the Work. DFCM may order minor changes within the scope of Work without granting an adjustment in the Contract Price or an extension of the Contract Time if such minor changes within the scope of Work are consistent with the intent of the Contract Documents. In order to expedite the Work and avoid or minimize delays in the Work that may affect the Contract Price or Contract Time, the Contract Documents shall be amended as described below. If the Construction Change Directive leaves open the determination of an increase, if any, in the Contract Price and/or extension, if any, of the Contract Time related to the change in the Work, then the Construction Change Directive shall indicate the timeframe(s) in which Contractor shall provide further information to resolve such open issue(s). When DFCM and Contractor agree upon an increase, if any, in the Contract Price and/or extension, if any, in the Contract Time related to a Construction Change Directive, the parties shall execute a Change Order. Additionally, the Construction Change Directive may be converted to a Change Order under Section 7.2.2.2 or Section 7.3.2.

7.5.2 PROCEED WITH WORK. Upon receipt of a Construction Change Directive, Contractor shall promptly proceed with the change in the Work involved.

7.5.3 INTERIM PAYMENTS BY DFCM. Pending the final determination of the increase in the Contract Price, if any, associated with a Construction Change Directive, DFCM shall pay any undisputed amount to Contractor.

7.6 ASI. The A/E may at any time that is consistent with maintaining the quality, safety, time, budget, and function of the Work, issue to Contractor an ASI after approval from DFCM is obtained.

7.7 PROCEDURE FOR PRELIMINARY RESOLUTION EFFORTS.

7.7.1 REQUEST FOR PRELIMINARY RESOLUTION EFFORT (PRE). If Contractor wishes to raise an issue related to an alleged breach of contract by DFCM or an issue concerning time or money, Contractor shall file a PRE as a prerequisite for any consideration of the issue by DFCM. The labeling of the notice or request shall not preclude the consideration of the issue by DFCM.

7.7.2 TIME FOR FILING. The PRE must be filed in writing with DFCM within twenty-one (21) days of any of the following:

7.7.2.1 Issuance of a Construction Change Directive that states the adjustment in Contract Price and/or Contract Time, if any, if Contractor disagrees with such adjustment;

7.7.2.2 Issuance of a statement of DFCM's position with respect to the adjustment in Contract Price and/or Contract Time, if any, in a previously issued Construction Change Directive that left open the adjustment in Contract Price and/or Contract Time, if Contractor disagrees with such statement;

7.7.2.3 Issuance of a denial of a PCO by DFCM;

7.7.2.4 In the case of a Subcontractor, after the expiration of the time period for the Contractor/Subcontractor PRE process under Section 7.7.5; or

7.7.2.5 Except as provided in Section 7.2.2, when Contractor knows or should have known about any other issue where Contractor seeks an adjustment in the Contract Price, Contract Time and/or other relief from DFCM.

7.7.3 CONTENT REQUIREMENT. The PRE shall be required to include in writing to the extent information is reasonably available at the time of filing of the PRE:

7.7.3.1 A description of the issue;

7.7.3.2 The potential impact on the Work, Contract Price and/or Contract Time; and

7.7.3.3 An indication of the relief sought.

7.7.4 SUPPLEMENTATION. Additional detail of the content requirement under Section 7.7.3 shall be provided later if the detail is not yet available at the initial filing as follows:

7.7.4.1 While the issue is continuing or the impact is being determined, Contractor shall provide a written updated status report every thirty (30) days or as otherwise reasonably requested by DFCM; and

7.7.4.2 After the issue is concluded and/or the impact is determinable, complete information, including any impacts on Contract Price, Contract Time and/or other relief requested, if any, must be provided to DFCM within twenty-one (21) days of the earlier of the date the issue is concluded or the impact is determinable.

7.7.5 SUBCONTRACTORS. Contractor must include the provisions of this Section 7.7.5 in Contractor's subcontract with each Subcontractor and require each Subcontractor to do likewise in each Subcontractor's sub-subcontracts with Sub-subcontractors. At Contractor's discretion, Contractor may allow a Sub-subcontractor at the second tier and beyond to submit a PRE directly to Contractor.

7.7.5.1 In order for a Subcontractor at any tier to be involved with the PRE of DFCM, the following conditions and process shall apply:

7.7.5.1.1 The Subcontractor must have attempted to resolve the issue with Contractor, including the submission of a PRE with Contractor.

7.7.5.1.2 The Subcontractor must file a copy of the PRE with DFCM;

7.7.5.1.3 The PRE to Contractor must meet the time, content, and supplementation requirements of Sections 7.7.2, 7.7.3 and 7.7.4. The triggering event for a Subcontractor to file a PRE shall be the time at which the issue cannot be resolved through negotiation;

7.7.5.1.4 The PRE submitted to Contractor shall only be eligible for consideration in DFCM's PRE process to the extent the issue is reasonably related to the performance of DFCM or an entity for which DFCM is liable;

7.7.5.1.5 Contractor shall resolve the PRE with the Subcontractor within sixty (60) days of its submittal to Contractor or such other time period as subsequently agreed to by the Subcontractor in writing. If Contractor fails to resolve the PRE with the Subcontractor within such required time period, the Subcontractor may submit in writing the PRE with Contractor and DFCM. In order to be eligible for DFCM's consideration of the PRE, the Subcontractor must submit the PRE within twenty-one (21) days of the expiration of the time period for the Contractor/Subcontractor PRE process. DFCM shall consider the PRE as being submitted by Contractor on behalf of the Subcontractor;

7.7.5.1.6 Upon such PRE being submitted, Contractor shall cooperate with DFCM in reviewing the issue;

7.7.5.1.7 DFCM shall not be obligated to consider any submission which is not in accordance with any provision of this Section 7.7;

7.7.5.1.8 The Subcontractor may accompany Contractor in participating with DFCM regarding the PRE raised by the Subcontractor. DFCM shall not be precluded from meeting with Contractor separately, and it shall be the responsibility of Contractor to keep the Subcontractor informed of any such meetings; and

7.7.5.1.9 Notwithstanding any provision of this Section 7.7.5, a Subcontractor shall be entitled to pursue a payment bond claim.

7.7.6 INFORMATION AND MEETINGS. DFCM may request additional information and may meet with the parties involved with the issue.

7.7.7 CONTRACTOR REQUIRED TO CONTINUE PERFORMANCE. Pending the final resolution of the issue, unless otherwise agreed upon in writing by DFCM, Contractor shall proceed diligently with performance of the Work and DFCM shall continue to make payments of undisputed amounts in accordance with the Contract Documents.

7.7.8 DECISION. DFCM shall issue to Contractor, and any other third party brought into the process by DFCM as being potentially liable to DFCM, a written decision providing the basis for the decision on the issues presented by all of the parties within thirty (30) days of receipt of all the information required under Sections 7.7.3 and 7.7.4.

7.7.9 DECISION FINAL UNLESS CLAIM SUBMITTED. The decision by DFCM shall be final, and not subject to any further administrative or judicial review (not including judicial enforcement) unless a Claim is submitted in accordance with these General Conditions.

7.7.10 EXTENSION REQUIRES MUTUAL AGREEMENT. Any time period specified in Section 7.7 may be extended by mutual agreement of Contractor and DFCM.

7.7.11 IF DECISION NOT ISSUED. If the decision is not issued within the thirty (30) day period, stated in Section 7.7.8 including any agreed to extensions, the issue may be pursued as a Claim.

7.7.12 PAYMENT FOR PERFORMANCE.

7.7.12.1 Except as otherwise provided in the Contract Documents, any final decision where DFCM is to pay additional monies to Contractor, shall not be delayed by any PRE, Claim, or appeal by another party.

7.7.12.2 Payment to Contractor in accordance with any final decision shall be made by DFCM consistent with the Contract Documents.

7.7.12.3 Notwithstanding any other provision of the Contract Documents, payment to Contractor shall be subject to any set-off, claims, or counterclaims of DFCM.

7.7.12.4 Payment to Contractor for a Subcontractor issue submitted by the Contractor shall be paid by Contractor to Subcontractor in accordance with the subcontract between Contractor and Subcontractor.

7.7.12.5 Any payment or performance determined owing by Contractor to DFCM shall be made in accordance with the Contract Documents.

7.8. RESOLUTION OF CLAIM.

7.8.1 CLAIM. If the decision on the PRE is not issued within the required timeframe or if Contractor is not satisfied with the decision, Contractor, or other party brought into the process by DFCM, may submit a Claim in accordance with this Section 7.8 as a prerequisite for any further consideration by DFCM or the right to any judicial review of the issue giving rise to the Claim.

7.8.2 SUBCONTRACTORS. In order for a Subcontractor to have its issue considered in the Claim process by DFCM, the Subcontractor that had its issue considered under Section 7.7.5 may submit the issue as a Claim by filing it with Contractor and DFCM within the same timeframe and with the same content requirements as required of a Claim submitted by Contractor under this Section 7.8.2. DFCM shall consider the Claim as being submitted by Contractor on behalf of the Subcontractor. Under no circumstances shall any provision of these General Conditions or the Contract Documents be construed so as to create any contractual relationship between DFCM and any Subcontractor.

7.8.2.1 Upon such Claim being submitted, the Contractor shall fully cooperate with the Director, the person(s) evaluating the claim and any subsequent reviewing authority.

7.8.2.2 The Director shall not be obligated to consider any submission which is not in accordance with this Section 7.8.2.

7.8.2.3 The Subcontractor may accompany Contractor in participating with the Director, the person(s) evaluating the Claim and any subsequent reviewing authority regarding the Claim. The Director, the person(s) evaluating the Claim, and any subsequent reviewing authority is not precluded from meeting with Contractor separately, and it shall be the responsibility of Contractor to keep the Subcontractor informed of any such meetings and matters discussed.

7.8.2.4 Notwithstanding any provision of this Section 7.8, a Subcontractor shall be entitled to pursue a payment bond claim.

7.8.3 TIME FOR FILING. The Claim must be filed in writing promptly with the Director of DFCM, but in no case more than twenty-one (21) days after the decision is issued on the PRE under Section 7.7.8 or no more than twenty-one (21) days after the thirty (30) day period under Section 7.7.11 has expired with a decision not issued.

7.8.4 CONTENT REQUIREMENT. The written Claim shall include:

7.8.4.1 A description of the issues in dispute;

7.8.4.2 The basis for the Claim, including documentation and analysis required by the Contract Documents and applicable law and rules that allow for the proper determination of the Claim;

7.8.4.3 A detailed cost estimate for any amount sought, including copies of any related invoices; and

7.8.4.4 A specific identification of the relief sought.

7.8.5 EXTENSION OF TIME TO SUBMIT DOCUMENTATION. The time period for submitting documentation and any analysis to support a Claim may be extended by the Director upon written request of the claimant showing just cause for such extension, which request must be included in the initial Claim submittal.

7.8.6 CONTRACTOR REQUIRED TO CONTINUE PERFORMANCE. Pending the final determination of the Claim, including any judicial review or appeal process, and unless otherwise agreed upon in writing by the Director, Contractor shall proceed diligently with performance of the Contract and DFCM shall continue to make payments of undisputed amounts in accordance with the Contract Documents.

7.8.7 AGREEMENT OF CLAIMANT ON METHOD AND PERSON(S) EVALUATING THE CLAIM. The Director shall first attempt to reach agreement with the claimant on the method and person(s) to evaluate the Claim. If such agreement cannot be made within fourteen (14) days of filing of the Claim, the Director shall select the method and person(s), considering the purposes described in Rule R23-26-1. Unless agreed to by the Director and the claimant, any selected person shall not have a conflict of interest or appearance of impropriety. Any party and the person(s) evaluating the Claim has a duty to promptly raise any circumstances regarding a conflict of interest or appearance of impropriety. If such a reasonable objection is raised, and unless otherwise agreed to by the Director and the claimant, the Director shall take appropriate action to eliminate the conflict of interest or appearance of impropriety. The dispute resolution methods and person(s) may include any of the following:

7.8.7.1 A single expert and/or hearing officer qualified in the field that is the subject of the Claim;

7.8.7.2 An expert panel, consisting of members that are qualified in a field that is the subject of the Claim;

7.8.7.3 An arbitration process which may be binding if agreed to by the parties to the Claim;

7.8.7.4 A mediator; or

7.8.7.5 Any other method that best accomplishes the purposes set forth in Rule R23-26-1.

7.8.8 THE EVALUATION PROCESS, TIMEFRAMES OF EVALUATOR(S), DIRECTOR'S DETERMINATION, ADMINISTRATIVE APPEAL TO THE EXECUTIVE DIRECTOR AND JUDICIAL REVIEW. The Claim shall be evaluated, the timeframe for specific events related to the person(s) evaluating the Claim, the Director's determination, any appeal to the Executive Director and any judicial review shall be subject to the provisions of Rule R23-26-5(8), R23-26-5(9), R23-26-6 and R23-26-8. A copy of these Administrative Rules is available at https://rules.utah.gov.

7.8.9 APPEAL PROCESS PREREQUISITE FOR FURTHER CONSIDERATION OR JUDICIAL REVIEW. The administrative appeal to the Executive Director is a prerequisite for any further consideration by the State of Utah, or to judicial review of the issue giving rise to the Claim. It shall be

considered that the Contractor, or another party brought into the process by DFCM, has not exhausted its administrative remedies if such an administrative appeal is not undertaken.

7.8.10 PAYMENT OF CLAIM.

7.8.10.1 When a stand-alone component of a Claim has received a final determination, and is no longer subject to review or appeal, that amount shall be paid in accordance with the payment provisions of the Contract Documents or judicial order.

7.8.10.2 When the entire Claim has received a final determination, and is no longer subject to review or appeal, the full amount shall be paid within fourteen (14) days of the date of the final determination unless the Work or services have not been completed, in which case the amount shall be paid in accordance with the payment provisions of the Contract Documents to the point that the Work is completed.

7.8.10.3 The final determination date is the earlier of the date upon which the claimant accepted the settlement in writing with an executed customary release document and waived its rights of appeal, or the expiration of the appeal period, with no appeal filed, or the determination made resulting from the final appeal.

7.8.10.4 Any final determination where DFCM is to pay additional monies to Contractor shall not be delayed by any appeal or request for judicial review by another party brought into the process by DFCM as being liable to DFCM.

7.8.10.5 Notwithstanding any other provision of the Contract Documents, payment of all or part of a Claim shall be subject to any set-off, claims, or counterclaims of DFCM.

7.8.10.6 Payment to Contractor for a Subcontractor issue (Claim) deemed filed by Contractor, shall be paid by Contractor to the Subcontractor in accordance with the subcontract between Contractor and the Subcontractor.

7.8.10.7 The execution of a customary release document by the claimant related to any payment may be required as a condition of making the payment. Unless expressly and specifically released in writing by DFCM, settlement of a Claim by DFCM shall not be deemed a waiver of Claims reserved under Section 8.8.3.

7.8.11 ALLOCATION OF COSTS OF CLAIM RESOLUTION PROCESS.

7.8.11.1 In order to file a Claim, a claimant must pay a Fifteen Hundred Dollar ($1,500.00.00) filing fee to DFCM. When the Claim is a pass-through from a Subcontractor in accordance with Section 7.7.5, the payment of the fee shall be made by the Subcontractor.

7.8.11.2 Unless otherwise agreed to by the parties to the Claim, the costs of resolving the Claim shall be allocated among the parties on the same proportionate basis as the determination of financial responsibility for the Claim.

7.8.11.3 The costs of resolving the Claim that are subject to allocation include the claimant's filing fee, the costs of any person(s) evaluating the Claim, the costs of making any required record of the process, and any additional testing or inspection procured to investigate and/or evaluate the Claim.

7.8.11.4 Each party shall be responsible for its own attorney fees.

7.8.12 ALTERNATIVE PROCEDURES. To the extent otherwise permitted by law, if all parties to a Claim agree in writing, a protocol for resolving a Claim may be used that differs from the process described in this Section 7.8.

7.8.13 IMPACT ON FUTURE SELECTIONS.

7.8.13.1 The presentation of a good faith and non-frivolous issue or Claim shall not be considered by DFCM in DFCM's selection process for a future award of contract; and

7.8.13.2 The submission of a bad faith and frivolous issue or Claim, or the failure by a Contractor to facilitate resolution of a Claim, may be considered in DFCM's evaluation of performance.

7.8.14* **DFCM'S RIGHT TO HAVE ISSUES, DISPUTES OR CLAIMS CONSIDERED.** As stated in Rule R23-26-1(6), Sections 7.7 and 7.8 do not limit the right of DFCM to have any of DFCM's issues, disputes or claims considered. DFCM reserves all rights to pursue DFCM's issues, disputes or claims in law or equity including, but not limited to, any or all of the following: damages, delay damages and impacts, losses, liability, patent or latent defects, or failure to perform under the Contract Documents. If the Director appoints an expert or a panel to consider any such issue(s), dispute(s) or claim(s) of DFCM, Contractor shall cooperate with such expert or panel process.

**The previous 'Section 7.8.14 REPORT TO THE BUILDING BOARD' has been removed as of 07122023.*
**The previous 'Section 7.8.15 DFCM'S RIGHT TO HAVE ISSUES, DISPUTES OR CLAIMS CONSIDERED' has been renumbered to Section 7.8.14 as of 07122023.*

ARTICLE 8. PAYMENTS AND COMPLETION.

8.1 SCHEDULE OF VALUES. With the first Application for Payment, Contractor shall submit to the A/E and DFCM a schedule of values allocated to all the various portions of the Work. The schedule of values shall be submitted on the form approved and provided by DFCM. The schedule of values must consist of a detailed and specific breakdown of values actually associated with the various items of Work and shall in no event be "frontloaded". The A/E shall make recommendations to DFCM regarding the schedule of values including any suggested modifications. When approved, including any approved modifications, by DFCM, it shall be the basis for future Contractor Applications for Payment. Contractor shall be entitled to reasonably reallocate values in the schedule of values with prior written notice to DFCM. Contractor shall not be entitled to payment until receipt and acceptance of the schedule of values.

8.2 APPLICATIONS FOR PAYMENT.

8.2.1 IN GENERAL. The following general requirements shall be met:

8.2.1.1 Contractor shall submit to the A/E an itemized Application for Payment for Work completed in accordance with the schedule of values and that reflects retainage as provided for in the Contractor's Agreement. The Application for Payment shall be on a form approved and provided by DFCM.

8.2.1.2 The Application for Payment shall be supported by such data substantiating Contractor's right to payment as DFCM or the A/E may require.

8.2.1.3 The Application for Payment may include requests for payment pursuant to approved Change Orders or Construction Change Directives.

8.2.1.4 The Application for Payment shall not include requests for payment for portions of the Work performed by a Subcontractor when Contractor does not intend to pay that Subcontractor because of a dispute or other reason.

8.2.1.5 In executing the Application for Payment, Contractor shall attest that Subcontractors involved with prior Applications for Payment have been paid, unless Contractor provides a detailed explanation why such

payment has not occurred. DFCM reserves the right to require Contractor to submit a Utah Conditional Waiver and Release Upon Progress Payment form from one or more Subcontractors.

8.2.2 PAYMENT FOR MATERIAL AND EQUIPMENT. Unless otherwise provided in the Contract Documents, payments shall be made on account of materials and equipment delivered and suitably stored at the Work site for subsequent incorporation into the Work. If approved in advance by DFCM and A/E, payment may similarly be made for materials and equipment suitably stored off-site at a location agreed upon in writing. Payment for materials and equipment stored on or off-site shall be conditioned upon compliance by Contractor with procedures satisfactory to DFCM to establish DFCM's title to such materials and equipment or otherwise protect DFCM's interest, and shall include applicable insurance, storage, and transportation to the Work site for such materials and equipment stored off-site. DFCM may require copies of invoices or other suitable documentation.

8.2.3 WARRANTY OF TITLE. Contractor warrants that title to all Work covered by an Application for Payment shall pass to DFCM no later than the time for payment. Contractor further warrants that upon submittal of an Application for Payment, all Work for which Certificates for Payment have been previously issued and payments received from DFCM shall, to the best of Contractor's knowledge, information, and belief, be free and clear of liens, claims, security interests, or encumbrances in favor of the Contractor, Subcontractors, or other persons or entities making a claim by reason of having provided labor, materials, and/or equipment relating to the Work.

8.2.4 HOLDBACK BY DFCM. Notwithstanding anything to the contrary contained in the Contract Documents, DFCM may, as a result of the claims resolution process, withhold any payment to Contractor if and for so long as Contractor fails to perform any of its obligations under the Contract Documents or otherwise is in default under any of the Contract Documents.

8.3 CERTIFICATES FOR PAYMENT.

8.3.1 ISSUED BY A/E. The A/E shall within seven (7) days after receipt of Contractor's Application for Payment, either issue to DFCM a Certificate for Payment, with a copy to the Contractor, for such amount as the A/E determines due or notify Contractor and DFCM in writing of the A/E's reasons for withholding certification in whole or in part as provided in Section 8.4.1. If the A/E fails to act within said seven (7) day period, Contractor may file the Application for Payment directly with DFCM and DFCM shall thereafter have twenty-one (21) days from the date of DFCM's receipt to resolve the amount to be paid and to pay the undisputed amount. The accuracy of Contractor's Applications for Payment shall be Contractor's responsibility, not A/E's.

8.3.2 A/E'S REPRESENTATIONS. The A/E's issuance of a Certificate for Payment shall constitute a representation to DFCM that to the best of the A/E's knowledge, information and belief, based upon the A/E's observations at the site, the data comprising the Application for Payment, and what is reasonably inferable from the observations and data, that the Work has progressed to the point indicated in the Application for Payment and that the quality of the Work is in accordance with the Contract Documents. The foregoing representations are subject to minor deviations from the Contract Documents correctable prior to completion and to specific qualifications expressed by the A/E. The issuance of a Certificate for Payment shall further constitute a representation that Contractor is entitled to payment in the amount certified. However, the issuance of a Certificate for Payment shall not be a representation that the A/E has: (1) made exhaustive or continuous on-site inspections to check the quality or quantity of the Work; (2) reviewed construction means, methods, techniques, sequences or procedures; (3) reviewed copies of requisitions received from Subcontractors and material suppliers and other data requested by DFCM to substantiate Contractor's right to payment; (4) ascertained how or for what purpose Contractor used money previously paid on account of Contract Price; or (5) any duty to make such inquiries.

8.4 DECISIONS TO WITHHOLD CERTIFICATION.

8.4.1 WHEN WITHHELD. The A/E may decide not to certify payment and may withhold a Certificate for Payment in whole or in part, to the extent reasonably necessary to protect DFCM, if in the A/E's judgment the representations to DFCM required in Section 8.3.2 cannot be made. If the A/E is unable to certify payment in the amount of the Application for Payment, the A/E shall notify Contractor and DFCM as provided in Section 8.3.1. If Contractor and the A/E cannot agree on a revised amount, the A/E shall promptly issue a Certificate for Payment for the amount to which the A/E makes such representations to DFCM. The A/E may also decide not to certify payment or, because of subsequently discovered evidence or observations, may nullify the whole or part of a Certificate for Payment previously issued, to such extent as may be necessary in the A/E's opinion to protect DFCM from loss because of:

8.4.1.1 Defective Work not remedied;

8.4.1.2 Third party claims filed or reasonable evidence indicating probable filing of such claims;

8.4.1.3 Failure of Contractor to make payments properly to Subcontractors or for labor, materials, or equipment;

8.4.1.4 Reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Price;

8.4.1.5 Damage to DFCM or another contractor;

8.4.1.6 Reasonable evidence that the Work will not be completed within the Contract Time, and that the unpaid balance of the Contract Price would not be adequate to cover actual or liquidated damages for the anticipated delay; or

8.4.1.7 Failure to carry out the Work in accordance with the Contract Documents.

8.4.2 CERTIFICATION ISSUED WHEN REASONS FOR WITHHOLDING REMOVED. When the reasons stated in Section 8.4.1 for withholding certification are removed, certification shall be made for such related amounts.

8.4.3 CONTINUE WORK EVEN IF CONTRACTOR DISPUTES A/E'S DETERMINATION. If Contractor disputes any determination by the A/E or the result of the claims resolution process with regard to any Certification of Payment, Contractor nevertheless shall expeditiously continue to prosecute the Work.

8.4.4 DFCM NOT IN BREACH. DFCM shall not be deemed to be in breach of Contractor's Agreement by reason of the withholding of any payment pursuant to any provision of the Contract Documents provided DFCM's action or such withholding is consistent with the results of the dispute resolution process.

8.5 PROGRESS PAYMENTS.

8.5.1 IN GENERAL, INTEREST OR LATE PAYMENTS.

8.5.1.1 Except as provided in Section 8.3.1, DFCM shall pay any undisputed amount within twenty-eight (28) days of the date that the Application for Payment was submitted to the A/E. In no event shall DFCM be required to pay any disputed amount.

8.5.1.2 Except as otherwise provided by law, if any payment is late based upon the provisions of the Contract Documents, Contractor shall be paid interest at the rate stated in Utah Code § 15-6-3.

8.5.2 CONTRACTOR AND SUBCONTRACTOR RESPONSIBILITY. Contractor shall promptly and no later than the date established in Utah Code § 15-6-5 pay each Subcontractor, upon receipt of payment from DFCM, out of the amount paid to Contractor on account of such Subcontractor's portion of the Work, the amount to which said Subcontractor is entitled. Contractor shall, by appropriate agreement with each Subcontractor, require each Subcontractor to make payment to its Sub-subcontractors in a similar manner.

8.5.3 INFORMATION FURNISHED BY A/E OR DFCM TO SUBCONTRACTOR. The A/E or DFCM shall, on request, furnish to a Subcontractor, if practicable, information regarding percentages of completion or amounts applied for by Contractor and action taken thereon by the A/E and DFCM on account of portions of the Work done by such Subcontractor.

8.5.4 DFCM AND A/E NOT LIABLE. Neither DFCM or A/E shall have an obligation to pay, monitor, or enforce the payment of money to a Subcontractor, except to the extent as may otherwise be required by law.

8.5.5 CERTIFICATE, PAYMENT OR USE NOT ACCEPTANCE OF DEFECTIVE WORK. A Certificate for Payment, a progress payment, or partial or entire use or occupancy of the Work by DFCM shall not constitute acceptance of Work that is not in accordance with the Contract Documents.

8.6 PAYMENT UPON SUBSTANTIAL COMPLETION. Upon Substantial Completion of the Work or designated portion thereof and upon application by Contractor and certification by the A/E, DFCM shall make payment, reflecting adjustment in retainage, if any, for such Work or portion thereof as provided in the Contract Documents. To the extent allowed by law, DFCM may retain until final completion up to twice the fair market value of the Work that has not been completed in accordance with the Contract Documents, or, in the absence of applicable Contract Documents, generally accepted craft standards.

8.7 PARTIAL OCCUPANCY OR USE.

8.7.1 IN GENERAL. DFCM may occupy or use any completed or partially completed portion of the Work at any stage when such portion is designated by separate agreement with Contractor and authorized by public authorities having jurisdiction over the Work. Such partial occupancy or use may commence whether or not the portion is Substantially Complete, provided DFCM and Contractor have accepted in writing the responsibilities assigned to each of them for payments, retainage if any, security, maintenance, heat, utilities, damage to the Work and insurance, and have agreed in writing concerning the period for correction of the Work and commencement of the warranties required by the Contract Documents. When Contractor considers a portion to be Substantially Complete, Contractor shall prepare and submit a list to the A/E as previously provided for herein. Consent of Contractor to partial occupancy or use shall not be unreasonably withheld. Contractor shall have continuing responsibility to protect the Work site and the Work during such partial occupancy or use and shall be responsible for damage except to the extent caused solely by DFCM during such partial occupancy or use. The stage of progress of the Work shall be determined by written agreement between DFCM and Contractor.

8.7.2 INSPECTION. Immediately prior to such partial occupancy or use, DFCM, Contractor and A/E shall jointly inspect the area to be occupied or portion of the Work to be used in order to determine and record the condition of the Work.

8.7.3 NOT CONSTITUTE ACCEPTANCE. Except to the extent it is agreed upon in writing by DFCM, partial occupancy or use of a portion of the Work shall not constitute acceptance of Work not complying with the requirements of the Contract Documents.

8.7.4 INSURANCE. Partial occupancy or use shall not commence until the insurance company or companies providing property insurance under Section 10.2 have provided any required consent to such partial

occupancy or use by endorsement or otherwise. DFCM shall take reasonable steps to obtain any required consent of the insurance company or companies and shall, without mutual written consent, take no action with respect to partial occupancy or use that would cause cancellation, lapse or reduction of insurance.

8.8 FINAL PAYMENT.

8.8.1 CERTIFICATE FOR PAYMENT. The A/E's final Certificate for Payment shall constitute a further representation that the conditions listed in Section 8.8.2 as precedent to Contractor's being entitled to final payment have been fulfilled.

8.8.2 CONDITIONS FOR FINAL PAYMENT. Neither final payment nor any remaining retained percentage shall become due until Contractor submits to the A/E the following to the extent required by DFCM:

8.8.2.1 An affidavit that payrolls, bills for material and equipment, and other indebtedness connected with the Work (less amounts withheld by DFCM) have been paid or otherwise satisfied;

8.8.2.2 A current or additional certificate evidencing that insurance required by the Contract Documents to remain in force after final payment is currently in effect and shall not be canceled or allowed to expire until at least twenty-eight (28) days prior written notice, by certified mail, return receipt requested, has been given to DFCM;

8.8.2.3 A written statement that Contractor knows of no reason that the insurance shall not be renewable to cover the period required by the Contract Documents;

8.8.2.4 If requested by the surety in a timely manner or by DFCM, consent of surety, to final payment;

8.8.2.5 Receipt of Record Drawings, Specifications, Addenda, Change Orders and other Modifications maintained at the site; the warranties, instructions, operation and maintenance manuals, and training videos required to be furnished by the Contract Documents;

8.8.2.6 Other data establishing payment or satisfaction of obligations, such as a Utah Waiver and Release Upon Final Payment form from Contractor, Subcontractors and Sub-subcontractors, receipts, other releases and waivers of liens, claims, security interests, or encumbrances arising out of Contractor's Agreement, to the extent and in such form as may be designated by DFCM. If a Subcontractor or Sub-subcontractor refuses to furnish a release or waiver required by DFCM, DFCM may require consent of surety to the final payment. If liens, claims, security interests, or encumbrances remain unsatisfied after payments are made, Contractor shall refund to DFCM all money that DFCM may be compelled to pay in discharging such liens, claims, security interests or encumbrances including all costs and reasonable attorney fees; and

8.8.2.7 A written statement demonstrating how Contractor shall distribute interest earned on retention to Subcontractors as required by Utah Code § 13-8-5.

8.8.3 WAIVER OF CLAIMS: FINAL PAYMENT. The making of final payment shall constitute a waiver of Claims by DFCM, except those arising from:

8.8.3.1 Liens, Claims, security interests, or encumbrances arising out of the Contract Documents and unsettled;

8.8.3.2 Failure of the Work to comply with the requirements of the Contract Documents;

8.8.3.3 Terms of warranties required by the Contract Documents; or

8.8.3.4 Claims arising within the one-year period for correction of the Work and Claims to the extent not barred by Utah Code § 78B-2-225 and/or Utah Code § 78B-4-513.

8.8.4 DELAYS NOT CONTRACTOR'S FAULT. If, after Substantial Completion of the Work, Final Completion is materially delayed through no fault of Contractor or by issuance of Change Orders affecting final completion, DFCM shall, upon application by Contractor and certification by the A/E, and without terminating Contractor's Agreement, make payment of the balance due for that portion of the Work fully completed and accepted. Such payment shall be made under terms and conditions governing final payment. Unless otherwise stated by DFCM in writing, the making of final payment shall constitute a waiver of claims by DFCM as provided in Section 8.8.3 for that portion of that Work fully completed and accepted by DFCM.

8.8.5 WAIVER BY ACCEPTING FINAL PAYMENT. Acceptance of final payment by Contractor or a Subcontractor shall constitute a waiver of Claims by that payee except those Claims previously made in writing and identified by that payee as unsettled at the time of final Application for Payment.

ARTICLE 9. TESTS AND INSPECTIONS, SUBSTANTIAL AND FINAL COMPLETION, UNCOVERING, CORRECTION OF WORK AND GUARANTY PERIOD.

9.1 TESTS AND INSPECTIONS.

9.1.1 IN GENERAL. Tests, inspections, and approvals of portions of the Work required by the Contract Documents or by laws, rules, regulations, or orders of public authorities having jurisdiction shall be made at an appropriate time. Unless otherwise specifically set forth in the Contract Documents or agreed to by DFCM in writing, DFCM shall contract for such tests, inspections, and approvals with an independent entity, or with the appropriate public authority, and DFCM shall bear all related costs of tests, inspections, and approvals, except as provided below. If any of the Work is required to be inspected or approved by the terms of the Contract Documents or by any public authority, Contractor shall, at least two (2) working days prior to the time of the desired inspection, and following the procedures established by DFCM, request such inspection or approval to be performed. Contractor shall give the A/E timely notice of when and where tests and inspections are to be made so that the A/E may observe such procedures.

9.1.2 FAILURE OF AN INSPECTOR TO APPEAR. Work shall not proceed without any required inspection and the associated authorization by DFCM to proceed unless the following procedures and requirements have been met:

9.1.2.1 The inspection or approval was requested in a timely manner as provided in Section 9.1.1;

9.1.2.2 Contractor received written confirmation from the inspection entity that the inspection was scheduled;

9.1.2.3 Contractor has contacted or attempted to contact the inspector to confirm whether the inspector is able to perform the inspection as scheduled;

9.1.2.4 If the inspector informs Contractor that the inspector is unable to perform the inspection as scheduled or if Contractor is unable to contact the inspector, Contractor shall attempt to contact the A/E or DFCM for instruction; and

9.1.2.5 Contractor has documented the condition of the Work prior to being covered through photos or other means.

9.1.3 NONCONFORMING WORK. If procedures for testing, inspection, or approval under Section 9.1.1 reveal failure of portions of the Work to comply with the requirements established by the Contract

Documents, Contractor shall bear all costs made necessary by such failure including those of repeated procedures and compensation for DFCM's expenses, including the cost of retesting for verification of compliance if necessary, until DFCM accepts the Work in question as complying with the requirements of the Contract Documents.

9.1.4 CERTIFICATES. Required certificates of testing, inspection, or approval shall, unless otherwise required by the Contract Documents, be secured by Contractor and promptly delivered to the A/E.

9.1.5 A/E OBSERVING. If the A/E is to observe tests, inspections, or approvals required by the Contract Documents, the A/E shall do so with reasonable promptness and, where practicable, at the normal place of testing.

9.1.6 PROMPTNESS. Tests, inspections, and arrangements for approvals conducted pursuant to the Contract Documents shall be made promptly to avoid delay in the Work.

9.2 UNCOVERING OF WORK.

9.2.1 UNCOVER UNINSPECTED WORK. Except as provided in Section 9.2.3, if a portion of the Work is covered prior to an inspector's approval to proceed, it must be uncovered for the inspector's inspection and be replaced at Contractor's expense without change in the Contract Price and/or Contract Time.

9.2.2 OBSERVATION PRIOR TO COVERING. Except as provided in Section 9.2.3, if DFCM or the A/E has requested in writing to observe conditions prior to any Work being covered or if such observation is required by the Contract Documents, and the Work is covered without such observation, Contractor shall be required to uncover and appropriately replace the Work at Contractor's expense without change in the Contract Price and/or Contract Time. If Contractor requests an inspection and DFCM or the A/E, including any inspector of each, does not appear, Contractor shall immediately notify DFCM of such failure to appear, but shall not cover the Work without such inspection.

9.2.3 WHEN AN INSPECTOR FAILS TO APPEAR OR A/E OR DFCM DID NOT MAKE PRIOR REQUEST. If Work is performed by Contractor without an inspection as provided in Section 9.1.2 or if a portion of the Work has been covered which the A/E or DFCM has not specifically requested to observe prior to its being covered or such observation is not required by the Contract Documents, the A/E or DFCM may request to see such Work and it shall be uncovered by Contractor. If such Work is in accordance with the Contract Documents, costs of uncovering and replacement, shall, by appropriate Change Order, be charged to DFCM. If such Work is not in accordance with the Contract Documents, Contractor shall pay such costs unless the condition was caused by DFCM or a separate contractor in which event DFCM shall be responsible for payment of such costs.

9.3 INSPECTIONS: SUBSTANTIAL AND FINAL.

9.3.1 SUBSTANTIAL COMPLETION INSPECTION. Prior to requesting a Substantial Completion inspection, Contractor shall prepare a comprehensive initial punchlist, including unresolved items from prior inspections, for review by DFCM and the A/E to determine if the Work is ready for a Substantial Completion inspection. If DFCM and A/E determine that the initial punchlist indicates that the Work is not Substantially Complete, the initial punchlist shall be returned to Contractor with written comments. If DFCM and A/E determines that the initial punchlist indicates that the Work may be Substantially Complete, the A/E shall promptly organize and perform a Substantial Completion inspection in the presence of DFCM and all appropriate authorities.

9.3.1.1 If the A/E reasonably determines that the initial punchlist prepared by Contractor substantially understates the amount of the Work remaining to be completed and the Work is not Substantially Complete, the A/E shall report this promptly to DFCM, and upon concurrence of DFCM, Contractor shall be assessed the costs of the inspection and punchlist review incurred by the A/E and DFCM.

9.3.1.2 When the Work or designated portion thereof is Substantially Complete, the A/E shall prepare a Certificate of Substantial Completion which shall establish the date of Substantial Completion; shall establish responsibilities of DFCM and Contractor for security, maintenance, heat, utilities, damage to the Work, and insurance; and shall fix the time within which Contractor shall finish all items on the punchlist accompanying the Certificate ("Punchlist Completion Date"). The Certificate of Substantial Completion shall require approval by DFCM. If there is a punchlist, Contractor shall proceed promptly to complete and correct items on the punchlist. Failure to include an item on the punchlist does not alter the responsibility of Contractor to complete all Work in accordance with the Contract Documents.

9.3.1.3 Warranties required by the Contract Documents shall commence on the date of Substantial Completion of the Work or designated portion thereof except to the extent as provided otherwise in the Contract Documents or if such warranty is related to an item where the Work is not complete. Written warranties shall state the length of the warranty, which must comply with the Contract Documents.

9.3.1.4 The Certificate of Substantial Completion shall be submitted by the A/E to DFCM and Contractor for their written acceptance of responsibilities assigned to them in such Certificate.

9.3.1.5 Except to the extent DFCM otherwise approves in advance and in writing, Contractor shall submit the following documents in order to achieve Substantial Completion: written warranties, guarantees, operation and maintenance manuals, and all complete as-built drawings. Contractor shall also provide or obtain any required approvals for occupancy. Contractor shall be responsible for the guaranty of all Work, whether performed by it or by its Subcontractors and Sub-subcontractors at any tier.

9.3.2 FINAL COMPLETION INSPECTION. Prior to requesting a final inspection, Contractor shall verify all punchlist items are corrected and completed. Once all punchlist items are corrected and completed, Contractor shall notify DFCM and request a final inspection. DFCM shall notify the A/E and perform a final inspection. When all punchlist items are completed, a final Application for Payment shall be provided by Contractor, certified by the A/E, and processed by DFCM.

9.3.3 PUNCHLIST COMPLETION. As compensation to DFCM for administrative costs incurred by DFCM as a result of delay in final project close-out, for each day subsequent to the Punchlist Completion Date that Contractor fails to complete the punchlist and subject to Section 8.8.4, Contractor shall pay to DFCM five percent (5%) of the liquidated damages amount stated in the Contractor's Agreement.

9.4 CORRECTION OF WORK AND GUARANTY PERIOD.

9.4.1 CONTRACTOR CORRECT THE WORK. Contractor shall correct Work rejected by the A/E, an inspector or DFCM, or failing to conform to the requirements of the Contract Documents, whether observed before or after Substantial Completion and whether or not fabricated, installed or completed. Contractor shall bear the costs of correcting such rejected Work, including additional testing and inspections and compensation for the A/E's and inspector's services and expenses made necessary thereby.

9.4.2 GUARANTY AND CORRECTION AFTER SUBSTANTIAL COMPLETION. If within one year after the date of Substantial Completion of the Work or designated portion thereof, or after the date for commencement of warranties established under Section 9.2.1 or by terms of an applicable special warranty or guaranty required by the Contract Documents, any of the Work is found not to be in accordance with the requirements of the Contract Documents, including failure to perform for its intended purpose, Contractor shall correct it promptly after receipt of written notice from DFCM to do so, unless DFCM has previously given Contractor a written acceptance of such condition. The period of one year shall be extended with respect to portions of the Work first performed after Substantial Completion by the period of time between Substantial Completion and the actual performance of the Work. This obligation of Contractor under this Section 9.4.2 shall be operative notwithstanding the acceptance of the Work under the Contract Documents, the issuance of a final certificate of payment, partial or total occupancy and/or termination of Contractor's Agreement. DFCM shall give notice of observed defects with reasonable promptness; however, failure to give such notice shall not relieve Contractor of its obligation to correct the Work. All corrected Work shall be subject to a one-year guaranty period the same in all respects as the original Work, except that such guaranty period shall commence from the time of Substantial Completion of the corrected Work. This guaranty period does not affect DFCM's right to pursue any available remedies against Contractor, including, but not limited to, DFCM's right to pursue a cause of action for defective construction against Contractor within the time period established by Utah Code § 78B-2-225.

9.4.3 REMOVAL OF WORK.

9.4.3.1 Contractor shall promptly remove from the Work site all Work that DFCM and/or the A/E determines as being in nonconformance with the Contract Documents, whether incorporated or not.

9.4.3.2 Contractor shall promptly replace and re-execute any Work not in accordance with the Contract Documents without change in the Contract Price and/or Contract Time.

9.4.3.3 Contractor shall bear the expense of correcting destroyed or damaged construction, whether completed or partially completed, by DFCM or separate contractors destroyed or damaged by such removal or replacement.

9.4.3.4 If Contractor does not remove such rejected Work within a reasonable time, fixed by written notice, DFCM may have the Work removed and stored at the expense of Contractor.

9.4.3.5 If Contractor does not correct the nonconforming Work within a reasonable time, fixed by written notice, DFCM may correct it in accordance with Section 2.2.2 of these General Conditions.

9.4.4 NOT LIMIT OTHER OBLIGATIONS. Nothing contained in this Section 9.4 shall be construed to establish a period of limitation with respect to other obligations that Contractor may have under the Contract Documents. Establishment of the time period of one year as described in Section 9.4.2 relates only to the specific obligation of Contractor to correct the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish Contractor's liability with respect to Contractor's obligations other than specifically to correct the Work.

9.5 ADDITIONAL WARRANTIES.

9.5.1 IN GENERAL. In addition to any other provisions of this Article 9, the following warranties shall apply:

9.5.1.1 Contractor warrants to DFCM that materials and equipment furnished under the Contract Documents shall be of good quality and new, except to the extent otherwise required or expressly permitted by the Contract Documents.

9.5.1.2 Contractor also warrants to DFCM that the Work shall be free from defects not inherent in the quality required or expressly permitted and that the Work shall conform with the requirements of the Contract Documents. Work not conforming to said requirements, including substitutions not implemented by Change Order, Construction Change Directive, or ASI as provided in Article 7, may be considered defective at DFCM's option.

9.5.2 EXCLUSION. Unless due to the negligent or intentional act or omission of Contractor or those under the Contractor's control, or as otherwise stated in the Contract Documents, Contractor's guaranty excludes remedy for damage or defect caused by abuse, modifications not executed by Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear under normal usage.

9.5.3 FURNISH EVIDENCE ON REQUEST. If requested by the A/E or DFCM, Contractor shall furnish satisfactory evidence as to the type and quality of materials and equipment.

9.6 ACCEPTANCE OF NONCONFORMING WORK. If DFCM prefers to accept Work that is not in accordance with the requirements of the Contract Documents, DFCM may do so in writing instead of requiring its removal and correction, in which case the Contract Price shall be reduced as appropriate. Such adjustment shall be effectuated whether or not final payment has been made.

ARTICLE 10. INSURANCE AND BONDS.

10.1 CONTRACTOR'S LIABILITY INSURANCE.

10.1.1 IN GENERAL. The Contractor shall purchase and maintain in a company or companies lawfully authorized to do business in the State of Utah such insurance as will protect the Contractor from claims set forth below which may arise out of or result from the Contractor's operations and completed operations under the Contract and for which Contractor may be legally liable, whether such operations be by the Contractor or by a Subcontractor or by a Sub-subcontractor or anyone directly employed by them, or by anyone for whose acts they may be liable:

10.1.1.1 Claims under workers' compensation, disability benefit and other similar employee benefit acts that are applicable to the Work to be performed;

10.1.1.2 Claims for damages because of bodily injury, occupational sickness or disease, or death of the Contractor's employees;

10.1.1.3 Claims for damages because of bodily injury, sickness or disease, or death of any person other than the Contractor's employees;

10.1.1.4 Claims for damages insured by usual personal injury liability coverage;

10.1.1.5 Claims for damages, other than to the Work itself, because of injury to or destruction of tangible property, including loss of use resulting therefrom;

10.1.1.6 Claims for damages because of bodily injury, death of a person or property damage arising out of ownership, maintenance or use of a motor vehicle;

10.1.1.7 Claims for bodily injury or property damage arising out of completed operations;

10.1.1.8 Claims involving contractual liability insurance applicable to the Contractor's obligations under Section 4.12; and

10.1.1.9 If the Contract Documents require the Contractor to provide and/or the Contractor provides professional services, claims for damages because of negligent errors or omissions in the performance of professional services.

10.1.2 **COVERAGE.** Without limiting Contractor's obligations or liabilities hereunder, the Contractor shall, at its sole expense, purchase and maintain the following insurance coverages required by Section 10.1.1 of these General Conditions from insurers authorized to do business in the state of Utah and rated "A-" or better with a financial size category of class VII or larger by the A.M. Best Company. The following insurance coverages required by Section 10.1.1 of these General Conditions shall be procured with the following terms and insurance limits unless otherwise agreed in writing by DFCM and the Contractor:

10.1.2.1 Commercial General Liability Insurance covering all liabilities for personal injury and property damage arising in connection with the Work, with limits of liability of Five Million Dollars ($5,000,000.00) per each occurrence and in the aggregate.

10.1.2.2 Workers Compensation Insurance in compliance with all applicable laws of each jurisdiction in which the Work will be performed.

10.1.2.3 Employers Liability Insurance covering all liabilities for personal injuries of the Contractor's employees, with limits of liability of Five Million Dollars ($5,000,000.00) for each occurrence and in the aggregate.

10.1.2.4 If the Contract Documents require the Contractor to provide and/or the Contractor provides professional services, Professional Liability Insurance with limits of liability of Two Million Dollars ($2,000,000.00) for each claim and in the aggregate with a retroactive or effective date not later than the effective date of the Contractor's Agreement and with a deductible or self-insured retention of not greater than One Hundred Thousand Dollars ($100,000.00) per claim.

10.1.2.5 Automobile Liability Insurance, including coverages of owned, non-owned and hired vehicles covering all liabilities for personal injury and property damage arising from the use of motor vehicles, with combined single limits of liability of Two Million Dollars ($2,000,000.00) for each occurrence and in the aggregate.

10.1.2.6 If the Contractor is unable to obtain the insurance required by this Section 10.1, Contractor may carry excess liability insurance and/or umbrella insurance that, when combined with Contractor's primary coverage in a given category of insurance, brings the total coverage in such category to be not less than the amount required by this Section 10.1 for that category of insurance.

10.1.3 **ENDORSEMENTS.** The Contractor shall provide the following coverage endorsements for each category of insurance required by this Section 10.1, except in the case of Workers' Compensation Insurance, Employers' Liability Insurance and Professional Liability Insurance:

10.1.3.1 An endorsement including DFCM as an additional insured;

10.1.3.2 An endorsement including a cross liability clause, noting that each of the parties comprising the insured shall be considered as a separate entity, the insurance applies as if a separate policy has been issued to each party, and no "insured-versus-insured" exclusion exists in the policy.

10.1.3.3 An endorsement waiving all expressed or implied rights of subrogation against DFCM and the State of Utah.

10.1.4 TERMS. Except as otherwise expressly provided in Section 10.1.2, the insurance of the Contractor required to be maintained pursuant to this Section 10.1 shall be on the following terms:

10.1.4.1 All insurance shall begin no later than the effective date of the Contractor's Agreement and shall continue until the final completion of the Work and for a period of two (2) years following the final completion of the Work, provided, however, if the Contractor's Agreement is terminated prior to the final completion of the Work, such insurance shall continue for a period of two (2) years following the termination of the Contractor's Agreement.

10.1.4.2 Before performing any of the Work and after each time the policies are renewed or varied, the Contractor shall provide to DFCM certificates of insurance and endorsements consistent with this Section 10.1.4 and Sections 10.1.1, 10.1.2 and 10.1.3 of these General Conditions. If required by DFCM the Contractor shall deliver copies of the insurance policies providing the insurance coverages required by this Section 10.1, and all endorsements thereto.

10.1.4.3 All insurance shall not be varied to the detriment of DFCM, cancelled or allowed to lapse until thirty (30) days' prior written notice has been given to DFCM.

10.1.5 FAILURE TO PROVIDE. Should the Contractor at any time neglect or refuse to provide the insurance required by this Section 10.1, or should such insurance be canceled, DFCM shall have the right, but not the obligation, to procure the same at the cost and expense of the Contractor, and the cost thereof may be deducted by DFCM from any monies then due or thereafter to become due to the Contractor. If DFCM or the other Indemnified Parties are damaged by the failure of the Contractor to purchase or maintain insurance as required by this Section 10.1, the Contractor shall bear all reasonable costs, expenses and damages incurred by DFCM and/or the other Indemnified Parties arising from such failure to purchase or maintain the insurance required by this Section 10.1.

10.1.6 CERTIFICATES. The acceptance of delivery of any Certificates of Insurance or copies of insurance policies required to be purchased and maintained pursuant to the Contract Documents does not constitute approval or agreement by the recipient that the insurance requirements have been met or that those Certificates of Insurance or insurance policies comply with the Contract Documents.

10.1.7 NO LIMITATION. The Contractor shall procure such insurance coverages and such insurance limits for its insurance coverages that the Contractor, in its sole discretion, after consultation with its insurance and risk advisors, determines to be sufficient for Contractor's purposes given the risks of the project. This Section 10.1 sets forth DFCM's minimum insurance requirements; the Contractor may procure additional or broader insurance coverages or greater insurance limits than required by Section 10.1 at Contractor's expense. Nothing in Section 10.1 or elsewhere in the Contract Documents is intended to limit the Contractor's liability to DFCM or the Indemnified Parties to liabilities covered by the insurance coverages required by Section 10.1 or to the minimum insurance limits required of such insurance coverages by Section 10.1.

10.2 "BUILDER'S RISK" INSURANCE.

10.2.1 IN GENERAL. Provided that the Contractor's Agreement is for new buildings, structures, or construction projects, or for the alteration or repair of, or addition to existing buildings, structures, or improvements (an "Eligible Project"), DFCM shall maintain insurance to protect the interest of the Contractor, Subcontractors, or Sub-subcontractors subject to all of the terms, conditions, limitations, exclusions, waivers and/or endorsements stated in the Commercial Property Policy Declarations and Scheduled Forms available on DFCM's website, dfcm.utah.gov ("Builder's Risk Insurance").

10.2.2 DEDUCTIBLE. To the extent that the Builder's Risk Insurance provides for a deductible (including, without limitation, a specific loss deductible, cumulative loss deductible and/or sub-deductible), with respect to any damages or losses to property covered by the Builder's Risk Insurance caused in whole or in part by the negligence, breach of contractual duty or other fault of DFCM (or those for whom DFCM is responsible, including the A/E and the A/E's consultants) or the Contractor (or those for whom the Contractor is responsible, including the Contractor's Subcontractors and Sub-subcontractors of any tier), any deductible applicable to such covered damages or losses to property shall be paid by the party, whether DFCM or the Contractor, legally responsible for the negligence, breach of contractual duty or other fault that caused the losses or damages. If both DFCM and the Contractor are legally responsible in part for the negligence, breach of contractual duty or other fault that caused such losses or damages to property, DFCM and the Contractor shall pay any deductible applicable to such covered damages or losses to property in proportion to their comparative fault. With respect to any damages or losses to property covered by the Builder's Risk Insurance caused by an act of nature, such as the weather or other natural disasters, and not caused in whole or in part by the negligence, breach of contractual duty or other fault of DFCM (or those for whom DFCM is responsible, including the A/E and the A/E's consultants) or the Contractor (or those for whom the Contractor is responsible, including the Contractor's Subcontractors and Sub-subcontractors of any tier), DFCM and Contractor shall each pay half of the amount of any deductible to such covered damages or losses to property.

10.2.3 WAIVER OF SUBROGATION. DFCM and Contractor waive all rights against: (1) each other and the other Indemnified Parties and any of their subcontractors, sub-subcontractors, agents and employees, each of the other; and (2) the A/E, A/E's consultants, separate contractors described in Section 2.2, if any, and any of their subcontractors, sub-subcontractors, agents and employees, for damages caused by fire or other causes of loss to the extent covered by Builder's Risk Insurance obtained pursuant to Section 10.2.1 and maintained during the course of construction, but only to the extent of the actual recovery of insurance proceeds by the injured party, except such rights as they have to proceeds of such insurance held by DFCM as fiduciary. DFCM or Contractor, as appropriate, shall require of the A/E, A/E's consultants, separate contractors described in Section 2.2, if any, and the subcontractors, sub-subcontractors, agents and employees of any of them, by appropriate agreements, written where legally required for validity, similar waivers each in favor of other parties enumerated herein. The policies shall provide such waivers of subrogation by endorsement or otherwise. A waiver of subrogation shall be effective as to a person or entity even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, did not pay the insurance premium directly or indirectly, and whether or not the person or entity had an insurable interest in the property damaged. The waiver of rights under this Section 10.2.3 shall not include: (1) subject to Section 10.2.2, the right to recover amounts deducted or excluded from the insurance proceeds in the form of deductibles paid by the injured party; and (2) claims arising out of design errors or omissions.

10.2.4 SPECIAL HAZARDS. If the Contractor's Agreement is for an Eligible Project, but Contractor desires insurance coverage for risks other than those covered by the Builder's Risk Insurance, the Contractor may obtain such insurance, however, the cost thereof shall be borne by the Contractor and shall not be included in the Contract Price.

10.2.5 NON-ELIGIBLE PROJECTS. If the Contractor's Agreement is not for an Eligible Project, Contractor shall bear the risk of damage and/or loss to Contractor's materials, equipment and other property,

until acceptance of the Work by DFCM in writing, and no protection from damage and/or loss of the Work (including, without limitation, so called "builders risk", "course of construction", "inland marine" and/or similar property insurance) will be provided by DFCM for the protection of Contractor. Contractor may obtain insurance to cover such risks, however, the cost thereof shall be borne by the Contractor and shall not be included in the Contract Price. Section 10.2.3 shall not apply to Non-Eligible Projects.

10.3 PERFORMANCE BOND AND PAYMENT BOND. The Contractor shall furnish a Performance and Payment Bond naming the Contractor as Principal and DFCM and DFCM's designees as Obligees written on AIA Document A312 (2010) Performance Bond and Labor and Material Payment Bond forms in a penal sum of not less than the Contract Price for the Work as the Contract Price may be modified by Change Order (the "Bonds"). The cost of the Bonds, without mark-up, may be included in the Contract Price. The Contractor shall deliver the Bonds to DFCM at least three (3) days before the commencement of any Work at the Work site. Delivery of the Bonds may be accomplished *via* email. The Bonds shall be procured from a surety authorized to do business in the State of Utah and rated A- or better by the A.M. Best Company at the time of issuance of the Bonds and holding Certificates of Authority as an acceptable surety on federal bonds as listed by the United States Department of Treasury (Circular 570, as amended) in its most recent list at the time of issuance of the Bonds. The penal sum of the Bonds shall be within the maximum specified for such surety in Circular 570, as amended. The attorney-in-fact who executes the Bonds on behalf of the surety shall affix to the Bonds a certified and current copy of his or her power of attorney. If the surety on any of the Bonds furnished by the Contractor is declared a bankrupt or becomes insolvent or its rights to do business are terminated in the State of Utah or it ceases to meet the requirements of this Section 10.3, the Contractor shall within ten (10) calendar days thereafter substitute another bond and surety, both of which must be acceptable to DFCM. Upon the request of any person or entity appearing to be a potential beneficiary of bonds covering payment of obligations arising under the Contract, the Contractor shall promptly furnish a copy of the bonds or shall authorize a copy to be furnished.

ARTICLE 11. MISCELLANEOUS PROVISIONS.

11.1 A/E'S RESPONSIBILITIES. These General Conditions are not intended to provide an exhaustive or complete list of the A/E's responsibilities. A separate agreement between DFCM and the A/E incorporates these General Conditions by reference and includes additional design and contract administration responsibilities.

11.2 SUCCESSORS AND ASSIGNS. DFCM and Contractor respectively bind themselves, their partners, successors, assigns and legal representatives to the other party hereto and to partners, successors, assigns and legal representatives of such other party in respect to covenants, agreements and obligations contained in the Contract Documents. Contractor shall not assign Contractor's Agreement without the prior written consent of DFCM, nor shall Contractor assign any amount due or to become due or any of Contractor's rights under the Contract Documents, without prior written consent of DFCM.

11.3 WRITTEN NOTICE.

11.3.1 PERSONAL DELIVERY AND REGISTERED OR CERTIFIED MAIL. Written notice shall be deemed to have been duly served if delivered in person to the individual or a member of the firm or entity or to an officer of the corporation for which it was intended, or if delivered at or sent by registered or certified mail, return receipt requested, to the last business address known to the party giving notice.

11.3.2 E-MAIL. Notwithstanding any other provision of these General Conditions, written notice shall also be deemed to have been duly served by verified use of an e-mail system by using the known and operative e-mail address of the intended recipient. Service by use of the e-mail system is encouraged when timely notice shall benefit DFCM, the A/E, or Contractor. Notice shall be considered complete and verified upon the sending and confirmation of delivery using the e-mail system, if on the same day notice is also sent by registered or

certified mail, return receipt requested, to the last business address known to the party giving notice, confirming the e-mail delivery.

11.4 RIGHTS AND REMEDIES.

11.4.1 NOT LIMIT. Duties and obligations imposed by the Contract Documents and rights and remedies available thereunder shall be in addition to and not a limitation of duties, obligations, rights, and remedies otherwise imposed or available by law.

11.4.2 NO WAIVER. Except as expressly provided elsewhere in the Contract Documents, no action or failure to act by DFCM, the A/E, or Contractor shall constitute a waiver of a right or duty afforded them under the Contract Documents, nor shall such action or failure to act constitute approval or acquiescence in a breach thereunder, except as any of the above may be specifically agreed to in writing. In no case shall Contractor or any Subcontractors be entitled to rely upon any waiver of any of these General Conditions, unless agreed to in writing by DFCM.

11.5 NO DISCRIMINATION, NO SEXUAL HARASSMENT. Pursuant to the laws of the United States and the State of Utah, Contractor, Subcontractors, or anyone for whose act any of them may be liable, shall take affirmative action to not discriminate against any employee or applicant for employment because of race, creed, color, sex, religion, ancestry or national origin. To the extent applicable, said persons shall comply with all provisions of Executive Order No. 11246 dated September 24, 1965 and rules, regulations, orders, instructions, designations and other directives promulgated pursuant thereto. Contractor, Subcontractors, or anyone for whose act any of them may be liable, shall not act in any manner as would violate the laws, regulations, and policies of the United States or the State of Utah prohibiting sexual harassment.

11.6 APPLICABLE LAWS AND ENFORCEMENT. The Contract Documents shall be governed by and construed in accordance with the laws of the State of Utah, excluding any choice of law provisions that would otherwise require application of laws of any other jurisdiction.

11.7 INTERPRETATION. In the interest of brevity, the Contract Documents frequently omit modifying words such as “all” and “any” and articles such as “the” and “an”, but the fact that a modification or an article is absent from one statement and appears in another is not intended to affect the interpretation of either statement.

11.8 VENUE. In case of any dispute that may arise under the Contract Documents, the place of venue shall be in the County of Salt Lake, State of Utah, unless otherwise agreed to by all of the parties in writing.

11.9 SEVERABILITY. The invalidity of any provision or part of a provision of the Contract Documents shall not impair or affect in any manner the validity, enforceability, or effect of the remainder of the Contract Documents.

11.10 CONSTRUCTION OF WORDS. Unless otherwise stated in the Contract Documents, words which have well-known technical or construction industry meanings shall be construed as having such recognized meanings. Unless the context requires otherwise, all other technical words shall be construed in accordance with the meaning normally established by the particular, applicable profession or industry. All other words, unless the context requires otherwise, shall be construed with an ordinary, plain meaning.

11.11 NO THIRD-PARTY RIGHTS. These General Conditions create rights and duties only as between DFCM and Contractor, and DFCM and A/E. Nothing contained herein shall be deemed as creating third party beneficiary contract rights or other actionable rights or duties as between Contractor and A/E, or as between DFCM, Contractor, or A/E on the one hand, and any other person or entity.

ARTICLE 12. TERMINATION OR SUSPENSION OF THE CONTRACT.

12.1 TERMINATION BY CONTRACTOR FOR CAUSE.

12.1.1 IN GENERAL. If the Work is stopped for a period of sixty (60) days through no act or fault of the Contractor or a Subcontractor, or their agents or employees or any other persons performing portions of the Work under contract with any of the above, the Contractor may terminate the Contractor's Agreement in accordance with Section 12.1.2 for any of the following reasons:

12.1.1.1 Because DFCM has persistently failed to fulfill material obligations of DFCM under the Contract Documents with respect to matters important to the progress of the Work;

12.1.1.2 Issuance of an order of a court or other public authority having jurisdiction which necessitates such termination, except that where the Contractor has standing, the Contractor must cooperate in efforts to stay and/or appeal such order;

12.1.1.3 An act of government, such as a declaration of national emergency, making material unavailable; or

12.1.1.4 Unavoidable casualties or other similar causes.

12.1.2 NOTICE. If one of the reasons for termination in Section 12.1.1 exists, the Contractor may, upon fourteen (14) additional days' written notice to DFCM and A/E, and such condition giving cause for termination still not cured, terminate Contractor's Agreement and recover from DFCM payment for Work properly executed as of the date of termination, including profit and overhead on Work properly completed as of the date of termination, on a percentage completion basis, along with Contractor's reasonable demobilization expenses incurred within seven (7) days of termination, but Contractor shall in no event be entitled to recover consequential damages as a result of such termination or profit and/or overhead on the Work not executed.

12.2 TERMINATION BY DFCM FOR CAUSE.

12.2.1 IN GENERAL. DFCM may terminate the Contractor's Agreement if Contractor fails to cure any of the following within a period of seven (7) days (or longer if DFCM so approves in writing) after receipt of notice from DFCM specifying the breach or failure:

12.2.1.1 Contractor refuses or fails to supply enough properly skilled workers or proper materials;

12.2.1.2 Contractor fails to make payment to Subcontractors for materials, equipment, or labor;

12.2.1.3 Contractor disregards laws, ordinances, rules, regulations, or orders of a public authority having jurisdiction;

12.2.1.4 Contractor fails to perform the Work such that the Work will be Substantially Completed within the Contract Time or Contractor fails to make progress with the Work as required by the Contract Documents;

12.2.1.5 Contractor fails to perform the Work in accordance with the Contract Documents or is otherwise in breach of a material provision of the Contract Documents;

12.2.1.6 As permissible by law for a reason to terminate, Contractor is adjudged bankrupt;

12.2.1.7 As permissible by law for a reason to terminate, Contractor should make a general assignment for the benefit of creditors;

12.2.1.8 As permissible by law for a reason to terminate, Contractor should have a receiver appointed on account of Contractor's insolvency; or

12.2.1.9 Contractor fails to follow safety requirements and precautions either as expressly provided in the Contract Documents or as consistent with the customary practices in the industry.

12.2.2 DFCM'S RIGHT TO CARRY OUT THE WORK UPON TERMINATION FOR CAUSE. If Contractor fails to remedy the breach or failure within seven (7) days or other mutually agreed period after notice from DFCM, DFCM may, without prejudice to other remedies available to DFCM and in addition to enforcement of any other of DFCM's rights, terminate the Contractor's Agreement, take possession of the Work site and all materials, finish the Work by whatever reasonable method DFCM may deem expedient, and charge Contractor, or file a claim against Contractor's bankruptcy estate, for any additional costs incurred by DFCM to complete the Work. Contractor shall not be entitled to receive any further payment until the Work is completed, nor shall Contractor be relieved from its obligations and liabilities assumed under the Contractor's Agreement. If DFCM's costs exceed the amount of any payment(s) owed by DFCM to Contractor subject to offset by DFCM, DFCM may bill Contractor for the difference, which Contractor shall pay within twenty-eight (28) days of receipt of DFCM's invoice.

12.2.3 ITEMS REQUIRED TO BE TRANSFERRED OR DELIVERED. DFCM may require Contractor to transfer title and deliver to DFCM, in the manner and to the extent directed by DFCM:

12.2.3.1 Any completed portion of the Work; and

12.2.3.2 Any partially completed portion of the Work and any parts, tools, dies, jigs, fixtures, drawings, information, and contract rights as Contractor has specifically produced or specifically acquired for the performance of such part of the Work as has been terminated; and Contractor shall, upon direction of DFCM, protect and preserve property in the possession of Contractor in which DFCM has an interest.

12.2.4 PAYMENT. When DFCM terminates Contractor's Agreement for one or more of the reasons stated in Section 12.2.1, DFCM may withhold payment and/or pursue all available remedies.

12.2.5 DFCM PROTECTION IF LIENABLE. When the Work is lienable, DFCM may withhold from amounts otherwise due Contractor for such Work such amount as DFCM determines to be necessary to protect the State against loss because of liens.

12.2.6 CREDITS AND DEFICITS. If the unpaid balance of the Contract Price exceeds the full cost of finishing the Work, including compensation for the A/E's services and expenses made necessary thereby, such excess shall be paid to Contractor. If such cost exceeds the unpaid balance of the Contract Price, Contractor shall pay the difference to DFCM and this obligation for payment shall survive the termination of Contractor's Agreement.

12.2.7 IF CONTRACTOR FOUND NOT IN DEFAULT OR EXCUSABLE. If, after notice of termination of Contractor's Agreement under the provisions of Section 12.2, it is determined for any reason that Contractor was not in default under the provisions of Section 12.2, or that the default was excusable under the provisions of Section 12.2, the rights and obligations of the parties shall be the same as if the notice of termination had been issued pursuant to the termination for convenience provisions of Section 12.3.

12.2.8 RIGHTS AND REMEDIES NOT EXCLUSIVE. The rights and remedies of DFCM provided in this Section 12.2 shall not be exclusive and are in addition to any other rights and remedies provided by law or under the Contract Documents.

12.2.9 TIME PERIOD FOR CLAIMS. Any PRE by Contractor for adjustment under this Section 12.2 must be asserted by Contractor, in writing, within twenty-one (21) days from the date of termination; provided that DFCM may, in its sole discretion, receive and act upon any such PRE asserted at any time prior to final payment under Contractor's Agreement.

12.3 TERMINATION FOR CONVENIENCE OF DFCM.

12.3.1 IN GENERAL. The performance of Work under Contractor's Agreement may be terminated by DFCM in accordance with this Section 12.3 in whole or in part, or from time to time, whenever DFCM shall determine that such termination is in the best interest of DFCM or any person or entity for whom DFCM is acting under Contractor's Agreement. Any such termination shall be effectuated by delivery to Contractor of a notice of termination specifying the extent to which performance of Work is terminated and the date upon which such termination becomes effective.

12.3.2 CONTRACTOR OBLIGATIONS. After receipt of a notice of termination, and except as otherwise directed by DFCM in writing, the Contractor shall:

12.3.2.1 Stop Work under Contractor's Agreement on the date and to the extent specified in the notice of termination;

12.3.2.2 Place no further orders or subcontracts for materials, services or facilities, except as may be necessary for completion of such portion of the Work that is not terminated;

12.3.2.3 Terminate all orders and subcontracts to the extent that they relate to performance of Work terminated by the notice of termination;

12.3.2.4 Assign to DFCM in the manner, at the times, and to the extent directed by DFCM, all of the right, title, and interest of Contractor under the orders and subcontracts so terminated, in which case DFCM shall have the right, in its discretion, to settle or pay any or all claims arising out of the termination of such orders and subcontracts;

12.3.2.5 Settle all outstanding liabilities and all claims arising out of such termination of orders and subcontracts, with the approval or ratification of DFCM, which approval or ratification shall be final for all the purposes of this Section 12.3;

12.3.2.6 Transfer title and deliver to DFCM in the manner, at the times, and to the extent, if any, directed by DFCM:

12.3.2.6.1 The fabricated or unfabricated parts, Work in process, completed Work, supplies, and other material produced as a part of, or acquired in connection with the performance of the Work terminated by the notice of termination; and

12.3.2.6.2 The completed or partially completed drawings, information, and other property which, if Contractor's Agreement had been completed, would have been required to be furnished to DFCM;

12.3.2.7 Use best efforts to sell, in the manner, at the times, to the extent, and at the price or prices directed or authorized by DFCM, any property of the types referred to in Section 12.3.2.6; provided, however, that Contractor:

12.3.2.7.1 Shall not be required to extend credit to any purchaser; and

12.3.2.7.2 Shall dispose of any such property under the conditions prescribed by and at a price or prices approved by DFCM; and provided further that the proceeds of any such transfer of or disposition shall be applied in reduction of any payments to be made by DFCM to Contractor under Contractor's Agreement or shall otherwise be credited against the Contract Price or paid in such other manner as DFCM may direct;

12.3.2.8 Complete performance of such part of the Work as shall not have been terminated by the notice of termination; and

12.3.2.9 Take such action as may be necessary, or as DFCM may direct, for the protection and preservation of the property related to Contractor's Agreement which is in the possession of Contractor in which the State of Utah has or may acquire an interest.

12.3.3 TERMINATION CLAIM. After receipt of a notice of termination, Contractor may submit to DFCM a PRE, in the form and with certification prescribed by DFCM. Such PRE shall be submitted promptly but in no event not later than twenty-one (21) days from the effective date of termination.

12.3.4 AGREED UPON PAYMENT. Subject to the provisions of Section 12.3.3 above, Contractor and DFCM may agree upon the amount to be paid to Contractor by reason of the total or partial termination of Work pursuant to this Section 12.3.

12.3.5 PAYMENT NOT AGREED UPON. In the event Contractor and DFCM fail to agree as provided in Section 12.3.4 upon the whole amount to be paid to Contractor by reason of the termination of Work pursuant to this Section 12.3, DFCM shall pay to the Contractor the amounts determined by DFCM as follows, but without duplication of any amounts agreed upon in accordance with Section 12.3.4:

12.3.5.1 With respect to all Work performed prior to effective date of termination, the total (without duplication of any items) of:

12.3.5.1.1 The cost of such Work including undisputed Claim amounts;

12.3.5.1.2 The cost of terminating, settling and paying claims arising out of the termination of Work under subcontracts or orders as provided in Section 12.3.2.5, exclusive of the amounts paid or payable on account of supplies or materials delivered or services furnished by Subcontractors prior to the effective date of termination under Contractor's Agreement, which amounts shall be included in the cost on account of which payment is made under Section 12.3.5.1.1;

12.3.5.1.3 An amount, as overhead and profit on Section 12.3.5.1.1 above, determined by DFCM to be fair and reasonable;

12.3.5.1.4 The reasonable cost of the preservation and protection of property incurred pursuant to Section 12.3.2.9; and any other reasonable cost incidental to termination of Work, including expenses incidental to the determination of the amount due to Contractor as the result of the termination of Work.

12.3.5.1.5 The total amount to be paid to Contractor under Section 12.3.5.1 above shall not exceed the Contract Price as reduced by the amount of payments otherwise made and as further reduced by the Contract Price of Work not terminated. Except for normal spoilage, and except to the extent that DFCM shall have otherwise expressly assumed the risk of loss in writing, there shall be excluded from the amounts payable to Contractor under Section 12.3.5.1 above, the fair value of property which is destroyed, lost, stolen, or damaged so as to become undeliverable to DFCM, or to a buyer pursuant to Section 12.3.2.7.

12.3.6 DEDUCTIONS. In arriving at the amount due Contractor under this Section 12.3, there shall be deducted:

12.3.6.1 All unliquidated advance or other payments on account theretofore made to the Contractor, applicable to the terminated portion of Contractor's Agreement;

12.3.6.2 Any Claim which DFCM and/or the State of Utah may have against Contractor in connection with Contractor's Agreement; and

12.3.6.3 The agreed price for, or the proceeds of sale of, any materials, supplies, or other things acquired by Contractor or sold, pursuant to the provisions of this Section 12.3, and not otherwise recovered by or credited to DFCM.

12.3.7 PARTIAL TERMINATION. If the termination is partial, Contractor may file with DFCM a PRE for the amounts specified in Contractor's Agreement relating to the continued portion of Contractor's Agreement and such equitable adjustment as may be agreed upon shall be made in such amounts. Any PRE under this Section 12.3.7 must be filed within twenty-one (21) days from the effective date of the partial termination.

12.3.8 PARTIAL PAYMENTS. DFCM may, from time to time, under such terms and conditions as it may prescribe, make partial payments and payments on account against costs incurred by Contractor in connection with the terminated portion of Contractor's Agreement whenever, in the opinion of DFCM, the aggregate of such payments shall be within the amount to which Contractor shall be entitled hereunder. If the total of such payments is in excess of the amount finally agreed or determined to be due under this Section 12.3, such excess shall be payable by Contractor to DFCM upon demand, together with interest at a rate stated in Utah Code § 15-1-1, for the period until the date such excess is repaid to DFCM; provided, however, that no interest shall be charged with respect to any such excess payment attributable to a reduction in Contractor's claim by reason of retention or other disposition of termination inventory until fourteen (14) days after the date of such retention or disposition, or such later date as determined by DFCM by reason of the circumstances.

12.3.9 PRESERVE AND MAKE AVAILABLE RECORDS. Unless otherwise provided for in Contractor's Agreement, or by applicable law, Contractor shall, from the effective date of termination until the expiration of three years after final settlement under Contractor's Agreement, preserve and make available to DFCM at all reasonable times at the office of Contractor, but without charge to DFCM, all books, records, documents, and other evidence bearing on the costs and expenses of Contractor under Contractor's Agreement and relating to the Work terminated hereunder, or, to the extent approved by DFCM, photographs, or other authentic reproductions thereof.

12.3.10 SUSPENSION, DELAY OR INTERRUPTION OF WORK BY DFCM FOR CONVENIENCE. DFCM may in writing and without cause, order Contractor to suspend, delay, or interrupt the Work, in whole or in part, for such period of time as DFCM may determine to be appropriate for the convenience of DFCM.

12.4 DFCM'S RIGHT TO STOP THE WORK. If Contractor fails to correct Work or fails to carry out Work as required by the Contract Documents or fails to comply with all required and customary safety precautions; DFCM, in writing, may order Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, the right of DFCM to stop the Work shall not give rise to a duty on the part of DFCM to exercise this right for the benefit of Contractor or any other person or entity.

SECTION 011000
SUMMARY

PART 1 GENERAL

1.01 PROJECT

A. Project Name: USU Bastian Agricultural Center - Arena Building.

B. Owner's Name: State of Utah, Division of Facilities Construction and Management and Utah State University.
   1. DFCM Project No. 25401770

C. Architect's Name: Method-Studio, 360 West Aspen Avenue, Salt Lake City, Utah 84101; 801.532.4422; Contact: Kelly Morgan

D. Architect's Consultants: The Architect has retained the following design professionals who have prepared designated portions of the Contract Documents:
   1. Civil Engineer: Ensign Engineering; Contact: David Jenkins
   2. Structural Engineer: Ensign Engineering; Contact: Cody Santos
   3. Mechanical Engineer: Spectrum Engineers; Contact: Tyler Anderson
   4. Electrical Engineer: Spectrum Engineers; Contact: Joshua Nett

1.02 WORK COVERED BY CONTRACT DOCUMENTS

A. The work of the Project is defined by the Contract Documents the Drawings and Specifications of Divisions 00 thru 33 for the project to include, but is not limited to; Construction of a pre-fabricated metal building (1 story tall and about 50,000 sf) containing a soil arena area, concrete slab patron/viewing area with bleacher seating, restrooms and support closets. Selected site work per the drawings, including grading cut/fill, minimal sidewalks, and underground utility work. Selected existing buildings to be demolished onsite, refer to civil demolition drawing.

1.03 CONTRACT DESCRIPTION

A. Contract Type: A single prime contract.

1.04 WORK RESTRICTIONS

A. On-Site Work Hours: Comply with Owner limitations and with other requirements of authorities having jurisdiction.

B. Hours for Utility Shutdowns: Only allowed as directly approved and coordinated with Owner and as approvals are required by authorities having jurisdiction.

C. Hours for Noisy Activities: Restricted only by local authorities.

D. Comply with limitations on use of public streets and with other requirements of surrounding neighbors and authorities having jurisdiction.

E. Controlled Substances: Use of tobacco products and other controlled substances on Project site is not permitted.

1.05 WORK BY OWNER

A. General: Cooperate fully with Owner so work may be carried out smoothly, without interfering with or delaying work under this Contract or work by Owner. Coordinate the Work of this Contract with work performed by Owner.

1.06 OWNER OCCUPANCY

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

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

C. Schedule the Work to accommodate Owner occupancy.

1.07 CONTRACTOR USE OF SITE

A. Construction Operations: Limited to areas noted on Drawings.

B. 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.

1.08 WORK SEQUENCE

1.09 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
   1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
   2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
   3. Where standards or requirements outlined in the specifications conflict with State of Utah 2023 DFCM standards, DFCM standards shall supersede the specification, unless a waiver of requirements has been granted. The Contractor is responsible for familiarizing themselves with DFCM requirements and standards.

B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
   1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
   2. Abbreviations: Materials and products are identified by abbreviations and scheduled on Drawings.
   3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

1.10 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

J. “Product”: Material, machinery, components, equipment, fixtures, and systems forming the work result. Not materials or equipment used for preparation, fabrication, conveying, or erection and not incorporated into the work result. Products may be new, never before used, or re-used materials or equipment.

K. “Project Manual”: The book-sized volume that includes available project information, the procurement requirements (if any), the contracting requirements, and the specifications.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 011000

SECTION 012000
PRICE AND PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedures for preparation and submittal of applications for progress payments.

B. Documentation of changes in Contract Sum and Contract Time.

C. Change procedures.

D. Correlation of Contractor submittals based on changes.

E. Procedures for preparation and submittal of application for final payment.

1.02 RELATED REQUIREMENTS

A. Section 005200 - Agreement Form: Contract Sum, retainages, payment period, monetary values of unit prices.

B. Section 007200 - General Conditions: Additional requirements for progress payments, final payment, changes in the Work.

C. Section 007300 - Supplementary Conditions: Percentage allowances for Contractor's overhead and profit.

D. Section 017800 - Closeout Submittals: Project record documents.

1.03 SCHEDULE OF VALUES

A. Use Schedule of Values Form: AIA G703, edition stipulated in the Agreement.

B. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit draft to Architect for approval.

C. Forms filled out by hand will not be accepted.

D. Submit Schedule of Values in duplicate within 15 days after date of Owner-Contractor Agreement.

E. Format: Utilize the Table of Contents of this Project Manual. Identify each line item with number and title of the specification section. Identify site mobilization.

F. Include separately from each line item, a direct proportional amount of Contractor's overhead and profit.

G. Revise schedule to list approved Change Orders, with each Application For Payment.

1.04 APPLICATIONS FOR PROGRESS PAYMENTS

A. Payment Period: Submit at intervals stipulated in the Agreement.

B. Use Form AIA G702 and Form AIA G703, edition stipulated in the Agreement.

C. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit sample to Architect for approval.

D. Forms filled out by hand will not be accepted.

E. Execute certification by signature of authorized officer.

F. Submit one electronic and three hard-copies of each Application for Payment.

G. When Architect requires substantiating information, submit data justifying dollar amounts in question. Provide one copy of data with cover letter for each copy of submittal. Show application number and date, and line item by number and description.

1.05 MODIFICATION PROCEDURES

A. For minor changes not involving an adjustment to the Contract Sum or Contract Time, Architect will issue instructions directly to Contractor.

B. For other required changes, Architect will issue a document signed by Owner instructing Contractor to proceed with the change, for subsequent inclusion in a Change Order.
   1. The document will describe the required changes and will designate method of determining any change in Contract Sum or Contract Time.
   2. Promptly execute the change.

C. For changes for which advance pricing is desired, Architect will issue a document that includes a detailed description of a proposed change with supplementary or revised drawings and specifications, a change in Contract Time for executing the change with a stipulation of any overtime work required and the period of time during which the requested price will be considered valid. Contractor shall prepare and submit a fixed price quotation within 7 days.

D. Computation of Change in Contract Amount: As specified in the Agreement and Conditions of the Contract.

E. Substantiation of Costs: Provide full information required for evaluation.
   1. Provide the following data:
      a. Quantities of products, labor, and equipment.
      b. Taxes, insurance, and bonds.
      c. Overhead and profit.
      d. Justification for any change in Contract Time.
      e. Credit for deletions from Contract, similarly documented.

F. Execution of Change Orders: Architect will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.

G. After execution of Change Order, promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Sum.

H. Promptly revise progress schedules to reflect any change in Contract Time, revise sub-schedules to adjust times for other items of work affected by the change, and resubmit.

I. Promptly enter changes in Project Record Documents.

1.06 APPLICATION FOR FINAL PAYMENT

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

B. Application for Final Payment will not be considered until the following have been accomplished:
   1. All closeout procedures specified in Section 017000.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 012000

SECTION 012200
UNIT PRICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. List of unit prices, for use in preparing Bids.

B. Measurement and payment criteria applicable to Work performed under a unit price payment method.

C. Defect assessment and non-payment for rejected work.

1.02 RELATED REQUIREMENTS

A. Document 002113 - Instructions to Bidders: Instructions for preparation of pricing for Unit Prices.

B. Document 004322 - Unit Prices Form: List of Unit Prices as supplement to Bid Form

1.03 COSTS INCLUDED

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

1.04 UNIT QUANTITIES SPECIFIED

A. Quantities indicated in the Bid Form are for bidding and contract purposes only. Quantities and measurements of actual Work will determine the payment amount.

1.05 MEASUREMENT OF QUANTITIES

A. Measurement methods delineated in the individual specification sections complement the criteria of this section. In the event of conflict, the requirements of the individual specification section govern.

B. Assist by providing necessary equipment, workers, and survey personnel as required.

1.06 PAYMENT

A. Payment for Work governed by unit prices will be made on the basis of the actual measurements and quantities of Work that is incorporated in or made necessary by the Work and accepted by the Architect, multiplied by the unit price.

B. Payment will not be made for any of the following:
   1. Products wasted or disposed of in a manner that is not acceptable.
   2. Products determined as unacceptable before or after placement.
   3. Products not completely unloaded from the transporting vehicle.
   4. Products placed beyond the lines and levels of the required Work.
   5. Products remaining on hand after completion of the Work.
   6. Loading, hauling, and disposing of rejected Products.

1.07 DEFECT ASSESSMENT

A. Replace Work, or portions of the Work, not complying with specified requirements.

B. If, in the opinion of Architect, it is not practical to remove and replace the Work, Architect will direct one of the following remedies:
   1. The defective Work may remain, but the unit price will be adjusted to a new unit price at the discretion of Architect.
   2. The defective Work will be partially repaired to the instructions of the Architect, and the unit price will be adjusted to a new unit price at the discretion of Architect.

C. If, in the opinion of Owner, it is not practical to remove and replace the Work, Owner will direct one of the following remedies:

1. The defective Work may remain, but the unit price will be adjusted to a new unit price at the discretion of Owner.
2. The defective Work will be partially repaired to the instructions of the Owner, and the unit price will be adjusted to a new unit price at the discretion of Owner.

D. The individual specification sections may modify these options or may identify a specific formula or percentage price reduction.

E. The authority of Architect to assess the defect and identify payment adjustment is final.

F. The authority of Owner to assess the defect and identify payment adjustment is final.

1.08 SCHEDULE OF UNIT PRICES

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 012200

SECTION 012300
ALTERNATES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes administrative and procedural requirements for alternates.

1.03 DEFINITIONS

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

1.04 PROCEDURES

A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
   1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.

B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated revisions to alternates.

C. Execute accepted alternates under the same conditions as other work of the Contract.

D. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

E. Acceptance of Alternates will be exercised at option of Owner in any order or combination.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SCHEDULE OF ALTERNATES

A. Additive Alternate No 1 - Increased Insulation:
   1. Provide all material, equipment, and labor required to complete and furnish the higher R-value spray foam wall and roof insulation as outlined in spec section 0721190 Foamed-in-place Insulation.

END OF SECTION 012300

SECTION 012500
SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedural requirements for proposed substitutions.

1.02 RELATED REQUIREMENTS

A. Section 002113 - Instructions to Bidders: Restrictions on timing of substitution requests.

B. Section 013000 - Administrative Requirements: Submittal procedures, coordination.

C. Section 016000 - Product Requirements: Fundamental product requirements, product options, delivery, storage, and handling.

D. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions: Restrictions on emissions of indoor substitute products.

1.03 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
   1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
   2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.04 SUBMITTALS

A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
   1. Substitution Request Form: Use CSI Form 13.1A.
   2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
      a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
      b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
      c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
      d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
      e. Samples, where applicable or requested.
      f. Certificates and qualification data, where applicable or requested.
      g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
      h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
      i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.

j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
k. Cost information, including a proposal of change, if any, in the Contract Sum.
l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
   a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.
   b. Use product specified if Architect does not issue a decision on use of a proposed substitution within time allocated.

1.05 QUALITY ASSURANCE

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

1.06 PROCEDURES

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

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
   1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
      a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
      b. Requested substitution provides sustainable design characteristics that specified product provided.
      c. Substitution request is fully documented and properly submitted.
      d. Requested substitution will not adversely affect Contractor's construction schedule.
      e. Requested substitution has received necessary approvals of authorities having jurisdiction.
      f. Requested substitution is compatible with other portions of the Work.
      g. Requested substitution has been coordinated with other portions of the Work.
      h. Requested substitution provides specified warranty.
      i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Architect will consider requests for substitution if received within 60 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Architect.
   1. Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
      a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Architect for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
      b. Requested substitution does not require extensive revisions to the Contract Documents.
      c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
      d. Requested substitution provides sustainable design characteristics that specified product provided.
      e. Substitution request is fully documented and properly submitted.
      f. Requested substitution will not adversely affect Contractor's construction schedule.
      g. Requested substitution has received necessary approvals of authorities having jurisdiction.
      h. Requested substitution is compatible with other portions of the Work.
      i. Requested substitution has been coordinated with other portions of the Work.
      j. Requested substitution provides specified warranty.
      k. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

END OF SECTION 012500

SECTION 012600
CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

B. Related Requirements:
   1. Section 01 2500 "Substitution Procedures" for administrative procedures for handling requests for substitutions made after the Contract award.

1.03 MINOR DETAILS & CHANGES IN THE WORK

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

1.04 PROPOSAL REQUESTS

A. Owner-Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
   1. Work Change Proposal Requests issued by Architect are not instructions either to stop work in progress or to execute the proposed change.
   2. Within time specified in Proposal Request after receipt of Proposal Request, submit a Proposed Change Order quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
      a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
      b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
      c. Include costs of labor and supervision directly attributable to the change, including labor rates and estimated labor hours.
      d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
      e. Additional costs, labor, and/or rework made necessary because the Contractor failed to return a Proposed Change Order within the specified time are the liability of the Contractor and should not be included in adjustments to the Contract Sum and the Contract Time.
      f. Proposed Change Order Quotation Form: Use forms acceptable to Architect.

B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect.
   1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
   2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
   3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.

4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Section 01 2500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.
7. Proposal Request Form: Use form acceptable to Architect.

1.05 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Work Changes Proposal Request or Proposed Change Order, Architect will issue a Change Order for signatures of Owner and Contractor on AIA Document G701.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 012600

SECTION 013000
ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General administrative requirements.

B. Electronic document submittal service.

C. Preconstruction meeting.

D. Progress meetings.

E. Preinstallation conferences.

F. Construction progress schedule.

G. Contractor's daily reports.

H. Coordination drawings.

I. Requests for Information (RFI) procedures.

J. Submittals for review, information, and project closeout.

K. Number of copies of submittals.

L. Submittal procedures.

M. Delegated-Design Services

1.02 RELATED REQUIREMENTS

A. Section 007200 - General Conditions: Dates for applications for payment.

B. Section 007300 - Supplementary Conditions: Duties of the Construction Manager.

C. Section 013200 - MS Construction Progress Documentation: For construction schedule and reports.

D. Section 013216 - Construction Progress Schedule: Form, content, and administration of schedules.

E. Section 016000 - Product Requirements: General product requirements.

F. Section 017000 - Execution and Closeout Requirements: Additional coordination requirements.

G. Section 017800 - Closeout Submittals: Project record documents; operation and maintenance data; warranties and bonds.

H. Section 017900 - Demonstration and Training: For submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.03 REFERENCE STANDARDS

A. AIA G716 - Request for Information; 2004.

B. AIA G810 - Transmittal Letter; 2001.

1.04 GENERAL ADMINISTRATIVE REQUIREMENTS

A. Comply with requirements of Section 017000 - Execution and Closeout Requirements for coordination of execution of administrative tasks with timing of construction activities.

B. Make the following types of submittals to Architect:
   1. Requests for Information (RFI).
   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 ELECTRONIC DOCUMENTS

A. All documents transmitted for purposes of administration of the contract are to be in electronic (PDF, MS Word, or MS Excel) format, as appropriate to the document, and transmitted via an Internet-based submittal that notifies addressees via email.
   1. Besides submittals for review, information, and closeout, electronic document requirements applies to Requests for Interpretation (RFIs), progress documentation, contract modification documents (e.g. supplementary instructions, change proposals, change orders), applications for payment, field reports and meeting minutes, Contractor's correction punchlist, and any other document any participant wishes to make part of the project record.
   2. It is Contractor's responsibility to submit documents in allowable format.
   3. Electronic document requirements do not apply to samples or color selection charts.

3.02 PRECONSTRUCTION MEETING

A. Schedule meeting before starting construction coordinated with attendees immediately after execution of the Agreement.

B. Attendance Required:
   1. Owner.
   2. Architect.
   3. Contractor.

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 key personnel and their duties representing the parties to Contract and Architect.
   7. Lines of communications.
   8. Scheduling with tentative construction schedule.
   9. Phasing.
   10. Critical work sequencing and long-lead items.
   11. Procedures for processing field decisions and Change Orders.
   12. Procedures for RFIs.
   13. Procedures for testing and inspecting.
   14. Procedures for processing Applications for Payment.
   15. Distribution of the Contract Documents.
   16. Submittal procedures.
   17. Preparation of record documents.
   18. Use of the premises.
   19. Work restrictions.
   20. Working hours.
   21. Owner's occupancy requirements.
   22. Responsibility for temporary facilities and controls.
   23. Procedures for moisture and mold control.

24. Procedures for disruptions and shutdowns.
25. Construction waste management and recycling.
26. Parking availability.
27. Office, work, and storage areas.
28. Equipment deliveries and priorities.
29. First aid.
30. Security.
31. Progress cleaning.

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

3.03 PROGRESS MEETINGS

A. Schedule and administer meetings throughout progress of the work at regular intervals agreeable to participants and the work.

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

C. Attendees: In addition to representatives of Contractor, Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.

D. Agenda:
1. Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
2. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
   a. Review schedule for next period.
3. Review present and future needs of each entity present, including the following:
   a. Interface requirements.
   b. Sequence of operations.
   c. Status of submittals.
   d. Deliveries.
   e. Off-site fabrication.
   f. Access.
   g. Site utilization.
   h. Temporary facilities and controls.
   i. Progress cleaning.
   j. Quality and work standards.
   k. Status of correction of deficient items.
   l. Field observations.
   m. Status of RFIs.
   n. Status of proposal requests.
   o. Pending changes.
   p. Status of Change Orders.
   q. Pending claims and disputes.
   r. Documentation of information for payment requests.
4. Other business relating to work.

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

3.04 PREINSTALLATION CONFERENCES

A. Conduct a preinstallation conference at Project site before each construction activity that requires coordination with other construction.

B. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect of scheduled meeting dates.

C. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:
   1. Contract Documents.
   2. Options.
   3. Related RFIs.
   4. Related Change Orders.
   5. Purchases.
   6. Deliveries.
   7. Submittals.
   8. Review of mockups.
   9. Possible conflicts.
   10. Compatibility requirements.
   11. Time schedules.
   12. Weather limitations.
   13. Manufacturer's written instructions.
   14. Warranty requirements.
   15. Compatibility of materials.
   16. Acceptability of substrates.
   17. Temporary facilities and controls.
   18. Space and access limitations.
   19. Regulations of authorities having jurisdiction.
   20. Testing and inspecting requirements.
   21. Installation procedures.
   22. Coordination with other work.
   23. Required performance results.
   24. Protection of adjacent work.
   25. Protection of construction and personnel.

D. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.

E. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.

F. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

3.05 CONSTRUCTION PROGRESS SCHEDULE

A. If preliminary schedule requires revision after review, submit revised schedule within 10 days.

B. 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.

C. Within 10 days after joint review, submit complete schedule.

D. Submit updated schedule with each Application for Payment.

3.06 DAILY CONSTRUCTION REPORTS

A. Prepare a daily construction report recording the following information concerning events at Project site and project progress:
   1. Date.
   2. Site Conditions: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.
   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. Meter readings and similar recordings.
   12. Services connected and disconnected.
   13. Emergency procedures.
   14. Directives and requests of Authority(s) Having Jurisdiction (AHJ).
   15. Change Orders received and implemented.
   16. Testing and/or inspections performed.
   17. Equipment or system tests and startups.
   18. Partial completions and occupancies.
   19. Substantial Completions authorized.

3.07 COORDINATION DRAWINGS

A. Coordination Drawings (or Building Information Models), General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
   1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts.
      a. Describe relationship of various systems and components.
      b. Coordinate the addition of trade-specific information to coordination drawings in a sequence that best provides for coordination of the information and resolution of conflicts between installed components.
      c. Indicated space requirements for maintenance and replacement of components and installation sequences.
      d. Include architectural, structural, mechanical, plumbing, fire protection, and electrical work. as needed.

B. Review drawings prior to submission to Architect.

3.08 REQUESTS FOR INFORMATION (RFI)

A. Whenever possible, request clarifications at the next appropriate project progress meeting, with response entered into meeting minutes, rendering unnecessary the issuance of a formal RFI.

B. 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.
c. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

2. Prepare in a format and with content acceptable to Owner.
   a. Use AIA G716 - Request for Information.

C. 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 - 016000 - Product Requirements)
      c. Changes that entail change in Contract Time or 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.

D. Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.
   1. Official Project name and number, and any additional required identifiers established in Contract Documents.
   2. Owner's, Architect's, and Contractor's names.
   3. Discrete and consecutive RFI number, and descriptive subject/title.
   4. Issue date, and requested reply date.
   5. Reference to particular Contract Document(s) requiring additional information/interpretation. Identify pertinent drawing and detail number and/or specification section number, title, and paragraph(s).
   6. Annotations: Field dimensions and/or description of conditions which have engendered the request.
   7. Contractor's suggested resolution: A written and/or a graphic solution, to scale, is required in cases where clarification of coordination issues is involved, for example; routing, clearances, and/or specific locations of work shown diagrammatically in Contract Documents. If applicable, state the likely impact of the suggested resolution on Contract Time or the Contract Sum.

E. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.
   1. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

F. RFI Log: Prepare and maintain a tabular log of RFIs organized by the RFI number for the duration of the project.
   1. Provide RFI description.
   2. Indicate current status of every RFI. Update log promptly and on a regular basis.

3. Note dates of when each request is made, and when a response is received.
4. Highlight items requiring priority or expedited response.
5. Highlight items for which a timely response has not been received to date.

G. 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.

H. The following Contractor-generated RFIs will be returned without action:
1. Requests for approval of submittals.
2. Requests for approval of substitutions.
3. Requests for approval of Contractor's means and methods.
4. Requests for coordination information already indicated in the Contract Documents.
5. Requests for adjustments in the Contract Time or the Contract Sum.
6. Requests for interpretation of Architect's actions on submittals.
7. Incomplete RFIs or inaccurately prepared RFIs.

I. Architect's action may include a request for additional information, in which case Architect's time for response will date from time of receipt of additional information.

J. Responses: Content of answered RFIs will not constitute in any manner a directive or authorization to perform extra work or delay the project. If in Contractor's belief it is likely to lead to a change to Contract Sum or Contract Time, promptly issue a notice to this effect, and follow up with an appropriate Change Order request to Owner.
1. Upon receipt of a response, promptly review and distribute it to all affected parties, and update the RFI Log.
2. 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. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Architect in writing within 10 days of receipt of the RFI response.

3.09 SUBMITTAL SCHEDULE

A. Submit to Architect for review a schedule for submittals in tabular format in chronological order by dates required by the construction schedule, including time for reviews, processing and revisions. Include contractor's professional design services for delegated design, if any.
1. Submit at the same time as the preliminary schedule specified in Section - 013216 - Construction Progress Schedule.
2. Coordinate with Contractor's construction schedule and schedule of values.
3. Format schedule to allow tracking of status of submittals throughout duration of construction.
4. 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.
5. 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.

3.10 SUBMITTALS FOR REVIEW

A. When the following are specified in individual sections, submit them for review:
1. Product data.
2. Shop drawings.

3. Samples for selection.
4. Samples for verification.

B. Submit to Architect for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.

C. Samples will be reviewed for aesthetic, color, or finish selection.

D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 017800 - Closeout Submittals.

3.11 SUBMITTALS FOR INFORMATION

A. When the following are specified in individual sections, submit them for information:
1. Design data.
2. Certificates.
3. Test reports.
4. Inspection reports.
5. Manufacturer's instructions.
6. Manufacturer's field reports.
7. Other types indicated.

B. Submit for Architect's information and for Owner records.

3.12 SUBMITTALS FOR PROJECT CLOSEOUT

A. Submit Correction Punch List for Substantial Completion.

B. Submit Final Correction Punch List for Substantial Completion.

C. When the following are specified in individual sections, submit them at project closeout in compliance with requirements of Section 017800 - Closeout Submittals:
1. Project record documents.
2. Operation and maintenance data.
3. Warranties.
4. Bonds.

D. Submit for Owner's benefit during and after project completion.

3.13 NUMBER OF COPIES OF SUBMITTALS

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.

B. 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.

3.14 SUBMITTAL PROCEDURES

A. General Requirements:
1. Post electronic submittals as bookmarked PDF electronic files directly to Project Web site specifically established for Project.
   a. Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
2. Submit electronic submittals via email as bookmarked PDF electronic files.
   a. Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
3. Use a separate transmittal for each item.
4. Transmit using approved form.
   a. Use Form AIA G810.

5. Sequentially identify each item. For revised submittals use original number and a sequential numerical suffix.
6. Identify: Project; Contractor; subcontractor or supplier; pertinent drawing and detail number; and specification section number and article/paragraph, as appropriate on each copy.
7. 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.
8. 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. Send pdf electronic submittals via email to Architect and deliver sample submittals to Architect at business address.
9. 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 7 days.
   c. For sequential reviews involving approval from authorities having jurisdiction (AHJ), in addition to Architect's approval, allow an additional 30 days.
10. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.
11. Provide space for Contractor and Architect review stamps.
12. When revised for resubmission, identify all changes made since previous submission.
13. Distribute reviewed submittals. Instruct parties to promptly report inability to comply with requirements.
14. 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.
15. Submittals not requested will not be recognized or processed.

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.
5. Include the following information, as applicable:
   a. Manufacturer's catalog cuts.
   b. Manufacturer's product specifications.
   c. Standard color charts.
   d. Statement of compliance with specified referenced standards.
   e. Testing by recognized testing agency.
   f. Application of testing agency labels and seals.
   g. Notation of coordination requirements.
   h. Availability and delivery time information.
6. For equipment, include the following in addition to the above, as applicable:
   a. Wiring diagrams showing factory-installed wiring.
   b. Printed performance curves.
   c. Operational range diagrams.
   d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
7. Submit Product Data before or concurrent with Samples.
8. Submit Product Data in the following format:
   a. Bookmarked PDF electronic file.

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.
   4. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
      a. Identification of products.
      b. Schedules.
      c. Compliance with specified standards.
      d. Notation of coordination requirements.
      e. Notation of dimensions established by field measurement.
      f. Relationship and attachment to adjoining construction clearly indicated.
      g. Seal and signature of professional engineer if specified.
   5. Submit Shop Drawings in the following format:
      a. Bookmarked PDF electronic file.

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. Include with transmittal high-resolution image files of samples to facilitate electronic review and approval. Provide separate submittal page for each item image.

3.15 SUBMITTAL REVIEW

A. Submit to Architect only after complete Contractor review, approval, and mark with field dimensions, coordination and corrections have been made. Mark with approval stamp.

B. Submittals for Review: Architect will review each submittal, and approve, or take other appropriate action.

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

D. 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.

E. Architect's and consultants' actions on items submitted for review:
   1. "Reviewed" - Submittal reviewed, or language with same legal meaning.
   2. Authorized as noted for project use:
      a. "Furnish as Noted", or language with same legal meaning.
   3. Not for project use:
      a. "Revise and Resubmit", or language with same legal meaning.
         1) Resubmit revised item, with review notations acknowledged and incorporated.
         2) Non-responsive resubmittals may be rejected.
      b. "Rejected", or language with same legal meaning.
         1) Submit item complying with requirements of Contract Documents.

3.16 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
   1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

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

END OF SECTION 013000

SECTION 013200
CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
   1. Contractor's construction schedule.
   2. Construction schedule updating reports.
   3. Daily construction reports.
   4. Material location reports.
   5. Site condition reports.
   6. Special reports.

B. Related Requirements:
   1. Section 01 3300 "Submittal Procedures" for submitting schedules and reports.
   2. Section 01 4000 "Quality Requirements" for submitting a schedule of tests and inspections.

1.03 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
   1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
   2. Predecessor Activity: An activity that precedes another activity in the network.
   3. Successor Activity: An activity that follows another activity in the network.

B. Cost Loading: The allocation of the schedule of values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum unless otherwise approved by Architect.

C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

E. Event: The starting or ending point of an activity.

F. Float: The measure of leeway in starting and completing an activity.
   1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
   2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
   3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

G. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.

1.04 INFORMATIONAL SUBMITTALS

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

1. Bookmarked PDF electronic file.
2. Two paper copies.

B. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
1. Submit a working electronic copy of schedule, using software indicated, and labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.

C. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
3. Total Float Report: List of all activities sorted in ascending order of total float.
4. Earnings Report: Compilation of Contractor's total earnings from the Notice to Proceed until most recent Application for Payment.

D. Construction Schedule Updating Reports: Submit with Applications for Payment.

E. Daily Construction Reports: Submit at monthly intervals.

F. Material Location Reports: Submit at monthly intervals.

G. Site Condition Reports: Submit at time of discovery of differing conditions.

H. Special Reports: Submit at time of unusual event.

I. Qualification Data: For scheduling consultant.

1.05 COORDINATION

A. Coordinate Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.
1. Secure time commitments for performing critical elements of the Work from entities involved.
2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.01 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Time Frame: Extend schedule from date established for the Notice to Proceed to date of Substantial Completion.
1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

B. Activities: Treat each story or separate area as a separate numbered activity for each main element of the Work. Comply with the following:
1. Activity Duration: Define activities so no activity is longer than 20 days, unless specifically allowed by Architect.
2. Submittal Review Time: Include review and resubmittal times indicated in Section 01 3300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
3. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
4. Substantial Completion: Indicate completion in advance of date established for Substantial Completion and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.

5. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.

C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule, and show how the sequence of the Work is affected.
1. Work Restrictions: Show the effect of the following items on the schedule:
   a. Coordination with existing construction.
   b. Limitations of continued occupancies.
   c. Uninterruptible services.
   d. Partial occupancy before Substantial Completion.
   e. Use of premises restrictions.
   f. Provisions for future construction.
   g. Seasonal variations.
   h. Environmental control.
2. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
   a. Subcontract awards.
   b. Submittals.
   c. Purchases.
   d. Mockups.
   e. Fabrication.
   f. Sample testing.
   g. Deliveries.
   h. Installation.
   i. Tests and inspections.
   j. Adjusting.
   k. Curing.
   l. Building flush-out.
   m. Startup and placement into final use and operation.
3. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:
   a. Structural completion.
   b. Temporary enclosure and space conditioning.
   c. Permanent space enclosure.
   d. Completion of mechanical installation.
   e. Completion of electrical installation.
   f. Substantial Completion.

D. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.

E. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.

2.02 CONTRACTOR'S CONSTRUCTION SCHEDULE (CPM SCHEDULE)

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

B. Startup Network Diagram: Submit diagram within 14 days of date established for the Notice to Proceed. Outline significant construction activities for the first 90 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

C. CPM Schedule: Prepare Contractor's construction schedule using a time-scaled CPM network analysis diagram for the Work.
   1. Develop network diagram in sufficient time to submit CPM schedule so it can be accepted for use no later than 30 days after date established for the Notice to Proceed.
      a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates, regardless of Architect's approval of the schedule.
   2. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
   3. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
   4. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule in order to coordinate with the Contract Time.

D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths.
   1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:
      a. Preparation and processing of submittals.
      b. Mobilization and demobilization.
      c. Purchase of materials.
      d. Delivery.
      e. Fabrication.
      f. Utility interruptions.
      g. Installation.
      h. Work by Owner that may affect or be affected by Contractor's activities.
      i. Testing.
      j. Punch list and final completion.
      k. Activities occurring following final completion.
   2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
   3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
   4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.
      a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.

E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall project schedule.

F. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:
   1. Contractor or subcontractor and the Work or activity.
   2. Description of activity.
   3. Main events of activity.
   4. Immediate preceding and succeeding activities.
   5. Early and late start dates.
   6. Early and late finish dates.
   7. Activity duration in workdays.

8. Total float or slack time.
9. Average size of workforce.
10. Dollar value of activity (coordinated with the schedule of values).

G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
1. Identification of activities that have changed.
2. Changes in early and late start dates.
3. Changes in early and late finish dates.
4. Changes in activity durations in workdays.
5. Changes in the critical path.
6. Changes in total float or slack time.
7. Changes in the Contract Time.

H. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.
1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.
2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.
   a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
   b. Submit value summary printouts one week before each regularly scheduled progress meeting.

2.03 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions, including presence of rain or snow.
7. Accidents.
8. Meetings and significant decisions.
9. Unusual events (see special reports).
10. Stoppages, delays, shortages, and losses.
11. Meter readings and similar recordings.
12. Emergency procedures.
13. Orders and requests of authorities having jurisdiction.
14. Change Orders received and implemented.
15. Construction Change Directives received and implemented.
16. Services connected and disconnected.
17. Equipment or system tests and startups.
18. Partial completions and occupancies.
19. Substantial Completions authorized.

B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on

and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:

1. Material stored prior to previous report and remaining in storage.
2. Material stored prior to previous report and since removed from storage and installed.
3. Material stored following previous report and remaining in storage.

C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.04 SPECIAL REPORTS

A. General: Submit special reports directly to Owner within one day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.

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

PART 3 - EXECUTION

3.01 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate final completion percentage for each activity.

B. Distribution: Distribute copies of approved schedule to Architect, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 013200

SECTION 013216
CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preliminary schedule.

B. Construction progress schedule, bar chart type.

C. Construction progress schedule, with network analysis diagrams and reports.

1.02 RELATED SECTIONS

A. Section 011000 - Summary: Work sequence.

B. Section 013000 - Administrative Requirements.

1.03 REFERENCE STANDARDS

A. AGC (CPSM) - Construction Planning and Scheduling Manual; 2004.

B. M-H (CPM) - CPM in Construction Management - Project Management with CPM; 2016.

1.04 SUBMITTALS

A. Within 10 days after date of Agreement, submit preliminary schedule.

B. If preliminary schedule requires revision after review, submit revised schedule within 10 days.

C. Within 20 days after review of preliminary schedule, submit draft of proposed complete schedule for review.
   1. Include written certification that major contractors have reviewed and accepted proposed schedule.

D. Within 10 days after joint review, submit complete schedule.

E. Submit updated schedule with each Application for Payment.

F. Submit in PDF format.

G. Submit under transmittal letter form specified in Section 013000 - Administrative Requirements.

1.05 QUALITY ASSURANCE

A. Contractor's Administrative Personnel: two years minimum experience in using and monitoring CPM schedules on comparable projects.

1.06 SCHEDULE FORMAT

A. Listings: In chronological order according to the start date for each activity. Identify each activity with the applicable specification section number.

B. Scale and Spacing: To allow for notations and revisions.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRELIMINARY SCHEDULE

A. Prepare preliminary schedule in the form of a horizontal bar chart.

3.02 CONTENT

A. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.

B. Identify each item by specification section number.

C. Identify work of separate stages and other logically grouped activities.

D. Show accumulated percentage of completion of each item, and total percentage of Work completed, as of the first day of each month.

E. Provide separate schedule of submittal dates for shop drawings, product data, and samples, and dates reviewed submittals will be required from Architect. Indicate decision dates for selection of finishes.

F. Indicate delivery dates for owner-furnished products.

G. Coordinate content with schedule of values specified in Section 012000 - Price and Payment Procedures.

H. Provide legend for symbols and abbreviations used.

3.03 BAR CHARTS

A. Include a separate bar for each major portion of Work or operation.

B. Identify the first work day of each week.

3.04 NETWORK ANALYSIS

A. Prepare network analysis diagrams and supporting mathematical analyses using the Critical Path Method.

B. Illustrate order and interdependence of activities and sequence of work; how start of a given activity depends on completion of preceding activities, and how completion of the activity may restrain start of subsequent activities.

C. Mathematical Analysis: Tabulate each activity of detailed network diagrams, using calendar dates, and identify for each activity:
   1. Preceding and following event numbers.
   2. Activity description.
   3. Estimated duration of activity, in maximum 15 day intervals.
   4. Earliest start date.
   5. Earliest finish date.
   6. Actual start date.
   7. Actual finish date.
   8. Latest start date.
   9. Latest finish date.
   10. Total and free float; float time shall accrue to Owner and to Owner's benefit.
   11. Monetary value of activity, keyed to Schedule of Values.
   12. Percentage of activity completed.
   13. Responsibility.

D. Analysis Program: Capable of compiling monetary value of completed and partially completed activities, accepting revised completion dates, and recomputation of all dates and float.

E. Required Reports: List activities in sorts or groups:
   1. By preceding work item or event number from lowest to highest.
   2. By amount of float, then in order of early start.
   3. By responsibility in order of earliest possible start date.
   4. In order of latest allowable start dates.
   5. In order of latest allowable finish dates.
   6. Contractor's periodic payment request sorted by Schedule of Values listings.
   7. Listing of basic input data that generates the report.
   8. Listing of activities on the critical path.

3.05 REVIEW AND EVALUATION OF SCHEDULE

A. Participate in joint review and evaluation of schedule with Architect at each submittal.

B. Evaluate project status to determine work behind schedule and work ahead of schedule.

3.06 UPDATING SCHEDULE

A. Maintain schedules to record actual start and finish dates of completed activities.

B. Indicate progress of each activity to date of revision, with projected completion date of each activity.

C. Annotate diagrams to graphically depict current status of Work.

D. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.

E. Indicate changes required to maintain Date of Substantial Completion.

F. Submit reports required to support recommended changes.

G. Provide narrative report to define problem areas, anticipated delays, and impact on the schedule. Report corrective action taken or proposed and its effect.

3.07 DISTRIBUTION OF SCHEDULE

A. Distribute copies of updated schedules to Contractor's project site file, to subcontractors, suppliers, Architect, Owner, and other concerned parties.

B. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.

END OF SECTION 013216

SECTION 013233
PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes administrative and procedural requirements for the following:
   1. Preconstruction photographs.
   2. Periodic construction photographs.
   3. Final completion construction photographs.

B. Related Sections:
   1. Section 01 3300 "Submittal Procedures" for submitting photographic documentation.
   2. Section 01 7700 "Closeout Procedures" for submitting photographic documentation as project record documents at Project closeout.
   3. Section 01 7900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.
   4. Section 31 1000 "Site Clearing" for photographic documentation before site clearing operations commence.

1.03 INFORMATIONAL SUBMITTALS

A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.

B. Digital Photographs: Submit image files within three (3) days of taking photographs.
   1. Digital Camera: Minimum sensor resolution of eight (12) megapixels.
   2. Format: Provide JPG format. Minimum 3200 by 2400 pixels minimum, in unaltered original files, with same aspect ratio as the sensor, uncropped, date- and time- stamped, in folder named by date of photograph, accompanied by key plan file. Use flash in low light levels or backlit conditions.
   3. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing or modifications using image-editing software.
   4. Identification: Provide the following information with each image description in file metadata tag:
      a. Name of Project.
      b. Date photograph was taken.
      c. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.

C. Construction Photographs: Submit digital files of any photographs as requested by the Architect and all photographs with record documents at project closeout.

1.04 USAGE RIGHTS

A. Obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.01 CONSTRUCTION PHOTOGRAPHS

A. Photographer: General Contractor to take construction photographs.

B. General: Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.

C. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
   1. Date and Time: Include date and time in file name for each image.
   2. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Architect.

D. Preconstruction Photographs: Before commencement of excavation, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
   1. Flag construction limits before taking construction photographs.
   2. Take photographs to show existing conditions adjacent to property before starting the Work.
   3. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

E. Periodic Construction Photographs: Take photographs monthly, with timing each month adjusted to coincide with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.

F. Architect-Directed Construction Photographs: From time to time, Architect will instruct photographer about number and frequency of photographs and general directions on vantage points. Select actual vantage points and take photographs to show the status of construction and progress since last photographs were taken.

G. Final Completion Construction Photographs: Take color photographs after date of Substantial Completion for submission as project record documents. Architect will inform photographer of desired vantage points.
   1. Do not include date stamp.
      a. Additional Photographs: Owner may request photographs in addition to periodic photographs specified.

END OF SECTION 013233

SECTION 014000
QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

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

1.03 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.

C. Mockups: Full-size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
   1. Laboratory Mockups: Full-size physical assemblies constructed at testing facility to verify performance characteristics.
   2. Integrated Exterior Mockups: Mockups of the exterior envelope erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies.
   3. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes, doors, windows, millwork, casework, specialties, furnishings and equipment, and lighting.

D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

F. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.

G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
   1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

J. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.04 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.05 ACTION SUBMITTALS

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

1.06 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.

B. Qualification Data: For Contractor's quality-control personnel.

C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work on the following systems:
   1. Seismic-force-resisting system, designated seismic system, or component listed in the designated seismic system quality-assurance plan prepared by Architect.
   2. Main wind-force-resisting system or a wind-resisting component listed in the wind-force-resisting system quality-assurance plan prepared by Architect.

D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
   1. Specification Section number and title.
   2. Entity responsible for performing tests and inspections.

3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

1.07 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Architect. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.

B. Quality-Control Personnel Qualifications: Engage qualified full-time personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
   1. Project quality-control manager shall not have other Project responsibilities.

C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
   1. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections.
   2. Special inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections."
   3. Owner-performed tests and inspections indicated in the Contract Documents.

E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.

F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.08 REPORTS AND DOCUMENTS

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

11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

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

D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.09 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
   1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
   2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
   1. Contractor responsibilities include the following:
      a. Provide test specimens representative of proposed products and construction.
      b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
      c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
      d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
      e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
      f. When testing is complete, remove test specimens, assemblies, and mockups; do not reuse products on Project.
   2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
   1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
   2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
   3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at Project.
   4. Demonstrate the proposed range of aesthetic effects and workmanship.
   5. Obtain Architect's approval of mockups before starting work, fabrication, or construction.
      a. Allow seven days for initial review and each re-review of each mockup.
   6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   7. Demolish and remove mockups when directed unless otherwise indicated.

L. Integrated Exterior Mockups: Construct integrated exterior mockup as indicated on Drawings. Coordinate installation of exterior envelope materials and products for which mockups are required in individual Specification Sections, along with supporting materials.

1.10 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
   1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
   2. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.
   1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
   2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
      a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
   3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
   4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
   5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
   6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 01 3300 "Submittal Procedures."

D. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

E. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

F. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
   1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
   2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
   3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
   4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.

5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform any duties of Contractor.

G. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspecting equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.
1. Distribution: Distribute schedule to Owner, Architect, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.11 SPECIAL TESTS AND INSPECTIONS

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Architect.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.

3.02 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
   1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 7300 "Execution."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 014200
REFERENCES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.03 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
2. HI - Hydraulic Institute; www.pumps.org.
3. AABC - Associated Air Balance Council; www.aabc.com.
4. AAMA - American Architectural Manufacturers Association; www.aamanet.org.
5. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
6. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
7. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
8. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
9. ACI - American Concrete Institute; (Formerly: ACI International); www.concrete.org.
10. ACPA - American Concrete Pipe Association; www.concrete-pipe.org.
11. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
12. AF&PA - American Forest & Paper Association; www.afandpa.org.
13. AGA - American Gas Association; www.aga.org.
14. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
15. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
16. AI - Asphalt Institute; www.asphaltinstitute.org.
17. AIA - American Institute of Architects (The); www.aia.org.
18. AISC - American Institute of Steel Construction; www.aisc.org.
19. AISI - American Iron and Steel Institute; www.steel.org.
20. AITC - American Institute of Timber Construction; www.aitc-glulam.org.
21. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.

22. ANSI - American National Standards Institute; www.ansi.org.
23. AOSA - Association of Official Seed Analysts, Inc.; www.aosaseed.com.
24. APA - APA - The Engineered Wood Association; www.apawood.org.
25. APA - Architectural Precast Association; www.archprecast.org.
26. API - American Petroleum Institute; www.api.org.
27. ARI - Air-Conditioning & Refrigeration Institute; (See AHRI).
28. ARI - American Refrigeration Institute; (See AHRI).
29. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
30. ASCE - American Society of Civil Engineers; www.asce.org.
31. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
32. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
33. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
34. ASSE - American Society of Safety Engineers (The); www.asse.org.
35. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
36. ASTM - ASTM International; (American Society for Testing and Materials International); www.astm.org.
37. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
38. AWEA - American Wind Energy Association; www.awea.org.
39. AWI - Architectural Woodwork Institute; www.awinet.org.
40. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
41. AWPA - American Wood Protection Association; (Formerly: American Wood-Preservers' Association); www.awpa.com.
42. AWS - American Welding Society; www.aws.org.
43. AWWA - American Water Works Association; www.awwa.org.
44. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
45. BIA - Brick Industry Association (The); www.gobrick.com.
46. BICSI - BICSI, Inc.; www.bicsi.org.
47. BIFMA - BIFMA International; (Business and Institutional Furniture Manufacturer's Association); www.bifma.com.
48. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
49. BWF - Badminton World Federation; (Formerly: International Badminton Federation); www.bwfbadminton.org.
50. CDA - Copper Development Association; www.copper.org.
51. CEA - Canadian Electricity Association; www.electricity.ca.
52. CEA - Consumer Electronics Association; www.ce.org.
53. CFFA - Chemical Fabrics & Film Association, Inc.; www.chemicalfabricsandfilm.com.
54. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
55. CGA - Compressed Gas Association; www.cganet.com.
56. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
57. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
58. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
59. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
60. CPA - Composite Panel Association; www.pbmdf.com.
61. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
62. CRRC - Cool Roof Rating Council; www.coolroofs.org.
63. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
64. CSA - Canadian Standards Association; www.csa.ca.
65. CSA - CSA International; (Formerly: IAS - International Approval Services); www.csa-international.org.

66. CSI - Construction Specifications Institute (The); www.csinet.org.
67. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
68. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
69. CWC - Composite Wood Council; (See CPA).
70. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
71. DHI - Door and Hardware Institute; www.dhi.org.
72. ECA - Electronic Components Association; (See ECIA).
73. ECAMA - Electronic Components Assemblies & Materials Association; (See ECIA).
74. ECIA ? Electronic Components Industry Association; www.eciaonline.org
75. EIA - Electronic Industries Alliance; (See TIA).
76. EIMA - EIFS Industry Members Association; www.eima.com.
77. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
78. ESD - ESD Association; (Electrostatic Discharge Association); www.esda.org.
79. ESTA - Entertainment Services and Technology Association; (See PLASA).
80. EVO - Efficiency Valuation Organization; www.evo-world.org.
81. FIBA - F?d?ration Internationale de Basketball; (The International Basketball Federation); www.fiba.com.
82. FIVB - F?d?ration Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
83. FM Approvals - FM Approvals LLC; www.fmglobal.com.
84. FM Global - FM Global; (Formerly: FMG - FM Global); www.fmglobal.com.
85. FRSA - Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc.; www.floridaroof.com.
86. FSA - Fluid Sealing Association; www.fluidsealing.com.
87. FSC - Forest Stewardship Council U.S.; www.fscus.org.
88. GA - Gypsum Association; www.gypsum.org.
89. GANA - Glass Association of North America; www.glasswebsite.com.
90. GS - Green Seal; www.greenseal.org.
91. HI - Hydraulic Institute; www.pumps.org.
92. HI/GAMA - Hydronics Institute/Gas Appliance Manufacturers Association; (See AHRI).
93. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
94. HPVA - Hardwood Plywood & Veneer Association; www.hpva.org.
95. HPW - H. P. White Laboratory, Inc.; www.hpwhite.com.
96. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
97. IAS - International Accreditation Service; www.iasonline.org.
98. IAS - International Approval Services; (See CSA).
99. ICBO - International Conference of Building Officials; (See ICC).
100. ICC - International Code Council; www.iccsafe.org.
101. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
102. ICPA - International Cast Polymer Alliance; www.icpa-hq.org.
103. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
104. IEC - International Electrotechnical Commission; www.iec.ch.
105. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
106. IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of North America); www.ies.org.
107. IESNA - Illuminating Engineering Society of North America; (See IES).
108. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
109. IGMA - Insulating Glass Manufacturers Alliance; www.igmaonline.org.
110. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.okstate.edu.
111. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
112. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.

113. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); www.isa.org.
114. ISAS - Instrumentation, Systems, and Automation Society (The); (See ISA).
115. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); www.isfanow.org.
116. ISO - International Organization for Standardization; www.iso.org.
117. ISSFA - International Solid Surface Fabricators Association; (See ISFA).
118. ITU - International Telecommunication Union; www.itu.int/home.
119. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
120. LMA - Laminating Materials Association; (See CPA).
121. LPI - Lightning Protection Institute; www.lightning.org.
122. MBMA - Metal Building Manufacturers Association; www.mbma.com.
123. MCA - Metal Construction Association; www.metalconstruction.org.
124. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
125. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
126. MHIA - Material Handling Industry of America; www.mhia.org.
127. MIA - Marble Institute of America; www.marble-institute.com.
128. MMPA - Moulding & Millwork Producers Association; (Formerly: Wood Moulding & Millwork Producers Association); www.wmmpa.com.
129. MPI - Master Painters Institute; www.paintinfo.com.
130. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org.
131. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
132. NACE - NACE International; (National Association of Corrosion Engineers International); www.nace.org.
133. NADCA - National Air Duct Cleaners Association; www.nadca.com.
134. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
135. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
136. NCAA - National Collegiate Athletic Association (The); www.ncaa.org.
137. NCMA - National Concrete Masonry Association; www.ncma.org.
138. NEBB - National Environmental Balancing Bureau; www.nebb.org.
139. NECA - National Electrical Contractors Association; www.necanet.org.
140. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
141. NEMA - National Electrical Manufacturers Association; www.nema.org.
142. NETA - InterNational Electrical Testing Association; www.netaworld.org.
143. NFHS - National Federation of State High School Associations; www.nfhs.org.
144. NFPA - NFPA; (National Fire Protection Association); www.nfpa.org.
145. NFPA - NFPA International; (See NFPA).
146. NFRC - National Fenestration Rating Council; www.nfrc.org.
147. NHLA - National Hardwood Lumber Association; www.nhla.com.
148. NLGA - National Lumber Grades Authority; www.nlga.org.
149. NOFMA - National Oak Flooring Manufacturers Association; (See NWFA).
150. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
151. NRCA - National Roofing Contractors Association; www.nrca.net.
152. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
153. NSF - NSF International; (National Sanitation Foundation International); www.nsf.org.
154. NSPE - National Society of Professional Engineers; www.nspe.org.
155. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
156. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
157. NWFA - National Wood Flooring Association; www.nwfa.org.
158. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
159. PDI - Plumbing & Drainage Institute; www.pdionline.org.

160. PLASA - PLASA; (Formerly: ESTA - Entertainment Services and Technology Association); www.plasa.org.
161. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
162. RFCI - Resilient Floor Covering Institute; www.rfci.com.
163. RIS - Redwood Inspection Service; www.redwoodinspection.com.
164. SAE - SAE International; (Society of Automotive Engineers); www.sae.org.
165. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
166. SDI - Steel Deck Institute; www.sdi.org.
167. SDI - Steel Door Institute; www.steeldoor.org.
168. SEFA - Scientific Equipment and Furniture Association; www.sefalabs.com.
169. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
170. SIA - Security Industry Association; www.siaonline.org.
171. SJI - Steel Joist Institute; www.steeljoist.org.
172. SMA - Screen Manufacturers Association; www.smainfo.org.
173. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
174. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
175. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
176. SPIB - Southern Pine Inspection Bureau; www.spib.org.
177. SPRI - Single Ply Roofing Industry; www.spri.org.
178. SRCC - Solar Rating and Certification Corporation; www.solar-rating.org.
179. SSINA - Specialty Steel Industry of North America; www.ssina.com.
180. SSPC - SSPC: The Society for Protective Coatings; www.sspc.org.
181. STI - Steel Tank Institute; www.steeltank.com.
182. SWI - Steel Window Institute; www.steelwindows.com.
183. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
184. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
185. TCNA - Tile Council of North America, Inc.; (Formerly: Tile Council of America); www.tileusa.com.
186. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
187. TIA - Telecommunications Industry Association; (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org.
188. TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).
189. TMS - The Masonry Society; www.masonrysociety.org.
190. TPI - Truss Plate Institute; www.tpinst.org.
191. TPI - Turfgrass Producers International; www.turfgrasssod.org.
192. TRI - Tile Roofing Institute; (Formerly: National Tile Roofing Manufacturing Association); www.tileroofing.org.
193. UBC - Uniform Building Code; (See ICC).
194. UL - Underwriters Laboratories Inc.; www.ul.com.
195. UNI - Uni-Bell PVC Pipe Association; www.uni-bell.org.
196. USAV - USA Volleyball; www.usavolleyball.org.
197. USGBC - U.S. Green Building Council; www.usgbc.org.
198. USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
199. WASTEC - Waste Equipment Technology Association; www.wastec.org.
200. WCLIB - West Coast Lumber Inspection Bureau; www.wclib.org.
201. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
202. WDMA - Window & Door Manufacturers Association; www.wdma.com.
203. WI - Woodwork Institute; (Formerly: WIC - Woodwork Institute of California); www.wicnet.org.
204. WMMPA - Wood Moulding & Millwork Producers Association; (See MMPA).

205. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
206. WPA - Western Wood Products Association; www.wwpa.org.

1.04 CODE AGENCIES: WHERE ABBREVIATIONS AND ACRONYMS ARE USED IN SPECIFICATIONS OR OTHER CONTRACT DOCUMENTS, THEY SHALL MEAN THE RECOGNIZED NAME OF THE ENTITIES IN THE FOLLOWING LIST. THIS INFORMATION IS BELIEVED TO BE ACCURATE AS OF THE DATE OF THE CONTRACT DOCUMENTS.

1. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
2. ICC - International Code Council; www.iccsafe.org.
3. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

B. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Information is subject to change and is up-to-date as of the date of the Contract Documents.

1. COE - Army Corps of Engineers; www.usace.army.mil.
2. CPSC - Consumer Product Safety Commission; www.cpsc.gov.
3. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.
4. DOD - Department of Defense; http://dodssp.daps.dla.mil.
5. DOE - Department of Energy; www.energy.gov.
6. EPA - Environmental Protection Agency; www.epa.gov.
7. FAA - Federal Aviation Administration; www.faa.gov.
8. FG - Federal Government Publications; www.gpo.gov.
9. GSA - General Services Administration; www.gsa.gov.
10. HUD - Department of Housing and Urban Development; www.hud.gov.
11. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; http://eetd.lbl.gov.
12. OSHA - Occupational Safety & Health Administration; www.osha.gov.
13. SD - Department of State; www.state.gov.
14. TRB - Transportation Research Board; National Cooperative Highway Research Program; www.trb.org.
15. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
16. USDA - Department of Agriculture; Rural Utilities Service; www.usda.gov.
17. USDJ - Department of Justice; Office of Justice Programs; National Institute of Justice; www.ojp.usdoj.gov.
18. USP - U.S. Pharmacopeia; www.usp.org.
19. USPS - United States Postal Service; www.usps.com.

C. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CFR - Code of Federal Regulations; Available from Government Printing Office; www.gpo.gov/fdsys.
2. DOD - Department of Defense; Military Specifications and Standards; Available from Department of Defense Single Stock Point; http://dodssp.daps.dla.mil.
3. DSCC - Defense Supply Center Columbus; (See FS).
4. FED-STD - Federal Standard; (See FS).
5. FS - Federal Specification; Available from Department of Defense Single Stock Point; http://dodssp.daps.dla.mil.
6. Available from Defense Standardization Program; www.dsp.dla.mil.
7. Available from General Services Administration; www.gsa.gov.
8. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org/ccb.

9. MILSPEC - Military Specification and Standards; (See DOD).
10. USAB - United States Access Board; www.access-board.gov.
11. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (See USAB).

D. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.
1. CBHF; State of California; Department of Consumer Affairs; Bureau of Electronic Appliance and Repair, Home Furnishings and Thermal Insulation; www.bearhfti.ca.gov.
2. PART 245 CCR; California Code of Regulations; Office of Administrative Law; California Title 24 Energy Code; www.calregs.com.
3. PART 246 CDHS; California Department of Health Services; (See CDPH).
4. PART 247 CDPH; California Department of Public Health; Indoor Air Quality Program; www.cal-iaq.org.
5. PART 248 CPUC; California Public Utilities Commission; www.cpuc.ca.gov.
6. PART 249 SCAQMD; South Coast Air Quality Management District; www.aqmd.gov.
7. PART 250 TFS; Texas Forest Service; Forest Resource Development and Sustainable Forestry; http://txforestservice.tamu.edu.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION 014200

SECTION 015000
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Temporary utilities.

B. Temporary telecommunications services.

C. Temporary sanitary facilities.

D. Temporary Controls: Barriers, enclosures, and fencing.

E. Security requirements.

F. Vehicular access and parking.

G. Waste removal facilities and services.

1.02 RELATED REQUIREMENTS

A. Section 015100 - Temporary Utilities.

B. Section 015500 - Vehicular Access and Parking.

1.03 TEMPORARY UTILITIES - SEE SECTION 015100

A. Provide and pay for all electrical power, lighting, water, heating and cooling, and ventilation required for construction purposes.

1.04 TELECOMMUNICATIONS SERVICES

A. Provide, maintain, and pay for telecommunications services to field office at time of project mobilization.

B. Telecommunications services shall include:

1. Provide a desktop computer(s) in the primary field office adequate for use by Architect and Owner to access and provide Project electronic documents, have internet supported meetings and maintain electronic communications. Windows-based personal computer(s) dedicated to project telecommunications, with necessary software and printer.
2. Telephone Land Lines: One line, minimum; one handset per line.
3. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.
4. Internet Connections: Minimum of one; DSL modem or faster.
5. Internet Service: Broadband modem, router and ISP, equipped with hardware firewall, providing minimum 1 Mbps upload and 50 Mbps download speeds at each computer.
6. Internet Security: Integrated software, providing software firewall, virus, spyware, phishing, and spam protection in a combined application.
7. Backup: External hard drive, minimum 40 gigabyte, with automated backup software providing daily backups.
8. Email: Account/address reserved for project use.
9. Printer: "All-in-one" unit equipped with printer server, combining color printing, photocopying, scanning, and faxing, or separate units for each of these three functions.

1.05 TEMPORARY SANITARY FACILITIES

A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization.

B. Maintain daily in clean and sanitary condition.

1.06 FENCING

A. Provide 6 foot (1.8 m) high fence around construction site; equip with vehicular and pedestrian gates with locks. As required to enclose entire Project site or portion determined sufficient to accommodate construction operations and toprevent people and animals from easily entering site except by entrance gates.

1.07 SECURITY - SEE SECTION 013553

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

1.08 VEHICULAR ACCESS AND PARKING - SEE SECTION 015500

A. Comply with regulations relating to use of streets and sidewalks, access to emergency facilities, and access for emergency vehicles.

B. Coordinate access and haul routes with governing authorities and Owner.

C. Provide and maintain access to fire hydrants, free of obstructions.

D. Provide means of removing mud from vehicle wheels before entering streets.

E. Provide temporary parking areas to accommodate construction personnel. When site space is not adequate, provide additional off-site parking.

1.09 WASTE REMOVAL

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

B. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.

C. Provide containers with lids. Remove trash from site periodically.

D. 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.

E. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.10 FIELD OFFICES

A. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Architect, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Weathertight, with lighting, electrical outlets, heating, cooling equipment, and equipped with sturdy furniture and drawing display table.

B. Provide space for Project meetings, with table and chairs to accommodate required meetings.

C. Locate offices a minimum distance of 30 feet (10 m) from existing and new structures.

D.

1.11 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary utilities, equipment, facilities, materials, prior to Date of Substantial Completion inspection.

B. Remove underground installations to a minimum depth of 2 feet (600 mm). Grade site as indicated.

C. Clean and repair damage caused by installation or use of temporary work.

D. Restore existing facilities used during construction to original condition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 015000

SECTION 015100
TEMPORARY UTILITIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Temporary Utilities: Provision of electricity, lighting, heat, ventilation, and water.

1.02 RELATED REQUIREMENTS

A. Section 015000 - Temporary Facilities and Controls:

1.03 REFERENCE STANDARDS

A. 29 CFR 1926 - Safety and Health Regulations for Construction; Current Edition.

1.04 TEMPORARY ELECTRICITY

A. Cost: By Contractor.

B. Provide power service required from utility source.

C. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.

D. Provide power outlets for construction operations, with branch wiring and distribution boxes located at each floor. Provide flexible power cords as required.
   1. Install electric power service underground unless otherwise indicated.

E. Provide main service disconnect and over-current protection at convenient location and meter.

F. Permanent convenience receptacles may be utilized during construction.

G. Provide adequate distribution equipment, wiring, and outlets to provide single phase branch circuits for power and lighting.

1.05 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

A. Provide and maintain LED lighting as suitable for the application for construction operations in accordance with requirements of 29 CFR 1926 and authorities having jurisdiction.

B. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

C. Maintain lighting and provide routine repairs.

1.06 TEMPORARY HEATING AND COOLING

A. Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

1.07 TEMPORARY VENTILATION

A. Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.

1.08 TEMPORARY WATER SERVICE

A. Provide and maintain suitable quality water service for construction operations at time of project mobilization. Install water service and distribution piping in sizes and pressures adequate for construction.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 015100

SECTION 015213
FIELD OFFICES AND SHEDS

PART 1 GENERAL - SUGGEST USING SECTION 015000-TEMPORARY FACILITIES AND CONTROLS

1.01 SECTION INCLUDES

A. Temporary field offices for use of Contractor.

B. Maintenance and removal.

1.02 RELATED REQUIREMENTS

A. Section 011000 - Summary: use of premises and responsibility for providing field offices.

B. Section 015000 - Temporary Facilities and Controls:

PART 2 PRODUCTS

2.01 MATERIALS, EQUIPMENT, FURNISHINGS

2.02 ENVIRONMENTAL CONTROL

A. Heating, Cooling, and Ventilating: Automatic equipment to maintain comfort conditions.

2.03 CONTRACTOR OFFICE AND FACILITIES

A. Size: For Contractor's needs and to provide space for project meetings.

B. Furnishings in Meeting Area: Conference table and chairs to seat at least eight persons; racks and files for Contract Documents, submittals, and project record documents.

PART 3 EXECUTION

3.01 PREPARATION

A. Fill and grade sites for temporary structures to provide drainage away from buildings.

3.02 INSTALLATION

A. Install office spaces ready for occupancy 15 days after date fixed in Notice to Proceed.

3.03 MAINTENANCE AND CLEANING

3.04 REMOVAL

A. At completion of Work remove buildings, foundations, utility services, and debris. Restore areas.

END OF SECTION 015213

SECTION 015500
VEHICULAR ACCESS AND PARKING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Access roads.

B. Parking.

C. Existing pavements and parking areas.

D. Maintenance.

E. Removal, repair.

F. Mud from site vehicles.

1.02 RELATED REQUIREMENTS

A. Section 011000 - Summary: For access to site, work sequence, and occupancy.

PART 2 PRODUCTS

2.01 SIGNS, SIGNALS, AND DEVICES

A. Automatic Traffic Control Signals: As approved by local jurisdictions.

B. Traffic Cones and Drums, Flares and Lights: As approved by local jurisdictions.

C. Flag Person Equipment: As required by local jurisdictions.

PART 3 EXECUTION

3.01 ACCESS ROADS

A. Tracked vehicles not allowed on paved areas.

B. Extend and relocate as work progress requires, provide detours as necessary for unimpeded traffic flow.

C. Provide unimpeded access for emergency vehicles. Maintain 20 foot (6 m) width driveways with turning space between and around combustible materials.

D. Provide and maintain access to fire hydrants free of obstructions.

3.02 PARKING

A. Use of designated areas of existing parking facilities by construction personnel is permitted.

B. Arrange for temporary parking areas to accommodate use of construction personnel.

C. When site space is not adequate, provide additional off-site parking.

3.03 MAINTENANCE

A. Maintain traffic and parking areas in a sound condition free of excavated material, construction equipment, products, mud, snow, and ice.

B. Maintain existing paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain paving and drainage in original, or specified, condition.

3.04 REMOVAL, REPAIR

A. Repair damage caused by installation.

3.05 MUD FROM SITE VEHICLES

A. Provide means of removing mud from vehicle wheels before entering streets.

END OF SECTION 015500

SECTION 016000
PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General product requirements.

B. Transportation, handling, storage and protection.

C. Product option requirements.

D. Substitution limitations.

E. Maintenance materials, including extra materials, spare parts, tools, and software.

1.02 RELATED REQUIREMENTS

A. Section 012500 - Substitution Procedures: Substitutions made during procurement and/or construction phases.

B. Section 014000 - Quality Requirements: Product quality monitoring.

C. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions: Requirements for VOC-restricted product categories.

D. Section 017419 - Construction Waste Management and Disposal: Waste disposal requirements potentially affecting product selection, packaging and substitutions.

1.03 REFERENCE STANDARDS

A. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers Version 1.2; 2017.

B. NEMA MG 1 - Motors and Generators; 2021.

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 DEFINITIONS

A. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.05 SUBMITTALS

A. Proposed Products List: Submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
   1. Submit within 15 days after date of Agreement.
   2. For products specified only by reference standards, list applicable reference standards.

B. 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.

C. 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.

D. 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

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

B. See Section 014000 - Quality Requirements, for additional source quality control requirements.

C. Use of products having any of the following characteristics is not permitted:
   1. Containing lead, cadmium, or asbestos.

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 016116.
   2. If wet-applied, have lower VOC content, as defined in Section 016116.

2.02 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.

C. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

D. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

E. Products with Visual Matching Specification: Where Specifications require "match Architect's sample", provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
   1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.

F. Products with Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.03 MAINTENANCE MATERIALS

A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.

B. Deliver to Project site; obtain receipt prior to final payment.

PART 3 EXECUTION

3.01 SUBSTITUTION LIMITATIONS

A. See Section 012500 - Substitution Procedures.

3.02 TRANSPORTATION AND HANDLING

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

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

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

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

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

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

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

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

3.03 STORAGE AND PROTECTION

A. 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 017419.

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.

B. Store and protect products in accordance with manufacturers' instructions.

C. Store with seals and labels intact and legible.

D. Arrange storage of materials and products to allow for visual inspection for the purpose of determination of quantities, amounts, and unit counts.

E. Store sensitive products in weathertight, climate-controlled enclosures in an environment favorable to product.

F. For exterior storage of fabricated products, place on sloped supports above ground.

G. Provide off-site storage and protection when site does not permit on-site storage or protection.

H. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.

I. Comply with manufacturer's warranty conditions, if any.

J. Do not store products directly on the ground.

K. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

L. Prevent contact with material that may cause corrosion, discoloration, or staining.

M. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

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 016000

SECTION 017000
EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Examination, preparation, and general installation procedures.

B. Requirements for alterations work, including selective demolition, _____.

C. Pre-installation meetings.

D. Cutting and patching.

E. Surveying for laying out the work.

F. Cleaning and protection.

G. Starting of systems and equipment.

H. Demonstration and instruction of Owner personnel.

I. Closeout procedures, including Contractor's Correction Punch List, except payment procedures.

J. General requirements for maintenance service.

1.02 RELATED REQUIREMENTS

A. Section 011000 - Summary: Limitations on working in existing building; continued occupancy; work sequence; identification of salvaged and relocated materials.

B. Section 013000 - Administrative Requirements: Submittals procedures, Electronic document submittal service.

C. Section 014000 - Quality Requirements: Testing and inspection procedures.

D. Section 015100 - Temporary Utilities: Temporary heating, cooling, and ventilating facilities.

E. Section 017800 - Closeout Submittals: Project record documents, operation and maintenance data, warranties, and bonds.

F. Section 017900 - Demonstration and Training: Demonstration of products and systems to be commissioned and where indicated in specific specification sections

G. Section 024100 - Demolition: Demolition of whole structures and parts thereof; site utility demolition.

H. Section 078400 - Firestopping.

1.03 REFERENCE STANDARDS

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

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

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.

C. Demolition Plan: Submit demolition plan as specified by OSHA and local authorities.
   1. Indicate extent of demolition, removal sequence, bracing and shoring, and location and construction of barricades and fences. Include design drawings and calculations for bracing and shoring.
   2. Identify demolition firm and submit qualifications.

3. Include a summary of safety procedures.

D. Cutting and Patching: Submit written request in advance of cutting or alteration that affects:
1. Structural integrity of any element of Project. Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended.
2. Integrity of weather exposed or moisture resistant element. Do not cut and patch other construction elements or components in a manner that could reduce their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
3. Efficiency, maintenance, or safety of any operational element.
4. Visual qualities of sight exposed elements. Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
5. Work of Owner or separate Contractor.

E. Project Record Documents: Accurately record actual locations of capped and active utilities.

1.05 QUALIFICATIONS

A. For demolition work, employ a firm specializing in the type of work required.

B. 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,

C. For field engineering, employ a professional engineer of the discipline required for specific service on Project, licensed in the State in which the Project is located. Employ only individual(s) trained and experienced in establishing and maintaining horizontal and vertical control points necessary for laying out construction work on project of similar size, scope and/or complexity.

D. For design of temporary shoring and bracing, employ a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

1.06 PROJECT CONDITIONS

A. Use of explosives is not permitted.

B. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.

C. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.

D. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

E. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere and over adjacent property.

F. 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.

G. Noise Control: Provide methods, means, and facilities to minimize noise produced by construction operations.

H. Pest and Rodent Control: Provide methods, means, and facilities to prevent pests and insects from damaging the work.

I. Rodent Control: Provide methods, means, and facilities to prevent rodents from accessing or invading premises.

J. Pollution Control: Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations. Comply with federal, state, and local regulations.

1.07 COORDINATION

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.

B. Notify affected utility companies and comply with their requirements.

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.

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.

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.

F. Coordinate completion and clean-up of work of separate sections.

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

A. New Materials: As specified in product sections; match existing products and work for patching and extending work.

B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.

C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 016000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.

E. Verify that utility services are available, of the correct characteristics, and in the correct locations.

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

A. Clean substrate surfaces prior to applying next material or substance.

B. Seal cracks or openings of substrate prior to applying next material or substance.

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

A. When required in individual specification sections, convene a preinstallation meeting at the site prior to commencing work of the section.

B. Require attendance of parties directly affecting, or affected by, work of the specific section.

C. Notify Architect four days in advance of meeting date.

D. Prepare agenda and preside at meeting:
   1. Review conditions of examination, preparation and installation procedures.
   2. Review coordination with related work.

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

A. Verify locations of survey control points prior to starting work.

B. Promptly notify Architect of any discrepancies discovered.

C. Protect survey control points prior to starting site work; preserve permanent reference points during construction.

D. Promptly report to Architect the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.

E. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Architect.

F. Utilize recognized engineering survey practices.

G. 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; and _____.
   2. Grid or axis for structures.
   3. Building foundation, column locations, ground floor elevations, and _____.

H. Periodically verify layouts by same means.

I. Maintain a complete and accurate log of control and survey work as it progresses.

3.05 GENERAL INSTALLATION REQUIREMENTS

A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.

B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.

C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.

D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.

E. Make neat transitions between different surfaces, maintaining texture and appearance.

3.06 ALTERATIONS

A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
   1. Verify that construction and utility arrangements are as indicated.

2. Report discrepancies to Architect before disturbing existing installation.
3. Beginning of alterations work constitutes acceptance of existing conditions.

B. Remove existing work as indicated and as required to accomplish new work.
1. Remove items indicated on drawings.
2. Relocate items indicated on drawings.
3. Where new surface finishes are to be applied to existing work, perform removals, patch, and prepare existing surfaces as required to receive new finish; remove existing finish if necessary for successful application of new finish.
4. Where new surface finishes are not specified or indicated, patch holes and damaged surfaces to match adjacent finished surfaces as closely as possible.

C. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, Telecommunications, and _____): Remove, relocate, and extend existing systems to accommodate new construction.
1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components; if necessary, modify installation to allow access or provide access panel.
2. Where existing systems or equipment are not active and Contract Documents require reactivation, put back into operational condition; repair supply, distribution, and equipment as required.
3. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
   a. Disable existing systems only to make switchovers and connections; minimize duration of outages.
   b. Provide temporary connections as required to maintain existing systems in service.
4. Verify that abandoned services serve only abandoned facilities.
5. Remove abandoned pipe, ducts, conduits, and equipment , including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification; patch holes left by removal using materials specified for new construction.

D. Protect existing work to remain.
1. Prevent movement of structure; provide shoring and bracing if necessary.
2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
3. Repair adjacent construction and finishes damaged during removal work.

E. Adapt existing work to fit new work: Make as neat and smooth transition as possible.

F. Patching: Where the existing surface is not indicated to be refinished, patch to match the surface finish that existed prior to cutting. Where the surface is indicated to be refinished, patch so that the substrate is ready for the new finish.

G. Refinish existing surfaces as indicated:
1. Where rooms or spaces are indicated to be refinished, refinish all visible existing surfaces to remain to the specified condition for each material, with a neat transition to adjacent finishes.
2. If mechanical or electrical work is exposed accidentally during the work, re-cover and refinish to match.

H. Clean existing systems and equipment.

I. Remove demolition debris and abandoned items from alterations areas and dispose of off-site; do not burn or bury.

J. Do not begin new construction in alterations areas before demolition is complete.

K. Comply with all other applicable requirements of this section.

3.07 CUTTING AND PATCHING

A. Whenever possible, execute the work by methods that avoid cutting or patching.

B. See Alterations article above for additional requirements.

C. 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.

D. 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.

E. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.

F. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.

G. Restore work with new products in accordance with requirements of Contract Documents.

H. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

I. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 078400, to full thickness of the penetrated element.

J. 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.

3.08 PROGRESS CLEANING

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

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.

C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

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

3.09 PROTECTION OF INSTALLED WORK

A. Protect installed work from damage by construction operations.

B. Provide special protection where specified in individual specification sections.

C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.

F. 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.

G. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

3.10 SYSTEM STARTUP

A. Coordinate schedule for start-up of various equipment and systems.

B. 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.

C. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

D. Verify that wiring and support components for equipment are complete and tested.

E. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.

F. 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.

G. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.11 DEMONSTRATION AND INSTRUCTION

A. See Section 017900 - Demonstration and Training.

3.12 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

3.13 FINAL CLEANING

A. Use cleaning materials that are nonhazardous that meet Owner VOC requirements.

B. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.

C. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.

D. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.

E. Clean filters of operating equipment.

F. Clean debris from roofs, gutters, downspouts, scuppers, overflow drains, area drains, and drainage systems.

G. Clean site; sweep paved areas, rake clean landscaped surfaces.

H. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.14 CLOSEOUT PROCEDURES

A. Make submittals that are required by governing or other authorities.
   1. Provide copies to Architect and Owner.

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.

C. Notify Architect when work is considered ready for Architect's Substantial Completion inspection.

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.

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.

F. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.

G. Notify Architect when work is considered finally complete and ready for Architect's Substantial Completion final inspection.

H. Complete items of work determined by Architect listed in executed Certificate of Substantial Completion.

3.15 MAINTENANCE

A. Provide service and maintenance of components indicated in specification sections.

B. Maintenance Period: As indicated in specification sections or, if not indicated, not less than one year from the Date of Substantial Completion or the length of the specified warranty, whichever is longer.

C. Examine system components at a frequency consistent with reliable operation. Clean, adjust, and lubricate as required.

D. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original component.

E. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of the Owner.

END OF SECTION 017000

SECTION 017419
CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 GENERAL

1.01 WASTE MANAGEMENT REQUIREMENTS

A. Owner requires that this project generate the least amount of trash and waste possible.

B. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.

C. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.

D. Contractor Reporting Responsibilities: Submit periodic Waste Disposal Reports; report landfill disposal, incineration, recycling, salvage, and reuse regardless of to whom the cost or savings accrues; use the same units of measure on required reports.

E. Methods of trash/waste disposal that are not acceptable are:
   1. Burning on the project site.
   2. Burying on the project site.
   3. Dumping or burying on other property, public or private.
   4. Other illegal dumping or burying.

F. Regulatory Requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, state and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

1.02 RELATED REQUIREMENTS

A. Section 013000 - Administrative Requirements: Additional requirements for project meetings, reports, submittal procedures, and project documentation.

B. Section 015000 - Temporary Facilities and Controls: Additional requirements related to trash/waste collection and removal facilities and services.

C. Section 016000 - Product Requirements: Waste prevention requirements related to delivery, storage, and handling.

D. Section 017000 - Execution and Closeout Requirements: Trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

E. Section 02 4119 "Selective Demolition" for disposition of waste resulting from partial demolition of buildings, structures, and site improvements.

1.03 DEFINITIONS

A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.

B. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.

C. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity or reactivity.

D. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity, or reactivity.

E. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.

F. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.

G. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.

H. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.

I. Return: To give back reusable items or unused products to vendors for credit.

J. Reuse: To reuse a construction waste material in some manner on the project site.

K. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.

L. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.

M. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.

N. Toxic: Poisonous to humans either immediately or after a long period of exposure.

O. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.

P. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

PART 3 EXECUTION

2.01 WASTE MANAGEMENT PROCEDURES

A. See Section 013000 for additional requirements for project meetings, reports, submittal procedures, and project documentation.

B. See Section 015000 for additional requirements related to trash/waste collection and removal facilities and services.

C. See Section 016000 for waste prevention requirements related to delivery, storage, and handling.

D. See Section 017000 for trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

2.02 WASTE MANAGEMENT PLAN IMPLEMENTATION

A. Manager: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan.

B. Communication: Distribute copies of the Waste Management Plan to job site foreman, each subcontractor, Owner, and Architect.

C. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.

D. Meetings: Discuss trash/waste management goals and issues at project meetings.
   1. Prebid meeting.
   2. Preconstruction meeting.
   3. Regular job-site meetings.

E. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return, and trash disposal, for use by all contractors and installers.
   1. Provide containers as required.
   2. Provide adequate space for pick-up and delivery and convenience to subcontractors.
   3. Keep recycling and trash/waste bin areas neat and clean and clearly marked in order to avoid contamination of materials.

F. Hazardous Wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.

G. Recycling: Separate, store, protect, and handle at the site identified recyclable waste products in order to prevent contamination of materials and to maximize recyclability of identified materials. Arrange for timely pickups from the site or deliveries to recycling facility in order to prevent contamination of recyclable materials.

H. Reuse of Materials On-Site: Set aside, sort, and protect separated products in preparation for reuse.

I. Salvage: Set aside, sort, and protect products to be salvaged for reuse off-site.

END OF SECTION 017419

SECTION 017800
CLOSEOUT SUBMITTALS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Project record documents.

B. Operation and maintenance data.

C. Warranties and bonds.

1.02 RELATED REQUIREMENTS

A. Section 013000 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.

B. Section 017000 - Execution and Closeout Requirements: Contract closeout procedures.

C. Individual Product Sections: Specific requirements for operation and maintenance data.

D. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS

A. Project Record Documents: Submit documents to Architect with claim for final Application for Payment.

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.

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

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.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress.

E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
   1. Manufacturer's name and product model and number.
   2. Product substitutions or alternates utilized.
   3. Changes made by Addenda and modifications.

F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
   1. Measured depths of foundations in relation to finish first floor datum.
   2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
   3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
   4. Field changes of dimension and detail.
   5. Details not on original Contract drawings.

3.02 OPERATION AND MAINTENANCE DATA

A. Source Data: For each product or system, list names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.

B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.

C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.

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

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.

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.

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.

D. Additional information as specified in individual product specification sections.

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

A. For Each Item of Equipment and Each System:
   1. Description of unit or system, and component parts.
   2. Identify function, normal operating characteristics, and limiting conditions.
   3. Include performance curves, with engineering data and tests.
   4. Complete nomenclature and model number of replaceable parts.

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

C. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.

D. Include color coded wiring diagrams as installed.

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.

F. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

G. Provide servicing and lubrication schedule, and list of lubricants required.

H. Include manufacturer's printed operation and maintenance instructions.

I. Include sequence of operation by controls manufacturer.

J. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

K. Provide control diagrams by controls manufacturer as installed.

L. Provide Contractor's coordination drawings, with color coded piping diagrams as installed.

M. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

N. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

O. Include test and balancing reports.

P. Additional Requirements: As specified in individual product specification sections.

3.05 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

A. Manuals to be fully digital in PDF, or similar, format.

B. Assemble operation and maintenance data into du manuals for Owner's personnel use, with data arranged in the same sequence as, and identified by, the specification sections.

C. Where systems involve more than one specification section, provide separate section for each system.

D. Project Directory: Title and address of Project; names, addresses, and telephone numbers of Architect, Consultants, Contractor and subcontractors, with names of responsible parties.

E. Tables of Contents: List every item; where multiple volumes are required, include all volumes Tables of Contents in each volume, with the current volume clearly identified.

F. Drawings: Provide digitally.

G. Arrangement of Contents: Organize each volume in parts as follows:
   1. Project Directory.
   2. Table of Contents, of all volumes, and of this volume.
   3. Operation and Maintenance Data: Arranged by system, then by product category.
      a. Source data.
      b. Product data, shop drawings, and other submittals.
      c. Operation and maintenance data.
      d. Field quality control data.
      e. Photocopies of warranties and bonds.

3.06 WARRANTIES AND BONDS

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

B. Verify that documents are in proper form, contain full information, and are notarized.

C. Co-execute submittals when required.

D. Retain warranties and bonds until time specified for submittal.

E. Include originals of each in operation and maintenance manuals, indexed separately on Table of Contents.

END OF SECTION 017800

SECTION 017839
PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

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

B. Related Requirements:
   1. Section 01 7300 "Execution" for final property survey.
   2. Section 01 7700 "Closeout Procedures" for general closeout procedures.
   3. Section 01 7823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.03 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:
   1. Number of Copies: Submit one set(s) of marked-up record prints.
   2. Number of Copies: Submit copies of record Drawings as follows:
      a. Initial Submittal:
         1) Submit one paper-copy set(s) of marked-up record prints.
         2) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
      b. Final Submittal:
         1) Submit PDF electronic files of scanned record.
         2) Submit one paper-copy set(s) of marked-up record prints.

B. Record Specifications: Submit one paper copy of Project's Specifications, including addenda and contract modifications.

C. Record Product Data: Submit one paper copy of each submittal.
   1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous recordkeeping requirements and submittals in connection with various construction activities. Submit one paper copy of each submittal.

E. Reports: Submit written report indicating items incorporated into project record documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

PART 2 - PRODUCTS

2.01 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
   1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
b. Accurately record information in an acceptable drawing technique.
c. Record data as soon as possible after obtaining it.
d. Record and check the markup before enclosing concealed installations.
e. Cross-reference record prints to corresponding archive photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:
   a. Dimensional changes to Drawings.
   b. Revisions to details shown on Drawings.
   c. Depths of foundations below first floor.
   d. Locations and depths of underground utilities.
   e. Revisions to routing of piping and conduits.
   f. Revisions to electrical circuitry.
   g. Actual equipment locations.
   h. Duct size and routing.
   i. Locations of concealed internal utilities.
   j. Changes made by Change Order or Construction Change Directive.
   k. Changes made following Architect's written orders.
   l. Details not on the original Contract Drawings.
   m. Field records for variable and concealed conditions.
   n. Record information on the Work that is shown only schematically.
3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Newly Prepared Record Drawings: Prepare new Drawings instead of preparing record Drawings where Architect determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.
   1. New Drawings may be required when a Change Order is issued as a result of accepting an alternate, substitution, or other modification.
   2. Consult Architect for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared record Drawings into record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.

C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
   1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
   2. Format: Annotated PDF electronic file with comment function enabled.
   3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
   4. Identification: As follows:
      a. Project name.
      b. Date.
      c. Designation "PROJECT RECORD DRAWINGS."
      d. Name of Architect.

e. Name of Contractor.

2.02 RECORD SPECIFICATIONS

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

B. Format: Submit record Specifications as scanned PDF electronic file(s) of marked-up paper copy of Specifications.

2.03 RECORD PRODUCT DATA

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

B. Format: Submit record Product Data as scanned PDF electronic file(s) of marked-up paper copy of Product Data.
   1. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

2.04 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as scanned PDF electronic file(s) of markedup miscellaneous record submittals.
   1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

PART 3 - EXECUTION

3.01 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's reference during normal working hours.

END OF SECTION 017839

SECTION 017900
DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.01 SUMMARY

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

B. Training of Owner personnel in operation and maintenance is required for:
   1. All software-operated systems.
   2. HVAC systems and equipment.
   3. Plumbing equipment.
   4. Electrical systems and equipment.
   5. Conveying systems.
   6. Landscape irrigation.
   7. Items specified in individual product Sections.

C. Training of Owner personnel in care, cleaning, maintenance, and repair is required for:
   1. Roofing, waterproofing, and other weather-exposed or moisture protection products.
   2. Finishes, including flooring, wall finishes, ceiling finishes.
   3. Fixtures and fittings.
   4. Items specified in individual product Sections.

1.02 RELATED REQUIREMENTS

A. Section 017800 - Closeout Submittals: Operation and maintenance manuals.

B. Section 019113 - General Commissioning Requirements: Additional requirements applicable to demonstration and training.

C. Other Specification Sections: Additional requirements for demonstration and training.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

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 a slides, hand-outs, etc.
      h. Training equipment required, such as projector, projection screen, etc., to be provided by Contractor.

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.

D. 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

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

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 DEMONSTRATION - GENERAL

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

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

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.

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

A. Conduct training on-site unless otherwise indicated.

B. Owner will provide classroom and seating at no cost to Contractor.

C. Provide training in minimum two hour segments.

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.

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.

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.

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 017900

SECTION 024100
DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Building demolition excluding removal of hazardous materials and toxic substances.

1.02 RELATED REQUIREMENTS

A. Section 011000 - Summary: Limitations on Contractor's use of site and premises.

B. Section 011000 - Summary: Description of items to be removed by Owner.

C. Section 011000 - Summary: Description of items to be salvaged or removed for re-use by Contractor.

D. Section 015000 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.

E. Section 016000 - Product Requirements: Handling and storage of items removed for salvage and relocation.

F. Section 017000 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring.

G. Section 017419 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.

H. Section 311000 - Site Clearing: Vegetation and existing debris removal.

I. Section 312200 - Grading: Topsoil removal.

J. Section 312200 - Grading: Fill material for filling holes, pits, and excavations generated as a result of removal operations.

K. Section 312323 - Fill: Fill material for filling holes, pits, and excavations generated as a result of removal operations.

L. Section 312323 - Fill: Filling holes, pits, and excavations generated as a result of removal operations.

1.03 DEFINITIONS

A. Demolition: Dismantle, raze, destroy or wreck any building or structure or any part thereof.

B. Remove: Detach or dismantle items from existing construction and dispose of them off site, unless items are indicated to be salvaged or reinstalled.

C. Remove and Salvage: Detach or dismantle items from existing construction in a manner to prevent damage. Clean, package, label and deliver salvaged items to Owner in ready-for-reuse condition.

D. Remove and Reinstall: Detach or dismantle items from existing construction in a manner to prevent damage. Clean and prepare for reuse and reinstall where indicated.

E. Existing to Remain: Designation for existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

1.04 REFERENCE STANDARDS

A. 29 CFR 1926 - Safety and Health Regulations for Construction; Current Edition.

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

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Site Plan: Indicate:

1. Areas for temporary construction and field offices.

C. Demolition Plan: Submit demolition plan as required by OSHA and local AHJs.
   1. Indicate extent of demolition, removal sequencing, bracing and shoring, and location and construction of barricades and fences.

D. Demolition firm qualifications.

E. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

PART 3 EXECUTION

2.01 DEMOLITION

A. Remove the entire building designated on civil demolition plan.

B. Remove other items indicated, for salvage, relocation, and recycling.

2.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
   1. Obtain required permits.
   2. Comply with applicable requirements of NFPA 241.
   3. Use of explosives is not permitted.
   4. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
   5. Provide, erect, and maintain temporary barriers and security devices.
   6. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
   7. Do not close or obstruct roadways or sidewalks without permits from authority having jurisdiction.
   8. Conduct operations to minimize obstruction of public and private entrances and exits. Do not obstruct required exits at any time. Protect persons using entrances and exits from removal operations.
   9. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon, or limit access to their property.

B. Do not begin removal until receipt of notification to proceed from Owner.

C. Protect existing structures and other elements to remain in place and not removed.
   1. Provide bracing and shoring.
   2. Prevent movement or settlement of adjacent structures.
   3. Stop work immediately if adjacent structures appear to be in danger.

D. Minimize production of dust due to demolition operations. Do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

E. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
   1. Hazardous materials will be removed by Owner before start of the Work.
   2. If hazardous materials are discovered during removal operations, stop work and notify Architect and Owner; hazardous materials include regulated asbestos containing materials, lead, PCBs, and mercury. Hazardous materials will be removed by Owner under a separate contract.

F. Perform demolition in a manner that maximizes salvage and recycling of materials.
   1. Comply with requirements of Section 017419 - Construction Waste Management and Disposal.
   2. Dismantle existing construction and separate materials.

3. Set aside reusable, recyclable, and salvageable materials; store and deliver to collection point or point of reuse.

2.03 EXISTING UTILITIES

A. Coordinate work with utility companies. Notify utilities before starting work, comply with their requirements, and obtain required permits.

B. Protect existing utilities to remain from damage.

C. Do not disrupt public utilities without permit from authority having jurisdiction.

D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner.

E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Owner.

F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.

G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

2.04 DEBRIS AND WASTE REMOVAL

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

B. Remove materials not to be reused on site; comply with requirements of Section 017419 - Waste Management.

C. Leave site in clean condition, ready for subsequent work.

D. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION 024100

SECTION 033000
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete formwork.

B. Floors and slabs on grade.

C. Concrete foundation walls.v

D. Concrete reinforcement.

E. Joint devices associated with concrete work.

F. Concrete curing.

1.02 RELATED REQUIREMENTS

A. Section 033511 - Concrete Floor Finishes: Densifiers, hardeners, applied coatings, and polishing.

1.03 REFERENCE STANDARDS

A. ACI CODE-318 - Building Code Requirements for Structural Concrete and Commentary; 2019 (Reapproved 2022).

B. ACI PRC-211.1 - Selecting Proportions for Normal-Density and High Density-Concrete - Guide; 2022.

C. ACI PRC-302.1 - Guide to Concrete Floor and Slab Construction; 2015.

D. ACI PRC-304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000 (Reapproved 2009).

E. ACI PRC-305 - Guide to Hot Weather Concreting; 2020.

F. ACI PRC-306 - Guide to Cold Weather Concreting; 2016.

G. ACI PRC-308 - Guide to External Curing of Concrete; 2016.

H. ACI PRC-347 - Guide to Formwork for Concrete; 2014 (Reapproved 2021).

I. ACI SPEC-117 - Specification for Tolerances for Concrete Construction and Materials; 2010 (Reapproved 2015).

J. ACI SPEC-301 - Specifications for Concrete Construction; 2020.

K. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.

L. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2022.

M. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2018.

N. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2021.

O. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2023.

P. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2020.

Q. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.

R. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete; 2020.

S. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2010a (Reapproved 2016).

T. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2019.

U. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2019, with Editorial Revision (2022).

V. ASTM C579 - Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes; 2023.

W. ASTM C618 - Standard Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2023, with Editorial Revision.

X. ASTM C827/C827M - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures; 2023.

Y. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 2020a.

Z. ASTM C1059/C1059M - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete; 2021.

AA. ASTM C1116/C1116M - Standard Specification for Fiber-Reinforced Concrete; 2010a (Reapproved 2015).

BB. ASTM C1202 - Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration; 2019.

CC. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures; 2020.

DD. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete; 2019.

EE. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete; 2018.

FF. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types); 2018.

GG. ASTM E154/E154M - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover; 2008a (Reapproved 2019).

HH. ASTM E1155 - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers; 2020.

II. ASTM E1155M - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers (Metric); 2014.

JJ. ASTM E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs; 2018a.

KK. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2017 (Reapproved 2023).

LL. COE CRD-C 513 - Handbook for Concrete and Cement Corps of Engineers Specifications for Rubber Waterstops; 1974.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
   1. For curing compounds, provide data on method of removal in the event of incompatibility with floor covering adhesives.
   2. For membrane-forming, moisture emission-reducing, curing and sealing compound, provide manufacturer's installation instructions,.

C. Mix Design: Submit proposed concrete mix design.
   1. Indicate proposed mix design complies with requirements of ACI SPEC-301, Section 4 - Concrete Mixtures.

2. Indicate proposed mix design complies with requirements of ACI CODE-318, Chapter 5 - Concrete Quality, Mixing and Placing.
3. Indicate proposed mix design complies with fiber reinforcing manufacturer's written recommendations.

D. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

E. Test Reports: Submit report for each test or series of tests specified.

F. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.

1.05 QUALITY ASSURANCE

A. Perform work of this section in accordance with ACI SPEC-301 and ACI CODE-318.

B. Follow recommendations of ACI PRC-305 when concreting during hot weather.

C. Follow recommendations of ACI PRC-306 when concreting during cold weather.

D. For slabs required to include moisture vapor reducing admixture (MVRA), do not proceed with placement unless manufacturer's representative is present for every day of placement.

E. For slabs indicated to receive membrane-forming, moisture emission-reducing, curing and sealing compound, do not proceed with application unless manufacturer's representative is present for every day of placement.

1.06 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Moisture Emission-Reducing Curing and Sealing Compound, Membrane-Forming: Provide warranty to cover cost of flooring delamination failures for 10 years.
1. Include cost of repair or removal of failed flooring, remediation with a moisture vapor impermeable surface coating, and replacement of flooring with comparable flooring system.

C. Moisture Emission-Reducing Curing and Sealing Compound, Penetrating: Provide non-prorated warranty to cover cost of flooring delamination failures for 20 years.
1. Include cost of repair or removal of failed flooring, remediation with a moisture vapor impermeable surface coating, and replacement of flooring with comparable flooring system.

PART 2 PRODUCTS

2.01 FORMWORK

A. Formwork Design and Construction: Comply with guidelines of ACI PRC-347 to provide formwork that will produce concrete complying with tolerances of ACI SPEC-117.

B. Form Materials: Contractor's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.
1. Form Facing for Exposed Finish Concrete: Contractor's choice of materials that will provide smooth, stain-free final appearance.
2. Form Coating: Release agent that will not adversely affect concrete or interfere with application of coatings.
   a. Formulate form-release agent with rust inhibitor for steel form-facing materials.
3. Form Ties: Cone snap type that will leave no metal within 1 inches (25 mm) of concrete surface and no larger than 1 inch (25 mm) in diameter in concrete surface.

2.02 REINFORCEMENT MATERIALS

A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi) (420 MPa).
1. Type, size and finishes: Deformed billet-steel bars as indicated in Drawings.

B. Steel Welded Wire Reinforcement (WWR): Plain, galvanized, deformed, or epoxy-coated deformed types, sizes and styles as indicated in Drawings.

C. Reinforcement Accessories:
   1. Tie Wire: Annealed, deformed and epoxy-coated wire, as required.
   2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.
   3. Provide stainless steel, galvanized, plastic, or plastic coated steel components for placement within 1-1/2 inches (38 mm) of weathering surfaces.
   4. Coupler Systems: Mechanical devices for splicing reinforcing bars; capable of developing full steel reinforcing design strength in tension and compression.

2.03 CONCRETE MATERIALS

A. Cement: ASTM C150/C150M, Type II - Moderate Portland type, or ASTM C595/C595M, Type IL – Blended Hydraulic type.

B. Fly Ash: ASTM C618, Class C or F.
   1. Fly ash shall not be used in exterior concrete slabs on grade.

C. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.

D. Structural Fiber Reinforcement: ASTM C1116/C1116M, Type III, 1 to 2-1/4 inches (25 to 57 mm) long as indicated in Drawings.

2.04 ADMIXTURES

A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.

B. Air Entrainment Admixture: ASTM C260/C260M.

C. High Range Water Reducing and Retarding Admixture: ASTM C494/C494M Type G.

D. High Range Water Reducing Admixture: ASTM C494/C494M Type F.

E. Water Reducing and Retarding Admixture: ASTM C494/C494M Type D.

F. Retarding Admixture: ASTM C494/C494M Type B.

G. Water Reducing Admixture: ASTM C494/C494M Type A.

H. Moisture Vapor Reducing Admixture (MVRA): Liquid, inorganic admixture free of volatile organic compounds (VOCs). Closes capillary systems formed during concrete curing to reduce moisture vapor emission and transmission. Reduces concrete shrinkage with no adverse effect on concrete properties or applied flooring.

2.05 ACCESSORY MATERIALS

A. Underslab Vapor Retarder:
   1. Sheet Material: ASTM E1745, Class A; stated by manufacturer as suitable for installation in contact with soil or granular fill under all concrete slabs on grade. Single-ply polyethylene is prohibited.
   2. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations.
   3. Products:
      a. Stego Industries, LLC; Wrap - 15 mils (0.381 mm): www.stegoindustries.com/#sle.
      b. W. R. Meadows, Inc; PERMINATOR Class A - 15 mils (0.381 mm): www.wrmeadows.com/#sle.
      c. Substitutions: See Section 016000 - Product Requirements.

B. Non-Shrink Epoxy Grout: Moisture-insensitive, two-part; consisting of epoxy resin, nonmetallic aggregate, and activator.
   1. Composition: High solids content material exhibiting positive expansion when tested in accordance with ASTM C827/C827M.
      a. Maximum Height Change: Plus 4 percent.

b. Minimum Height Change: Plus 1 percent.

2. Minimum Compressive Strength at 7 days, ASTM C579: 12,000 pounds per square inch (82.7 MPa).

2.06 BONDING AND JOINTING PRODUCTS

A. Latex Bonding Agent: Non-redispersable acrylic latex, complying with ASTM C1059/C1059M, Type II.

B. Epoxy Bonding System:
   1. Complying with ASTM C881/C881M and of Type required for specific application.

C. Slab Isolation Joint Filler: 1/2-inch (13 mm) thick, height equal to slab thickness, with removable top section forming 1/2-inch (13 mm) deep sealant pocket after removal.
   1. Material: ASTM D1751, cellulose fiber.
   2. Products:
      a. W. R. Meadows, Inc; Fiber Expansion Joint Filler with Snap-Cap: www.wrmeadows.com/#sle.
      b. Substitutions: See Section 016000 - Product Requirements.

2.07 CURING MATERIALS

A. Evaporation Reducer: Liquid thin-film-forming compound that reduces rapid moisture loss caused by high temperature, low humidity, and high winds; intended for application immediately after concrete placement.
   1. Products:
      a. Dayton Superior Corporation: www.daytonsuperior.com/#sle.
      b. Euclid Chemical Company ; EUCOBAR: www.euclidchemical.com/#sle.
      c. Kaufman Products Inc; VaporAid: www.kaufmanproducts.net/#sle.
      d. Nox-Crete Inc; Monofilm: www.nox-crete.com/#sle.
      e. SpecChem, LLC; SpecFilm Concentrate or SpecFilm: www.specchemllc.com/#sle.
      f. W. R. Meadows, Inc ; Evapre or Evapre-RTU: www.wrmeadows.com/#sle.
      g. Substitutions: See Section 016000 - Product Requirements.

B. Curing Compound, Naturally Dissipating: Clear, water-based, liquid membrane-forming compound; complying with ASTM C309.
   1. Products:
      a. Dayton Superior Corporation: www.daytonsuperior.com/#sle.
      b. Euclid Chemical Company; COLOR-CRETE CURE AND SEAL VOC: www.euclidchemical.com/#sle.
      c. Kaufman Products Inc; Thinfilm 420 Resin Base: www.kaufmanproducts.net/#sle.
      d. Mapei Corporation; Mapecure DR: www.mapei.com/#sle.
      e. Nox-Crete Inc; Res-Cure DH 100: www.nox-crete.com/#sle.
      f. Sinak Corporation; Cure3D: www.sinak.com/#sle.
      g. SpecChem, LLC; SpecRez: www.specchemllc.com/#sle.
      h. W. R. Meadows, Inc; 1100-Clear: www.wrmeadows.com/#sle.
      i. Substitutions: See Section 016000 - Product Requirements.

C. Curing and Sealing Compound, Moisture Emission-Reducing, Membrane-Forming: Clear, liquid sealer for application to newly-placed concrete; capable of providing adequate bond for flooring adhesives, initially and over the long term; with sufficient moisture vapor impermeability to prevent deterioration of flooring adhesives due to moisture emission.

D. Curing and Sealing Compound, Moisture Emission-Reducing, Penetrating: Clear, water-based, non-film-forming curing agent; capable of providing adequate bond for flooring adhesives, initially and over the long term; with sufficient moisture vapor impermeability to prevent deterioration of flooring adhesives due to moisture emission, moisture vapor emission, and alkalinity.
   1. Use this product to cure and seal all slabs to receive adhesively applied flooring or roofing.

2. Compressive Strength of Treated Concrete: Equal to or greater than strength after 28-day water cure when tested according to ASTM C39/C39M.
3. Chloride Ion Resistance of Treated Concrete: Equal to or greater than strength after 28-day water cure when tested according to ASTM C1202.
4. Comply with ASTM C309 and ASTM C1315 Type I Class A.
5. VOC Content: Zero.
6. UL GREENGUARD Gold certified.
7. Products:
   a. Sinak Corporation; VC5: www.sinak.com/#sle.
   b. Substitutions: See Section 016000 - Product Requirements.

E. Curing and Densifying Compound, Membrane-Forming: Lithium polysilicate-based, clear, liquid densifier for application to newly-placed concrete.
1. Comply with ASTM C309.
2. VOC Content: Less than 50 g/L.
3. Solids Content: 25 percent, minimum.
4. Products:
   a. Adhesives Technology Corporation; Pentra-Cure (MH): www.atcepoxy.com/#sle.
   b. Green Umbrella Architectural Concrete Systems; SoloCure: www.greenumbrellasystems.com/#sle.
   c. Substitutions: See Section 016000 - Product Requirements.

F. Curing Compound, Non-Dissipating: Liquid, membrane-forming, clear, nonyellowing acrylic; complying with ASTM C309.
1. Products:
   a. Kaufman Products Inc; Krystal 15 Emulsion: www.kaufmanproducts.net/#sle.
   b. LATICRETE International, Inc; Dress & Seal WB: www.laticrete.com/#sle.
   c. W. R. Meadows, Inc; VOCOMP-20: www.wrmeadows.com/#sle.
   d. Substitutions: See Section 016000 - Product Requirements.

G. Moisture-Retaining Sheet: ASTM C171.
1. White-burlap-polyethylene sheet, weighing not less than 3.8 ounces per square yard (1.71 kg/sq m).

H. Water: Potable, not detrimental to concrete.

2.08 CONCRETE MIX DESIGN

A. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI SPEC-301.
1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.

B. Admixtures: Add acceptable admixtures as recommended in ACI PRC-211.1 and at rates recommended or required by manufacturer.

C. Fiber Reinforcement: Add to mix at rate of 1.5 pounds per cubic yard (0.89 kg per cu m), or as recommended by manufacturer for specific project conditions and as indicated in Drawings.

2.09 MIXING

A. Transit Mixers: Comply with ASTM C94/C94M.

B. Adding Water: If concrete arrives on-site with slump less than suitable for placement, do not add water that exceeds the maximum water-cement ratio or exceeds the maximum permissible slump.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify lines, levels, and dimensions before proceeding with work of this section.

3.02 PREPARATION

A. Formwork: Comply with requirements of ACI SPEC-301. Design and fabricate forms to support all applied loads until concrete is cured and for easy removal without damage to concrete.

B. Verify that forms are clean and free of rust before applying release agent.

C. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.

D. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning and applying bonding agent in accordance to bonding agent manufacturer's instructions.
   1. Use epoxy bonding system for bonding to damp surfaces, for structural load-bearing applications, and where curing under humid conditions is required.
   2. Use latex bonding agent only for non-load-bearing applications.

E. Interior Slabs on Grade: Install vapor retarder under interior slabs on grade. Comply with ASTM E1643. Lap joints minimum 6 inches (150 mm). Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.
   1. Vapor Retarder Over Granular Fill: Install compactible granular fill before placing vapor retarder as indicated on drawings. Do not use sand.

3.03 INSTALLING REINFORCEMENT AND OTHER EMBEDDED ITEMS

A. Comply with requirements of ACI SPEC-301. Clean reinforcement of loose rust and mill scale, and accurately position, support, and secure in place to achieve not less than minimum concrete coverage required for protection.

B. Install welded wire reinforcement in maximum possible lengths, and offset end laps in both directions. Splice laps with tie wire.

C. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with concrete placement.

3.04 PLACING CONCRETE

A. Place concrete in accordance with ACI PRC-304.

B. Place concrete for floor slabs in accordance with ACI PRC-302.1.

C. Notify Architect not less than 24 hours prior to commencement of placement operations.

D. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.

E. At locations shown on architectural and/or mechanical drawings, provide 6 inch (150 mm) high concrete housekeeping pads where indicated for equipment.

F. The Soils Engineer shall determine the moisture content of the base material prior to placing the concrete and shall make the final determination as to whether the moisture content of the base material is appropriate for concrete placement.

G. Finish floors level and flat, unless otherwise indicated.

3.05 SLAB JOINTING

A. Locate joints as indicated on drawings.

B. Install joint devices in accordance with manufacturer's written instructions.

C. Anchor joint fillers and devices to prevent movement during concrete placement.

D. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
   1. Install wherever necessary to separate slab from other building members, including columns, walls, equipment foundations, footings, stairs, manholes, sumps, and drains.

E. Saw Cut Contraction Joints: Saw cut joints before concrete begins to cool, within 4 to 12 hours after placing; use 3/16 inch (5 mm) thick blade and cut at least 1 inch (25 mm) deep but not less than one quarter (1/4) the depth of the slab.

F. Construction Joints: Where not otherwise indicated, use metal combination screed and key form, with removable top section for joint sealant.

3.06 FLOOR FLATNESS AND LEVELNESS TOLERANCES

A. Correct defects by grinding or by removal and replacement of the defective work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.

3.07 CONCRETE FINISHING

A. Repair surface defects, including tie holes, immediately after removing formwork.

B. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch (6 mm) or more in height.

C. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch (6 mm) or more in height. Provide finish as follows:
   1. Smooth Rubbed Finish: Wet concrete and rub with carborundum brick or other abrasive, not more than 24 hours after form removal.

D. Finish - Exposed Vertical Surfaces to be painted:
   1. Form ties shall be broken back 1 inch from the surface of the concrete.
   2. Form ridges and other projections shall be removed immediately, after forms are removed.
   3. All voids and honeycomb, larger than 1/4 inch in diameter shall be filled with a 1:2 cement/fine sand mortar mix.
   4. All patches shall be rubbed with a carborundum brick.
   5. Design intent is for patches to blend into surface and not stand out after painting.

E. Concrete Slabs: Finish to requirements of ACI PRC-302.1 and as follows:
   1. Surfaces to Receive Thick Floor Coverings: "Wood float" as described in ACI PRC-302.1; thick floor coverings include quarry tile, ceramic tile, and Portland cement terrazzo with full bed setting system.
   2. Surfaces to Receive Thin Floor Coverings: "Steel trowel" as described in ACI PRC-302.1; thin floor coverings include carpeting, resilient flooring, seamless flooring, resinous matrix terrazzo, thin set quarry tile, and thin set ceramic tile.
   3. Exposed Surfaces: Trowel as described in ACI PRC-302.1; take measures (use plastic trowels) necessary to avoid black-burnish marks (from steel trowels); exposed surfaces include all other exposed slab surfaces.

F. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains at 1:100 nominal.

G. Concrete Polishing: See Section 033511.

3.08 CURING AND PROTECTION

A. Comply with requirements of ACI PRC-308. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
   1. Normal concrete: Not less than seven days.

C. Surfaces Not in Contact with Forms:
   1. Slabs and Floors To Receive Adhesive-Applied Flooring: Curing compounds and other surface coatings are usually considered unacceptable by flooring and adhesive manufacturers. If such materials must be used, either obtain the approval of the flooring and adhesive manufacturers prior to use or remove the surface coating after curing to flooring manufacturer's satisfaction.

2. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding or water-fog spray.
3. Final Curing: Begin after initial curing but before surface is dry by one of the methods below.
   a. Moisture-Retaining Sheet: Lap strips not less than 3 inches (75 mm) and seal with waterproof tape or adhesive; secure at edges.
   b. Curing Compound: Apply in two coats at right angles, using application rate recommended by manufacturer. Backroll sprayed applications with short nap roller.

3.09 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests, as specified in Section 014000 - Quality Requirements.

B. Provide free access to concrete operations at project site and cooperate with appointed firm.

C. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.

D. Tests of concrete and concrete materials may be performed at any time to ensure compliance with specified requirements.

E. Compressive Strength Tests: ASTM C39/C39M, for each test, mold and cure concrete test cylinders in accordance with Drawings.

F. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.

G. Perform one slump test for each set of test cylinders taken, following procedures of ASTM C143/C143M.

3.10 DEFECTIVE CONCRETE

A. Test Results: The testing agency shall report test results in writing to Architect and Contractor within 24 hours of test.

B. Defective Concrete: Concrete not complying with required lines, details, dimensions, tolerances or specified requirements.

C. Repair or replacement of defective concrete will be determined by the Architect. The cost of additional testing shall be borne by Contractor when defective concrete is identified.

D. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect for each individual area.

3.11 PROTECTION

A. Do not permit traffic over unprotected concrete floor surface until fully cured.

3.12 SCHEDULE - CONCRETE TYPES AND FINISHES: REFER TO DRAWINGS

END OF SECTION 033000

SECTION 033511
SEALED CONCRETE FLOOR FINISHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General: Furnish all labor, materials, equipment, tools and services required to fully complete all Exposed Concrete Floor Finish work as required by the Drawings and/or specified herein including, but not limited to, the following described items.

B. Concrete floor sealer, hardener & densifier for all "sealed" concrete floors.

C. Liquid densifiers and hardeners.

1.02 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Finishing of concrete surface to tolerance; floating, troweling, and similar operations; curing.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the work with concrete floor placement and concrete floor curing.

B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; review concrete finishes and finishing, concrete repair procedures, and concrete protection of concrete floor surfaces.

1.04 SUBMITTALS

A. See Section 013300 Submittal Procedures, for submittal procedures.

B. Product Data: Manufacturer's published data on each finishing product, including information on compatibility of different products and limitations.

C. Maintenance Data: Provide data on maintenance and renewal of applied finishes.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 301, ACI 302.1R, ACI 303R

B. Manufacturer Qualifications: Company specializing in manufacturing the product specified in this section, with not less than five years of documented experience.

C. Applicator Qualifications: Company specializing in performing the work of this section and approved by the manufacturer.

D. Source Limitations: Obtain primary floor treatment materials through one source from a single manufacturer. Provide secondary materials, including honing and polishing material of type and from source recommended by manufacturer of primary materials.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original sealed packaging, including application and storage instructions.

B. Store materials to prevent deterioration from moisture, heat, cold, direct sunlight, or other detrimental effects.

1.07 FIELD CONDITIONS

A. General:
   1. Protection of Unfinished Slab (No satisfactory chemical or cleaning procedure is available to remove petroleum stains from the concrete surface. Prevention is therefore essential.):
      a. All hydraulic powered equipment must be diapered to avoid staining of the concrete.
      b. No trade will park vehicles on the concrete slab. If necessary to complete their scope of work, drop cloths will be placed under vehicles at all times.
      c. No pipe cutting machine will be used on the concrete slab.
      d. Steel will not be placed on concrete slab to avoid rust staining.
      e. Acids and acidic detergents will not come into contact with concrete slab.

f. All trades to be informed that the concrete slab must be protected at all times.

PART 2 PRODUCTS

2.01 CONCRETE FLOOR FINISH APPLICATIONS

A. Unless otherwise indicated, all "sealed" concrete floors are to be finished using liquid densifier/hardener as indicated on Drawings.

2.02 SEALERS, DENSIFIERS AND HARDENERS

A. Liquid Densifier and Hardener: Penetrating chemical compound that reacts with concrete, filling the pores, hardening, and dustproofing.
   1. Composition: Lithium silicate.
   2. Products:
      a. Euclid Chemical Company; ULTRASIL LI+: www.euclidchemical.com/#sle.
      b. Kaufman Products Inc; SureHard LS: www.kaufmanproducts.net/#sle.
      c. PROSOCO, Inc; Consolideck LS/CS: www.prosoco.com/consolideck/#sle.
      d. Sinak Corporation; LithoHard: www.sinak.com/#sle.
      e. W. R. Meadows, Inc; Liqui-Hard Ultra: www.wrmeadows.com/#sle.
      f. Substitutions: See Section 012500 Substitution Procedures.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that floor surfaces are acceptable to receive the work of this section.

B. Verify that flaws in concrete have been patched and joints filled with methods and materials suitable for further finishes.

3.02 GENERAL

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

END OF SECTION 033511

SECTION 071113
BITUMINOUS DAMPPROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Bituminous dampproofing.

B. Drainage panels.

1.02 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-place Concrete

B. Section 312323 - Fill.

C. Section 334100 - Subdrainage.

1.03 REFERENCE STANDARDS

A. ASTM D41/D41M - Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing; 2011 (Reapproved 2023).

B. ASTM D1227/D1227M - Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing; 2013, with Editorial Revision (2019).

C. NRCA (WM) - The NRCA Waterproofing Manual; 2021.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide properties of primer, bitumen, and mastics.

C. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

D. Installer's qualification statement.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the work of this section with at least three years of documented experience.

1.06 FIELD CONDITIONS

A. Maintain ambient temperatures above 40 degrees F (5 degrees C) for 24 hours before and during application until dampproofing has cured.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Bituminous Dampproofing Manufacturers:
   1. Karnak Corporation;[_____]: www.karnakcorp.com/#sle.
   2. Mar-flex Waterproofing & Building Products;[_____]: www.mar-flex.com/#sle.
   3. W. R. Meadows, Inc;[_____]: www.wrmeadows.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

2.02 BITUMINOUS DAMPPROOFING

A. Bituminous Dampproofing: Cold-applied water-based emulsion; asphalt with mineral colloid or chemical emulsifying agent; with or without fiber reinforcement; asbestos-free; suitable for application on vertical and horizontal surfaces.
   1. VOC Content: Not more than permitted by local, State, and federal regulations.
   2. Applied Thickness: 1/16 inch (1.5 mm), minimum, wet film.
   3. Products:
      a. Karnak Corporation; 220 Fibered Emulsion Dampproofing: www.karnakcorp.com/#sle.

b. W. R. Meadows, Inc; Sealmastic Emulsion Type I (spray-grade): www.wrmeadows.com/#sle.
c. Substitutions: See Section 016000 - Product Requirements.

2.03 BITUMEN MATERIALS

A. Cold Asphaltic Type:
1. Emulsified Asphalt: ASTM D1227/D1227M, with fiber reinforcement other than asbestos, Type II, Class 1 or 2.
2. Asphalt Primer: ASTM D41/D41M, compatible with substrate.

2.04 ACCESSORIES

A. Drainage Panel: 1/4-inch (6 mm) thick formed plastic, embossed with cover sheet.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions are acceptable prior to starting this work.

B. Verify substrate surfaces are durable, free of matter detrimental to adhesion or application of dampproofing system.

C. Verify that items penetrating surfaces to receive dampproofing are securely installed.

3.02 PREPARATION

A. Protect adjacent surfaces not designated to receive dampproofing.

B. Clean and prepare surfaces to receive dampproofing in accordance with manufacturer's instructions.

C. Do not apply dampproofing to surfaces unacceptable to manufacturer.

D. Apply mastic to seal penetrations, small cracks, or minor honeycombs in substrate.

3.03 APPLICATION

A. Foundation Walls: Apply two coats of asphalt dampproofing.

B. Perform this work in accordance with manufacturer's instructions and NRCA (WM) applicable requirements.

C. Prime surfaces in accordance with manufacturer's instructions and NRCA (WM) applicable requirements.

D. Apply bitumen by spray application.

E. Apply bitumen in two coats, continuous and uniform, at a rate of 25 sq ft/gal (0.6 sq m/L) per coat.

F. Apply from 2 inches (50 mm) below finish grade elevation down to top of footings.

G. Seal items watertight with mastic, that project through dampproofing surface.

H. Place drainage panel directly over dampproofing, butt joints, and position to ensure downward drainage.

I. Scribe and cut boards around projections, penetrations, and interruptions.

END OF SECTION 071113

SECTION 072119
FOAMED-IN-PLACE INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Foamed-in-place insulation.
   1. In exterior framed walls.
   2. In roof systems.

1.02 REFERENCE STANDARDS

A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.

B. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2019.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023a.

D. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2022a, with Editorial Revision (2023).

E. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials; 2021a.

F. FM 4880 - Examination Standard for Class 1 Fire Rating of Building Panels or Interior Finish Materials; 2022.

G. NFPA 275 - Standard Method of Fire Tests for the Evaluation of Thermal Barriers; 2022.

H. NFPA 286 - Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth; 2024.

I. UL 1040 - Standard for Safety Fire Test of Insulated Wall Construction; Current Edition, Including All Revisions.

J. UL 1715 - Standard for Safety Fire Test of Interior Finish Material; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide product description, insulation properties, overcoat properties, and preparation requirements.

C. Manufacturer's Installation Instructions: Indicate special procedures, and perimeter conditions requiring special attention.

D. Manufacturer Qualification: Submit documentation of current evaluation of proposed manufacturer and materials.

E. Installer Qualification: Submit documentation of current contractor accreditation and current installer certification. Keep copies of all contractor accreditation and installer certification on site during and after installation. Present on-site documentation upon request.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with not less than three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified, with minimum three years documented experience, and approved by manufacturer.

1.05 FIELD CONDITIONS

A. Do not apply foam when temperature is below that specified by the manufacturer for ambient air and substrate.

B. Do not apply foam when temperature is within 5 degrees F (2.78 degrees C) of dew point.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Foamed-In-Place Insulation:
1. BASF Corporation; WALLTITE US Series Closed Cell: www.spf.basf.com/#sle.
2. Carlisle Spray Foam Insulation; _____: www.carlislesfi.com/#sle.
3. Gaco Western; _____: www.gaco.com/#sle.
4. Henry Company; _____: www.henry.com/#sle.
5. Huntsman Building Solutions; Heatlok HFO Pro: www.huntsmanbuildingsolutions.com/#sle.
6. Johns Manville; JM Corbond III Closed Cell Spray Polyurethane Foam: www.jm.com/#sle.
7. NCFI Polyurethanes; _____: www.ncfi.com/#sle.
8. Preferred Solutions, Inc; _____: www.preferredsolutions.net/#sle.
9. Rhino Linings Corporation; ThermalGuard CC2: www.rhinolinings.com/#sle.
10. Substitutions: See Section 016000 - Product Requirements.

2.02 MATERIALS

A. Foamed-In-Place Insulation: Medium-density, rigid or semi-rigid, closed cell polyurethane foam; foamed on-site, using blowing agent of water or non-ozone-depleting gas.
1. Regulatory Requirements: Comply with applicable code for flame and smoke, concealment, and fire protection requirements.
   a. Fire Protection: Provide 15-minute thermal barrier of 1/2 inch (12.7 mm) gypsum board or equivalent material complying with NFPA 275 test method, or foamed-in-place insulation either exposed or with covering that complies with FM 4880, NFPA 286, UL 1040, or UL 1715.
2. Thermal Resistance: R-value (RSI-value) of 5.0 (0.88), minimum, per 1 inch (25.4 mm) thickness at 75 degrees F (24 degrees C) mean temperature when tested in accordance with ASTM C518.
3. Water Vapor Permeance: Vapor retarder; 2 perms (115 ng/(Pa s sq m)), maximum, when tested at intended thickness in accordance with ASTM E96/E96M, desiccant method.
4. Water Absorption: Less than 2 percent by volume, maximum, when tested in accordance with ASTM D2842.
5. Air Permeance: 0.04 cfm per square foot (0.2 L/(s/sq m)), maximum, when tested at intended thickness in accordance with ASTM E2178 at 1.57 psf (75 Pa).
6. Closed Cell Content: At least 90 percent.
7. Surface Burning Characteristics: Flame spread/smoke developed index of 25/450, maximum, when tested in accordance with ASTM E84.

2.03 ACCESSORIES

A. Primer: As required by insulation manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify work within construction spaces or crevices is complete before insulation application.

B. Verify that surfaces are clean, dry, and free of matter that may inhibit insulation adhesion.

3.02 PREPARATION

A. Mask and protect adjacent surfaces from over spray or dusting.

B. Apply primer in accordance with manufacturer's instructions.

3.03 APPLICATION

A. Apply insulation in accordance with manufacturer's instructions.

B. Apply insulation by spray method, to a uniform monolithic density without voids.

C. Apply to achieve a thermal resistance R-value of 5 minimum (RSI-value of ____).

D. Where applied to voids and gaps assure space for expansion to avoid pressure on adjacent materials that may bind operable parts.

E. Trim excess away for applied trim or remove as required for continuous sealant bead.

3.04 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

3.05 PROTECTION

A. Do not permit subsequent construction work to disturb applied insulation.

END OF SECTION 072119

SECTION 074213
METAL WALL PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manufactured metal panels for interior liner panels and subgirt framing assembly, with related flashings and accessory components.

1.02 REFERENCE STANDARDS

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data - Wall System: Manufacturer's data sheets on each product to be used, including:
   1. Physical characteristics of components shown on shop drawings.
   2. Storage and handling requirements and recommendations.
   3. Installation instructions and recommendations.

C. Shop Drawings: Indicate dimensions, layout, joints, construction details, support clips, and methods of anchorage.

D. Samples: Submit two samples of wall panel and soffit panel, 12 inches by 12 inches (305 mm by 305 mm) in size illustrating finish color, sheen, and texture.

E. Manufacturer's qualification statement.

F. Installer's qualification statement.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.

B. Installer Qualifications: Company specializing in installing products specified in this section with minimum three years of documented experience.

1.05 MOCK-UPS

A. Construct mock-up, 8 feet (____ m) long by 10 feet (____ m) wide; include panel system, attachments to building frame, associated vapor retarder and air seal materials, weep drainage system, sealants and seals, _____, and related insulation in mock-up.

B. Mock-up may remain as part of work.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.

B. Store prefinished material off the ground and protected from weather; prevent twisting, bending, or abrasion; provide ventilation; slope metal sheets to ensure proper drainage.

C. Prevent contact with materials that may cause discoloration or staining of products.

1.07 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Finish Warranty: Provide 15-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Metal Wall Panels - Exposed Fasteners:

1. ATAS International, Inc; Belvedere PenumWall: www.atas.com/#sle.
2. Fabral; 4 Inch Rib: www.fabral.com/#sle.
3. MBCI, a Cornerstone Building Brands Company; AVP Panel: www.mbci.com/#sle.
4. Petersen Aluminum Corporation; M-36 Panel: www.pac-clad.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

2.02 METAL WALL PANEL SYSTEM

A. Wall Panel System: Factory fabricated prefinished metal panel system, site assembled.
   1. Provide interior liner panels, retrofit wall panels, and subgirt framing assembly.
   2. Design and size components to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of wall.
   3. Maximum Allowable Deflection of Panel: L/180 for length(L) of span.
   4. Movement: Accommodate movement within system without damage to components or deterioration of seals, movement between system and perimeter components when subject to seasonal temperature cycling; dynamic loading and release of loads; and deflection of structural support framing.
   5. Fabrication: Formed true to shape, accurate in size, square, and free from distortion or defects; pieces of longest practical lengths.
   6. Corners: Factory-fabricated in one continuous piece with minimum 2-inch (51 mm) returns.

B. Interior Liner Panels:
   1. Profile: Vertical; style as indicated.
   2. Side Seams: Interlocking, sealed with continuous bead of sealant.
   3. Material: Precoated steel sheet, 22 gauge, 0.0299 inch (0.76 mm) minimum thickness.
   4. Panel Width: ___ inch (___ mm).
   5. Color: As selected by Architect from manufacturer's standard line.

C. Subgirt Framing Assembly:
   1. 16 gauge, 0.0598 inch (1.52 mm) thick formed non-precoated steel sheet.

D. Internal and External Corners: Same material, thickness, and finish as exterior sheets; profile to suit system; shop cut and factory mitered to required angles.

E. Trim: Same material, thickness and finish as exterior sheets; brake formed to required profiles.

F. Anchors: Galvanized steel.

2.03 MATERIALS

A. Precoated Steel Sheet: Hot-dipped galvanized steel sheet, ASTM A653/A653M, Structural Steel (SS) or Forming Steel (FS), with G90/Z275 coating; continuous coil-coated on exposed surfaces with specified finish coating and on panel back with specified panel back coating.

2.04 FINISHES

A. Panel Backside Finish: Panel manufacturer's standard siliconized polyester wash coat.

B. Interior Application, Panel Finish: Panel manufacturer's standard siliconized polyester coating, top coat over recommended primer.

2.05 ACCESSORIES

A. Support for Cladding and Continuous Insulation: Thermal clips.
   1. Thermally-broken clips that provide attachment support for girts, angles, channels, and other cladding support framing.
   2. Fasteners: As recommended by clip manufacturer.

B. Fasteners: Manufacturer's standard type to suit application; with soft neoprene washers, steel, hot dip galvanized. Fastener cap same color as exterior panel.

C. Field Touch-up Paint: As recommended by panel manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that building framing members are ready to receive panels.

3.02 PREPARATION

A. Install subgirts perpendicular to panel length, securely fastened to substrates and shimmed and leveled to uniform plane, and spaced at intervals indicated.

B. Protect surrounding areas and adjacent surfaces from damage during execution of this work.

3.03 INSTALLATION

A. Install panels on walls in accordance with manufacturer's instructions.

B. Fasten panels to structural supports; aligned, level, and plumb.

C. Locate joints over supports.

D. Lap panel ends 2 inches (51 mm), minimum.

E. Provide expansion and control joints where indicated.

3.04 CLEANING

A. Remove site cuttings from finish surfaces.

B. Remove protective material from wall panel surfaces.

3.05 PROTECTION

A. Protect metal wall panels until completion of project.

B. Touch-up, repair, or replace damaged wall panels or accessories before Date of Substantial Completion.

END OF SECTION 074213

SECTION 079200
JOINT SEALANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nonsag gunnable joint sealants.

B. Joint backings and accessories.

1.02 RELATED REQUIREMENTS

A. Section 016116 - Volatile Organic Compound (VOC) Content Restrictions: Additional requirements for sealants and primers.

B. Section 092116 - Gypsum Board Assemblies: Sealing acoustical and sound-rated walls and ceilings.

1.03 REFERENCE STANDARDS

A. ASTM C834 - Standard Specification for Latex Sealants; 2017 (Reapproved 2023).

B. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.

C. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016 (Reapproved 2023).

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

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

C. Executed warranty.

1.05 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide 2-year manufacturer warranty for installed sealants and accessories that fail to achieve a watertight seal, exhibit loss of adhesion or cohesion, or do not cure. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Nonsag Sealants:
   1. Bostik Inc; _____: www.bostik-us.com/#sle.
   2. Dow; _____: www.dow.com/#sle.
   3. Henry Company; _____: www.henry.com/#sle.
   4. Pecora Corporation; _____: www.pecora.com/#sle.
   5. QUIKRETE Companies; _____: www.quikrete.com/#sle.
   6. Sika Corporation; _____: www.usa.sika.com/#sle.
   7. Tremco Commercial Sealants & Waterproofing; ____: www.tremcosealants.com/#sle.
   8. W.R. Meadows, Inc; _____: www.wrmeadows.com/#sle.
   9. Substitutions: See Section 016000 - Product Requirements.

2.02 JOINT SEALANT APPLICATIONS

A. Scope:
   1. 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.

B. Type NT - Interior Joints: Use nonsag polyurethane sealant, unless otherwise indicated.
   1. Type NT - Wall and Ceiling Joints in Nonwet Areas: Acrylic emulsion latex sealant.
   2. Type NT - Wall and Ceiling Joints in Wet Areas: Nonsag polyurethane sealant for continuous liquid immersion.
   3. Type NT - Floor Joints in Wet Areas: Nonsag polyurethane non-traffic-grade sealant suitable for continuous liquid immersion.

2.03 JOINT SEALANTS - GENERAL

A. Sealants and Primers: Provide products with acceptable levels of volatile organic compound (VOC) content; see Section 016116.

B. Colors: As selected by Architect from full range.

2.04 NONSAG JOINT SEALANTS

A. Type NT - Polyurethane Sealant: ASTM C920, Grade NS, Uses M and A; single or multi-component; not expected to withstand continuous water immersion or traffic.
   1. Movement Capability: Plus and minus 12.5 percent, minimum.

B. Type NT - Polyurethane Sealant for Continuous Water Immersion: ASTM C920, Grade NS, Uses M and A; single or multicomponent; explicitly approved by manufacturer for continuous water immersion; suitable for traffic exposure when recessed below traffic surface.
   1. Movement Capability: Plus and minus 35 percent, minimum.

C. Type NT - Acrylic Emulsion Latex: Water-based; ASTM C834, single component, nonstaining, nonbleeding, nonsagging; not intended for exterior use.

2.05 ACCESSORIES

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.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that joints are ready to receive work.

B. Verify that backing materials are compatible with sealants.

C. Verify that backer rods are of the correct size.

3.02 PREPARATION

A. Remove loose materials and foreign matter that could impair adhesion of sealant.

B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.

C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.

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.

3.03 INSTALLATION

A. Install this work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

B. Provide joint sealant installations complying with ASTM C1193.

C. Install bond breaker backing tape where backer rod cannot be used.

D. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.

E. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.

F. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

END OF SECTION 079200

SECTION 083323
OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Exterior coiling doors.

B. Electric operators and control stations.

C. Wiring from electric circuit disconnect to operators and control stations.

1.02 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

B. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.

D. ITS (DIR) - Directory of Listed Products; Current Edition.

E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.

F. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).

G. UL (DIR) - Online Certifications Directory; Current Edition.

H. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide general construction, electrical equipment, and component connections and details.

C. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details.

D. Samples: Two slats, ___ by ___ inches (___ by ___ mm) in size illustrating shape, color and finish texture.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years documented experience.

C. Products Requiring Electrical Connection: Listed and classified by ITS (DIR), UL (DIR), or testing firm acceptable to authorities having jurisdiction as suitable for purpose specified and indicated.

1.05 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide 2-year manufacturer warranty for roller shaft counterbalance assembly. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Overhead Coiling Metal Doors:

1. Alpine Overhead Doors, Inc; IMB-V7 - Insulated Roll Up Door : www.alpinedoors.com/#sle.
2. Amarr; Amarr 4200 Series Rolling Slat Door: www.amarr.com/commercial/#sle.
3. Clopay Building Products; Model CERD20: www.clopaydoor.com/#sle.
4. Overhead Door Corporation; Model 625 Stormtite Insulated Rolling Service Door : www.overheaddoor.com/#sle.
5. Raynor Garage Doors; DuraCoil, Model ___: www.raynor.com/#sle.
6. Rite-Hite Corp; ____: www.ritehite.com/#sle.
7. The Cookson Company; ____: www.cooksondoor.com/#sle.
8. Wayne-Dalton, a Division of Overhead Door Corporation; Model 900 Rolling Service Door: www.wayne-dalton.com/#sle.
9. Substitutions: See Section 016000 - Product Requirements.

2.02 COILING DOORS

A. Exterior Coiling Doors: Steel slat curtain.
   1. Capable of withstanding positive and negative wind loads of 20 psf (940 Pa) without undue deflection or damage to components.
   2. Sandwich Slats: Manufacturer's standard, with core of foamed-in-place polyurethane insulation; minimum R-value of 8.1 (RSI-value of 1.43).
   3. Nominal Slat Size: 2 inches (50 mm) wide by required length.
   4. Finish: Galvanized. Custom field paint to be applied on site (matching building color)
   5. Guide, Angles: Galvanized steel.
   6. Hood Enclosure: Manufacturer's standard; primed steel.
   7. Electric operation.
   8. Mounting: Within framed opening.
   9. Locking Devices: Chain lock keeper on inside.

2.03 MATERIALS

A. Metal Curtain Construction: Interlocking slats.
   1. Curtain Bottom for Slat Curtains: Fitted with angles to provide reinforcement and positive contact in closed position.
   2. Weatherstripping for Exterior Doors: Moisture and rot proof, resilient type, located at jamb edges, bottom of curtain, and where curtain enters hood enclosure of exterior doors.
   3. Steel Slats: Minimum thickness, ___ gauge, ___ inch (___ mm); ASTM A653/A653M galvanized steel sheet.

B. Guide Construction: Continuous, of profile to retain door in place with snap-on trim, mounting brackets of same metal.

C. Guides - Angle: ASTM A36/A36M metal angles, size as indicated.
   1. Hot-dip galvanized in compliance with ASTM A123/A123M.

D. Hood Enclosure and Trim: Internally reinforced to maintain rigidity and shape.

E. Lock Hardware:
   1. For motor operated units, additional lock or latching mechanisms are not required.

2.04 ELECTRIC OPERATION

A. Operator, Controls, Actuators, and Safeties: Comply with UL 325; provide products listed by ITS (DIR), UL (DIR), or testing agency acceptable to authorities having jurisdiction.
   1. Provide interlock switches on motor operated units.

B. Electric Operators:
   1. Mounting: Side mounted.
   2. Motor Enclosure:
   3. Motor Rating: 1/3 HP (250 W); continuous duty.
   4. Motor Voltage: 120 volts, single phase, 60 Hz.
   5. Motor Controller: NEMA ICS 2, full voltage, reversing magnetic motor starter.

6. Controller Enclosure: NEMA 250, Type 4.
7. Opening Speed: 12 inches per second (300 mm/sec).
8. Brake: Manufacturer's standard type, activated by motor controller.
9. Manual override in case of power failure.
10. See Section 260583 for electrical connections.

C. Control Station: Provide standard three button, 'Open-Close-Stop' momentary-contact control device for each operator complying with UL 325.
   1. 24 volt circuit.
   2. Surface mounted, at interior door jamb.
   3. Entrapment Protection Devices: Provide sensing devices and safety mechanisms complying with UL 325.
      a. Primary Device: Provide electric sensing edge, wireless sensing, NEMA 1 photo eye sensors, or NEMA 4X photo eye sensors as required with momentary-contact control device.

D. Safety Edge: Located at bottom of coiling door, full width, electro-mechanical sensitized type, wired to stop and reverse door direction upon striking object, hollow neoprene covered.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that adjacent construction is suitable for door installation.

B. Verify that electrical services have been installed and are accessible.

C. Verify that door opening is plumb, header is level, and dimensions are correct.

D. Notify Architect of any unacceptable conditions or varying dimensions.

E. Commencement of installation indicates acceptance of substrate and door opening conditions.

3.02 INSTALLATION

A. Install units in accordance with manufacturer's instructions.

B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

C. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.

D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

E. Coordinate installation of electrical service with Section 260583.

F. Complete wiring from disconnect to unit components.

G. Install enclosure and perimeter trim.

3.03 ADJUSTING

A. Adjust operating assemblies for smooth and noiseless operation.

3.04 CLEANING

A. Clean installed components.

B. Remove labels and visible markings.

END OF SECTION 083323

SECTION 084313
ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aluminum-framed storefront, with vision glass.

B. Aluminum doors and frames.

C. Aluminum windows in storefront frames.

D. Weatherstripping.

1.02 RELATED REQUIREMENTS

A. Section 079200 - Joint Sealants: Sealing joints between frames and adjacent construction.

B. Section 087100 - Door Hardware: Hardware items other than specified in this section.

C. Section 088000 - Glazing: Glass and glazing accessories.

1.03 REFERENCE STANDARDS

A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2015.

B. AAMA 501.2 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems; 2015.

C. AAMA 503 - Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems; 2014.

D. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document); 2015.

E. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 2020.

F. AAMA 612 - Voluntary Specification, Performance Requirements, and Test Procedures for Combined Coatings of Anodic Oxide and Transparent Organic Coatings on Architectural Aluminum; 2020, with Errata (2022).

G. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections; 2009.

H. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.

I. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.

J. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.

K. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.

L. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

M. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.

N. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

O. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.

P. 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.

Q. 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).

R. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference; 2000 (Reapproved 2023).

S. ASTM E783 - Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors; 2002 (Reapproved 2018).

T. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference; 2015 (Reapproved 2023).

U. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes; 2023.

V. FBC TAS 203 - Criteria for Testing Products Subject To Cyclic Wind Pressure Loading; Testing Application Standard; 1994.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with installation of other components that comprise the exterior enclosure.

B. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

A. See Section 01 3300 Submittal Procedures for submittal procedures.

B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, and internal drainage details.

C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.
   1. Include design engineer's stamp or seal on shop drawings for attachments and anchors.

D. Samples: Submit two samples illustrating finished aluminum surface, glass, infill panels, glazing materials.

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

F. Delegated Design Data: Provide framing member structural and physical characteristics, engineering calculations, and dimensional limitations.

G. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.

H. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.

I. Field Quality Control Submittals: Report of field testing for water penetration and air leakage.

J. Specimen warranty.

1.06 QUALITY ASSURANCE

A. Designer Qualifications: Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State in which the Project is located.

B. Manufacturer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.

C. 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

A. Handle products of this section in accordance with AAMA CW-10.

B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.08 FIELD CONDITIONS

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

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Correct defective Work within a 10 year period after Date of Substantial Completion.

C. Provide 10 year manufacturer warranty against failure of materials or workmanship of excessive deflection, noise or vibration created by wind and thermal and structural movements, water penetration through fixed glazing and framing, glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.

D. Provide 10 year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, cracking, checking, peeling, or flaking.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Aluminum-Framed Storefronts Basis-of-Design Product: Subject to compliance with requirements, provide Basis of Design Kawneer Trifab 451 T, front-set style, and Kawneer GLASSvent T window units where indicated in Drawings, or comparable product by one of the following::
   1. Kawneer North America: www.kawneer.com/#sle.
   2. Oldcastle BuildingEnvelope; Series 3000 XT storefront, Signature Series, ZeroSightline-HT: www.oldcastlebe.com/#sle.
   3. Pittco Architectural Metals Inc; TMS114XT, No = to GLASSvent UT : www.pittcometals.com/#sle.
   4. Tubelite, Inc; TU24000 Therml=Block, No window = to GLASSvent UT : www.tubeliteinc.com/#sle.
   5. YKK AP America, Inc; YES 45 XT, YES SSG TU Vent: www.ykkap.com/commercial/#sle.
   6. Substitutions: See Section 01 2500 - Substitution Procedures.

2.02 BASIS OF DESIGN -- SWINGING DOORS

A. Kawneer 560 T Insulclad Wide Stile, Insulating Glazing, Thermally-Broken 2 1/4 inch thick aluminum door.

2.03 ALUMINUM-FRAMED STOREFRONT

A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill windows where indicated on drawings, and related flashings, anchorage and attachment devices.
   1. Glazing Position: Front-set.
   2. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep (50 mm wide by 114 mm deep).
   3. Finish: Class I clear anodized.
      a. Factory finish all surfaces that will be exposed in completed assemblies.
      b. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.

4. Finish Color: Clear Anodized..Class I.
5. 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.
6. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
7. 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.
8. 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.
9. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
10. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.
11. Maintain continuous air barrier and/or vapor retarder seal throughout assembly, primarily in line with inside pane of glazing and inner sheet of infill panel, and heel bead of glazing compound.
12. Preparation for Window Treatments: Provide reinforced interior horizontal head rail.

B. Performance Requirements:
1. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrances and storefronts.
2. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
   a. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
   b. Failure also includes the following:
      1) Thermal stresses transferring to building structure.
      2) Glass breakage.
      3) Noise or vibration created by wind and thermal and structural movements.
      4) Loosening or weakening of fasteners, attachments, and other components.
      5) Failure of operating units.
3. Structural Loads:
   a. Wind Loads: As indicated on Drawings.
   b. Other Design Loads: As indicated on Drawings.
4. Deflection of Framing Members: At design wind pressure, as follows:
   a. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
   b. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch.
5. Structural: Test according to ASTM E 330 as follows:
   a. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
   b. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural

distress, or permanent deformation of main framing members exceeding 0.2 percent of span.

c. Test Durations: As required by design wind velocity, but not less than 10 seconds.

6. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
   a. Fixed Framing and Glass Area:
      1) Maximum air leakage of 0.06 cfm/sq. ft. at a static-air-pressure differential of 6.24 lbf/sq. ft.
   b. Entrance Doors:
      1) Pair of Doors: Maximum air leakage of 1.0 cfm/sq. ft. at a static-air-pressure differential of 6.2 lbf/sq. ft.
      2) Single Doors: Maximum air leakage of 0.5 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft.
7. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
   a. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft.
   b. Test Performance: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.4 at design displacement and 1.5 times the design displacement.
8. Seismic Performance: Aluminum-framed entrances and storefronts shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   a. Seismic Drift Causing Glass Fallout: Complying with criteria for passing based on building occupancy type when tested according to AAMA 501.6 at design displacement and 1.5 times the design displacement.
9. Energy Performance: Certify and label energy performance according to NFRC as follows:
   a. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.38 Btu/sq. ft. x h x deg F as determined according to NFRC 100. PER IBC/IECC 2021.
10. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
    a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
    b. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
       1) High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F.
       2) Low Exterior Ambient-Air Temperature: 0 deg F.
       3) Interior Ambient-Air Temperature: 75 deg F.
11. Condensation Resistance Factor of Framing: 50, minimum, measured in accordance with AAMA 1503.

2.04 COMPONENTS

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.

B. Glazing: See Section 088000.

C. Swing Doors: Glazed aluminum.
   1. Thickness: 2 1/4 inches (57 mm).
   2. Finish: Class I Clear Anodized.

2.05 MATERIALS

A. Extruded Aluminum: ASTM B221 (ASTM B221M).

B. Sheet Aluminum: ASTM B209/B209M.

C. Structural Supporting Anchors Attached to Structural Steel: Design for bolted attachment.

D. Fasteners: Stainless steel.

E. Exposed Flashings: Aluminum sheet, 20 gauge, 0.032 inch (0.81 mm) minimum thickness; finish to match framing members.

F. Concealed Flashings: Stainless steel, 26 gauge, 0.0187 inch (0.48 mm) minimum thickness.

G. Concealed Flashings: Sheet aluminum, 26 gauge, 0.017 inch (0.43 mm) minimum thickness.

H. Sill Flashing Sealant: Elastomeric, silicone or polyurethane, compatible with flashing material.

I. Sealant for Setting Thresholds: Non-curing butyl type.

J. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.
   1. Aluminum window glazing gaskets.
      a. Manufacturer's standard compression types
      b. Replaceable, extruded EPDM rubber

K. Glazing Accessories: See Section 088000.

L. Spacers and Setting Blocks:
   1. Manufacturer's standard elastomeric type.

M. Bond-Breaker Tape:
   1. Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

2.06 FINISHES

A. Class I Color Anodized Finish: AAMA 611 AA-M12C22A42 Integrally colored anodic coating not less than 0.7 mils (0.018 mm) thick.

B. Color: Black.

2.07 DOOR HARDWARE

A. For each door, include continuous-gear hinges with stainless-steel bearings between knuckles fabricated to full height of door and frame, weatherstripping, sill sweep strip, and threshold.

B. Other Door Hardware: See Section 087100.

C. Weatherstripping: Wool pile, continuous and replaceable; provide on all doors.

D. Sill Sweep Strips: Resilient seal type, retracting, of neoprene; provide on all doors.

E. Threshold: Extruded aluminum, one piece per door opening, ribbed surface; provide on all doors.

2.08 ACCESSORY MATERIALS

A. Joint Sealants:
   1. For installation at perimeter of aluminum-framed systems, as specified in Division 07 Joint Sealants Section.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify dimensions, tolerances, and method of attachment with other work.

B. Verify that storefront wall openings and adjoining water-resistive and/or air barrier seal materials are ready to receive work of this section.

3.02 INSTALLATION

A. Install wall system in accordance with manufacturer's instructions.

B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

C. Provide alignment attachments and shims to permanently fasten system to building structure.

D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

E. Provide thermal isolation where components penetrate or disrupt building insulation.

F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.

G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.

H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

I. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.

J. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

K. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum storefront system to exterior.

L. Set thresholds in bed of sealant and secure.

M. Install hardware using templates provided.
   1. See Section 087100 for hardware installation requirements.

N. Install glass and infill panels using glazing method required to achieve performance criteria; see Section 088000.

O. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

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.

B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch (0.8 mm).

3.04 FIELD QUALITY CONTROL

A. Provide services of storefront manufacturer's field representative to observe for proper installation of system and submit report.

B. See Section 014000 - Quality Requirements for independent field testing and inspection requirements, and requirements for monitoring quality of specified product installations.

C. Repair or replace storefront components that have failed designated field testing, and retest to verify performance complies with specified requirements.

3.05 ADJUSTING

A. Adjust operating hardware and sash for smooth operation.

3.06 CLEANING

A. Remove protective material from pre-finished aluminum surfaces.

B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths, and take care to remove dirt from corners and to wipe surfaces clean.

C. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

3.07 PROTECTION

A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION 084313

SECTION 088000
GLAZING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes:
   1. Glass for service and teller window speak-through portal & pass-through device in insulated glazing as indicated on Drawings, steel doors and frames, wood doors and frames, glazed casework, aluminum storefront framing, and aluminum curtain walls as indicated on Drawings.
   2. Glazing sealants and accessories.

B. Related Requirements:
   1. Section 084313 - Aluminum-Framed Storefronts.

1.03 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. IBC: International Building Code.

D. Interspace: Space between lites of an insulating-glass unit.

1.04 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.05 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   2. Review temporary protection requirements for glazing during and after installation.

1.06 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Glass Samples: For each type of glass product other than clear monolithic vision glass the following products; 12 inches square.
   1. Insulating glass.

C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

D. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.07 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturers of insulating-glass units with sputter-coated, low-E coatings.

B. Product Certificates: For glass.

C. Product Test Reports: For tinted glass, coated glass, insulating glass and glazing sealants, for tests performed by a qualified testing agency.

1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

D. Sample Warranties: For special warranties.

1.08 QUALITY ASSURANCE

A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified by coated-glass manufacturer.

B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
   1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F.

1.11 WARRANTY

A. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis-of-Design Glass Product: Subject to compliance with requirements, provide product indicated in glass schedules or comparable product by one of the following:
   1. Guardian Industries Corp.
   2. Northwestern Industries, Inc.
   3. Oldcastle BuildingEnvelope.
   4. PPG Industries, Inc.
   5. Viracon, Inc.

B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
   1. Obtain tinted glass from single source from single manufacturer.

C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.02 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazing.

C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E 1300.
   1. Design Wind Pressures: As indicated on Drawings.
   2. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.
   3. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
   1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.
   2. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
   3. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
   4. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
   5. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.03 GLASS PRODUCTS

A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.

B. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
   1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

C. Heat-Strengthened Float Glass: ASTM C 1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
   1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

2.04 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.
   1. Sealing System: Dual seal, with manufacturer's standard polyisobutylene and polyurethane primary and secondary sealants.
   2. Spacer: Aluminum with black, color anodic finish.
   3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.05 GLAZING SEALANTS

A. General:

1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Field-applied sealants shall have a VOC content of not more than 250 g/L.
4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.

B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Dow Corning Corporation; 790.
      b. GE Advanced Materials - Silicones; SilPruf LM SCS2700.
      c. Pecora Corporation; 890NST.
      d. Sika Corporation U.S.; Sikasil WS-290.
      e. Tremco Incorporated; Spectrem 1.

C. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Dow Corning Corporation; 795.
      b. GE Advanced Materials - Silicones; SilGlaze II SCS2800.
      c. Pecora Corporation; 895NST.
      d. Sika Corporation U.S.; Sikasil WS-295.
      e. Tremco Incorporated; Spectrem 2.

2.06 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.07 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
   1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
   1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
   2. Presence and functioning of weep systems.
   3. Minimum required face and edge clearances.
   4. Effective sealing between joints of glass-framing members.

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

3.02 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.03 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches.
   1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
   2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.04 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.05 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.06 CLEANING AND PROTECTION

A. Immediately after installation remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
   1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.07 INSULATING GLASS SCHEDULE BASIS OF DESIGN - SOLARBAN 70 CLEAR OR APPROVED EQUAL.

A. Glass Type : Low-E-coated, clear insulating glass.
   1. Overall Unit Thickness: 1 inch.

2. Minimum Thickness of Each Glass Lite: ¼ inch.
3. Outdoor Lite: Clear fully tempered / annealed / heat-strengthened float glass.
4. Interspace Content: Air.
5. Indoor Lite: Clear fully tempered / annealed / heat-strengthened float glass.
6. Low-E Coating: Sputtered on second surface.
7. Visible Light Transmittance: Not less than 64 percent.
8. Visible Light Reflectance (Exterior / Interior): 1.
9. Winter Nighttime U-Factor: 0.28 maximum.
10. Solar Heat Gain Coefficient: 0.27 maximum.
11. Safety glazing required.

END OF SECTION 088000

SECTION 088300
MIRRORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Glass mirrors.
   1. Annealed float glass.

1.02 REFERENCE STANDARDS

A. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.

B. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data on Mirror Types: Submit structural, physical and environmental characteristics, size limitations, special handling and installation requirements.

1.04 QUALITY ASSURANCE

A. Fabricate, store, transport, receive, install, and clean mirrors in accordance with manufacturer's recommendations.

1.05 FIELD CONDITIONS

A. Do not install mirrors when ambient temperature is less than 50 degrees F (10 degrees C).

B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.06 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for reflective coating on mirrors and replacement of same.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Mirrors:
   1. Binswanger Mirror/ACI Distribution; ____: www.binswangerglass.com/#sle.
   2. Bobrick; B-165 series: www.bobrick.com
   3. Bradley Corp; model 780; www.bradleycorp.com
   4. Dreamwalls by Gardner Glass Products; Standard Mirrors: www.dreamwalls.com/#sle.
   5. Lenoir Mirror Co; ____: www.lenoirmirror.com/#sle.
   6. Trulite Glass and Aluminum Solutions; _____: www.trulite.com/#sle.
   7. Walker Glass Company Ltd; Walker Glass Mirrors: www.walkerglass.com/#sle.
   8. Substitutions: See Section 016000 - Product Requirements.

2.02 ACCESSORIES

A. Glazing Clips: Manufacturer's standard type.

B. Mirror Attachment Accessories: Stainless steel clips.

C. Mirror Adhesive: Silicone pre-polymer based, chemically compatible with mirror coating and wall substrate.

D. Rolled Formed Frame: One piece, roll-formed angle frame, stainless steel, Type 430, satin finish, with welded frame corners, ground and polished smooth.

E. J-Shape Frame: Aluminum extrusion, dimensions as detailed on drawings.

1. Material: Comply with ASTM B221 (ASTM B221M), 6005-T6 alloy and temper.
2. Finish: Anodized, clear.

F. U-Shape Frame: Aluminum extrusion, dimensions as detailed on drawings.
1. Material: Comply with ASTM B221 (ASTM B221M), 6005-T6 alloy and temper.
2. Finish: Anodized, clear.

G. Channel Frame: One piece, channel frame, stainless steel, Type 430, satin finish, 1/2 inch by 1/2 inch by 3/8 inch deep (12.7 mm by 12.7 mm by 9.5 mm deep) with 90 degree mitered corners.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces of mirror frames or recesses are clean, free of obstructions, and ready for installation of mirrors.

3.02 PREPARATION

A. Clean contact surfaces with solvent and wipe dry.

3.03 INSTALLATION

A. Install mirrors in accordance with manufacturer's recommendations.

B. Set mirrors plumb and level, and free of optical distortion.

C. Set mirrors with edge clearance free of surrounding construction including countertops or backsplashes.

3.04 CLEANING

A. Remove wet glazing materials from finish surfaces.

B. Remove labels after work is complete.

C. Clean mirrors and adjacent surfaces.

END OF SECTION 088300

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Performance criteria for gypsum board assemblies.

B. Metal stud wall framing.

C. Metal channel ceiling framing.

D. Gypsum wallboard.

E. Joint treatment and accessories.

1.02 RELATED REQUIREMENTS

A. Section 079200 - Joint Sealants: Sealing acoustical gaps in construction other than gypsum board or plaster work.

1.03 REFERENCE STANDARDS

A. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members; 2016, with Supplement (2020).

B. AISI S201 - North American Standard for Cold-Formed Steel Framing - Product Data; 2017.

C. AISI S220 - North American Standard for Cold-Formed Steel Nonstructural Framing; 2020.

D. AISI S240 - North American Standard for Cold-Formed Steel Structural Framing; 2015, with Errata (2020).

E. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.

F. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

H. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.

I. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members; 2015.

J. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories; 2020.

K. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2017 (Reapproved 2022).

L. ASTM C514 - Standard Specification for Nails for the Application of Gypsum Board; 2004 (Reapproved 2020).

M. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.

N. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2020.

O. 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.

P. 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.

Q. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; 2019.

R. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2017.

S. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023a.

T. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2022.

U. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems; 2015 (Reapproved 2019).

V. GA-216 - Application and Finishing of Gypsum Panel Products; 2021.

W. GA-600 - Fire Resistance and Sound Control Design Manual; 2021.

X. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

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

Z. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

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

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the installation of gypsum board assemblies with size, location, and installation of service utilities.

B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

C. Sequencing: Install service utilities in an orderly and expeditious manner.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

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.

C. Shop Drawings: Indicate special details associated with fireproofing.

D. Installer's Qualification Statement.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Member of Steel Stud Manufacturers Association (SSMA): www.ssma.com/#sle.

B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.07 Delivery, Storage, and Handling

A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.

B. Store gypsum products and accessories indoors and keep above freezing. Elevate boards above floor, on nonwicking supports, in accordance with manufacturer's recommendations.

C. Store metal products to prevent corrosion.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

A. Provide completed assemblies complying with ASTM C840 and GA-216.

B. Seismic Performance: Ceiling systems designed to withstand the effects of earthquake motions in accordance with ASCE 7 for Seismic Design Category D, E, or F and complying with the following:
   1. Local authorities having jurisdiction.

2.02 METAL FRAMING MATERIALS

A. Material and Product Requirements Criteria: AISI S201.

B. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S220 or equivalent.
   1. Structural Grade: As required to meet design criteria.
   2. Corrosion Protection Coating Designation: G60, or equivalent in accordance with AISI S220.

C. Manufacturers - Metal Framing, Connectors, and Accessories:
   1. ClarkDietrich; ____: www.clarkdietrich.com/#sle.
   2. SCAFCO Corporation; _____: www.scafco.com/#sle.
   3. Steel Construction Systems; _____: www.steelconsystems.com/#sle.
   4. Substitutions: See Section 016000 - Product Requirements.

D. 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. Paired Studs for Sound-Rated Assemblies: Engineered single-piece assemblies comprised of paired studs coupled by sound isolators, designed to replace conventional side-by-side, parallel, double-wall partition framing.
      a. Widths: As indicated on drawings.
   3. Runners: U shaped, sized to match studs.
   4. Ceiling Channels: C-shaped.
   5. Furring Members: Hat-shaped sections, minimum depth of 7/8 inch (22 mm).

E. Non-structural Framing Accessories:
   1. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
   2. Partial Height Wall Framing Support: Provides stud reinforcement and anchored connection to floor.
   3. Framing Connectors: ASTM A653/A653M G90 galvanized steel clips; secures cold rolled channel to wall studs for lateral bracing.

2.03 BOARD MATERIALS

A. Manufacturers - Gypsum-Based Board:
   1. American Gypsum Company; ____: www.americangypsum.com/#sle.
   2. CertainTeed Corporation; ____: www.certainteed.com/#sle.
   3. Georgia-Pacific Gypsum; ____: www.gpgypsum.com/#sle.
   4. Gold Bond Building Products, LLC provided by National Gypsum Company; ____: www.goldbondbuilding.com/#sle.
   5. PABCO Gypsum; ____: www.pabcogypsum.com/#sle.
   6. USG Corporation; ____: www.usg.com/#sle.
   7. Substitutions: See Section 016000 - Product Requirements.

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 for vertical surfaces and ceilings, unless otherwise indicated.
   2. Thickness:
      a. Vertical Surfaces: 5/8 inch (16 mm).
      b. Ceilings: 5/8 inch (16 mm).

2.04 GYPSUM BOARD ACCESSORIES

A. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.

B. Beads, Joint Accessories, and Other Trim: ASTM C1047, rigid plastic, galvanized steel, or rolled zinc, unless noted otherwise.
   1. Corner Beads: Low profile, for 90 degree outside corners.

C. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
   1. Paper Tape: 2 inch (50 mm) wide, creased paper tape for joints and corners, except as otherwise indicated.
   2. Joint Compound: Drying type, vinyl-based, ready-mixed.
   3. Joint Compound: Setting type, field-mixed.

D. Finishing Compound: Surface coat and primer, takes the place of skim coating.

E. 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.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that project conditions are appropriate for work of this section to commence.

3.02 FRAMING INSTALLATION

A. Metal Framing: Install in accordance with ASTM C1007AISI S220 and manufacturer's instructions.

B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
   1. Level ceiling system to a tolerance of 1/1200.
   2. Laterally brace entire suspension system.
   3. Install bracing as required at exterior locations to resist wind uplift.

C. 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 top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.

D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.

3.03 BOARD INSTALLATION

A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.

B. Single-Layer Nonrated: Install gypsum board perpendicular to framing, with ends and edges occurring over firm bearing.
   1. Exception: Tapered edges to receive joint treatment at right angles to framing.

C. Installation on Metal Framing: Use screws for attachment of gypsum board.

3.04 INSTALLATION OF TRIM AND ACCESSORIES

A. Corner Beads: Install at external corners, using longest practical lengths.

B. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.

3.05 JOINT TREATMENT

A. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.

B. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
   1. Level 5: Walls and ceilings to receive semi-gloss or gloss paint finish and other areas specifically indicated.
   2. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
   3. Level 3: Walls to receive textured wall finish.
   4. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
   5. Level 1: Fire-resistance-rated wall areas above finished ceilings, whether or not accessible in the completed construction.
   6. Level 0: Temporary partitions.

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).

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 TOLERANCES

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.

3.07 Cleaning

A. See Section 017000 - Execution and Closeout Requirements for additional requirements.

3.08 Protection

A. Protect installed gypsum board assemblies from subsequent construction operations.

END OF SECTION 092116

SECTION 099123
INTERIOR PAINTING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes surface preparation and field painting of the following:
   1. Exposed interior items and surfaces.
   2. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.

B. Paint exposed surfaces, except where the paint schedules indicate that a surface or material is not to be painted or is to remain natural. If the paint schedules do not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces whether or not schedules indicate colors. If the schedules do not indicate color or finish, the Architect will select from standard colors and finishes available.
   1. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment.

C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
   1. Prefinished items include the following factory-finished components:
      a. Architectural woodwork and casework.
      b. Acoustical wall panels.
      c. Metal toilet enclosures.
      d. Metal lockers.
      e. Finished mechanical and electrical equipment-electrical panels exposed in walls other than storage rooms, electric room, mechanical room or other utility type room may not be painted, all others to match wall surface color.
      f. Light fixtures.
      g. Distribution cabinets.
   2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
      a. Foundation spaces.
      b. Furred areas.
      c. Ceiling plenums.
      d. Utility tunnels.
      e. Pipe spaces.
      f. Duct shafts.
      g. Elevator shafts.
   3. Finished metal surfaces include the following:
      a. Anodized aluminum.
      b. Stainless steel.
      c. Chromium plate.
      d. Copper.
      e. Bronze and brass.
   4. Operating parts include moving parts of operating equipment and the following:
      a. Valve and damper operators.
      b. Linkages.
      c. Sensing devices.
      d. Motor and fan shafts.

5. Labels: Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

D. Related Sections include the following:
1. Division 8 Section "Steel Doors and Frames" for shop priming steel doors and frames.
2. Division 9 Section "Gypsum Board Assemblies" for surface preparation for gypsum board.
3. Divisions 22, 23 and 26: Coordinate painting of mechanical and electrical work with requirements in these Divisions respectively.

E. Reference the Painting and Decorating Contractor's of America (PDCA) Technical Manual as a reference for a "type 1 standard job".

F. When epoxy or lacquer materials are specified, include a requirement for providing positive ventilation of the spaces, and a requirement that the application be made after 5:00pm on Friday (to allow odors to dissipate over the weekend, or other acceptable time).

1.03 DEFINITIONS

A. General: Standard coating terms defined in ASTM D 16 apply to this Section.
1. Gloss Level 1: Matte/Flat - Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523, a matte flat finish.
2. Gloss Level 2: Velvet/Sheen Flat - Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523, a high-side sheen flat, velvet-like finish.
3. Gloss Level 3: Eggshell - 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523, an eggshell finish.
4. Gloss Level 4: Satin - 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523, a satin-like finish.
5. Gloss Level 5: Semi-gloss - 35 to 70 units at 60 degrees, according to ASTM D 523, a semi-gloss finish.
6. Gloss Level 6: High Gloss - 70 to 85 units at 60 degrees, according to ASTM D 523, a gloss finish.

1.04 SUBMITTALS

A. Product Data: For each paint system specified. Include block fillers and primers.
1. Material List: Provide an inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
2. Manufacturer's Information: Provide manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use.
3. Certification by the manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

B. Samples for Verification: Of each color and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.
1. Provide stepped Samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
2. Provide a list of materials and applications for each coat of each sample. Label each sample for location and application.

C. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.05 QUALITY ASSURANCE

A. Applicator Qualifications: Engage an experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with a record of successful in-service performance.

B. Source Limitations: Obtain block fillers, primers, and undercoat materials for each coating system from the same manufacturer as the finish coats.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the Project Site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:
   1. Product name or title of material.
   2. Product description (generic classification or binder type).
   3. Manufacturer's stock number and date of manufacture.
   4. Contents by volume, for pigment and vehicle constituents.
   5. Thinning instructions.
   6. Application instructions.
   7. Color name and number.
   8. VOC content.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F (7 deg C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.
   1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.07 PROJECT CONDITIONS

A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 and 90 deg F (10 and 32 deg C).

B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 and 95 deg F (7.2 and 35 deg C).

C. Do not apply when the relative humidity exceeds 85 percent; or at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.
   1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

1.08 EXTRA MATERIALS

A. Furnish extra paint materials from the same production run as the materials applied in the quantities described below. Package paint materials in unopened, factory-sealed containers for storage and identify with labels describing contents. Deliver extra materials to the Owner.
   1. Quantity: Furnish the Owner with an additional 5 percent, but not less than 1 gal. (3.785 L) or 1 case, as appropriate, of each material and color applied.

PART 2 PRODUCTS

2.01 PAINT MATERIALS, GENERAL

A. Material Compatibility: Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified. Paint-material containers not displaying manufacturer's product identification will not be acceptable. Top-of-the-line products for approved manufacturers are:
   1. Basis of Design Products: Sherwin-Williams Company.
   2. Benjamin Moore & Co.

3. ICI Paints.
4. Kelly-Moore Paints.
5. Kwal-Howells Paint.
6. Porter Paints.
7. Or equal.

C. Colors: Provide color specified in finish schedule or matching color as approved by the Architect. See finish schedule.

2.02 ACCESSORIES

A. Material Compatibility: Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Provide all accessories necessary for application of paint system, protection of adjacent surfaces, and cleanup.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with the Applicator present, under which painting will be performed for compliance with paint application requirements.
   1. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
   2. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
   1. Notify the Architect about anticipated problems using the materials specified over substrates primed by others.

3.02 PREPARATION

A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Cleaning: Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease before cleaning.
   1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
   1. Provide barrier coats over incompatible primers or remove and reprime.
   2. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with the Steel Structures Painting Council's (SSPC) recommendations.
      a. Blast steel surfaces clean as recommended by paint system manufacturer and according to requirements of SSPC-SP 10.
      b. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.

c. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with the same primer as the shop coat.

3. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

D. Materials Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
3. Use only thinners approved by paint manufacturer and only within recommended limits.

E. Tinting: Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.03 APPLICATION

A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
1. Paint colors, surface treatments, and finishes are indicated in the schedules.
2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
3. Provide finish coats that are compatible with primers used.
4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
6. Paint interior surfaces of ducts, plenums, or associated supports with a flat, nonspecular black paint where visible through registers or grilles.
7. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
8. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
9. Finish interior of wall and base cabinets and similar field-finished casework to match exterior.
10. Sand lightly between each succeeding enamel or varnish coat.

B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
1. The number of coats and the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
2. Omit primer on metal surfaces that have been shop primed and touchup painted.
3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under

moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.

C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
   1. Brushes: Use brushes best suited for the type of material applied. Use brush of appropriate size for the surface or item being painted.
   2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.
   3. Spray Equipment: Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.

D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.

E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and in occupied spaces.

F. Mechanical items to be painted include, but are not limited to, the following:
   1. Piping, pipe hangers, and supports.
   2. Heat exchangers.
   3. Tanks.
   4. Ductwork.
   5. Insulation.
   6. Motors and mechanical equipment.
   7. Accessory items.

G. Electrical items to be painted include, but are not limited to, the following:
   1. Conduit and fittings.
   2. Switchgear.
   3. Panelboards.

H. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or other defects due to insufficient sealing.

I. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

J. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.

K. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.04 FIELD QUALITY CONTROL

A. The Owner reserves the right to invoke the following test procedure at any time and as often as the Owner deems necessary during the period when paint is being applied:
   1. The Owner will engage the services of an independent testing agency to sample the paint material being used. Samples of material delivered to the Project will be taken, identified, sealed, and certified in the presence of the Contractor.
   2. The testing agency will perform appropriate tests for the following characteristics as required by the Owner:
      a. Quantitative material analysis.

b. Abrasion resistance.
c. Apparent reflectivity.
d. Flexibility.
e. Washability.
f. Absorption.
g. Accelerated weathering.
h. Dry opacity.
i. Accelerated yellowness.
j. Recoating.
k. Skinning.
l. Color retention.
m. Alkali and mildew resistance.

3. The Owner may direct the Contractor to stop painting if test results show material being used does not comply with specified requirements. The Contractor shall remove noncomplying paint from the site, pay for testing, and repaint surfaces previously coated with the rejected paint. If necessary, the Contractor may be required to remove rejected paint from previously painted surfaces if, on repainting with specified paint, the 2 coatings are incompatible.
4. The Owner will preform inspection after each primer and finish coat, prior to application of the succeeding coat.

3.05 CLEANING

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the site.
   1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.

3.06 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.

B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.
   1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

3.07 INTERIOR PAINT SCHEDULE (SEE DRAWINGS FOR LOCATION OF FINISHES AND COLORS)

A. Gypsum Board: Provide the following finish systems over interior gypsum board surfaces:
   1. Satin or eggshell, Acrylic-Enamel Finish: 2 finish coats over a primer, typical unless noted otherwise.
      a. Primer: Alkali-resistant, acrylic-latex, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.0 mil (0.025 mm).
      b. First and Second Coats: Low-luster (eggshell or satin), acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.8 mils (0.071 mm).
   2. Semigloss, Acrylic-Enamel Finish: 2 finish coats over a primer, typical in Toilet and Janitor rooms.
      a. Primer: Latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils (0.031 mm).
      b. First and Second Coats: Semigloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.6 mils (0.066 mm).

3. Water Based Satin Primer:: 2 finish coats.
   a. First and Second Coats: Satin, acrylic, polymer interior water based primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 3 mils.
      1) Rosco: Tough-prime.

B. Ferrous Metal: Provide the following finish systems over ferrous metal:
   1. Semigloss, Acrylic-Enamel Finish: One finish coat over an enamel undercoater and a primer.
      a. Primer: Quick-drying, rust-inhibitive, alkyd-based or epoxy-metal primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 mils (0.038 mm).
      b. Undercoat: Alkyd, interior enamel undercoat or semigloss, acrylic-latex, interior enamel, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.3 mils (0.033 mm).
      c. Finish Coat: Semigloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.3 mils (0.033 mm).

C. Zinc-Coated Metal: Provide the following finish systems over zinc-coated metal:
   1. Semigloss, Acrylic-Enamel Finish: 2 finish coats over a primer.
      a. Primer: Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils (0.031 mm).
      b. First and Second Coats: Semigloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.6 mils (0.066 mm).

END OF SECTION 099123

SECTION 102800
TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Commercial toilet accessories.

B. Commercial shower and bath accessories.

C. Under-lavatory pipe supply covers.

1.02 RELATED REQUIREMENTS

A. Section 088300 - Mirrors: Other mirrors.

B. Section 224000 - Plumbing Fixtures: Under-lavatory pipe and supply covers.

1.03 REFERENCE STANDARDS

A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.

B. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2022.

C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.

D. ASTM C1036 - Standard Specification for Flat Glass; 2021.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.

C. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

PART 2 PRODUCTS

2.01 MATERIALS

A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.

B. Stainless Steel Sheet: ASTM A666, Type 304.

C. Stainless Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.

D. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.

2.02 FINISHES

A. See finish schedules

2.03 COMMERCIAL TOILET ACCESSORIES

A. Toilet Paper Dispenser: Double roll, semi-recessed, stainless steel unit with pivot hinge, tumbler lock.
   1. Products:
      a. Basis of Design - Bobrick; Trimline B-2888.
      b. Substitutions: Section 016000 - Product Requirements.

B. Combination Towel Dispenser/Waste Receptacle: Recessed flush with wall, stainless steel; seamless wall flanges, continuous piano hinges, tumbler locks on upper and lower doors.
   1. Towel dispenser capacity: 400 C-fold.
   2. Products:
      a. Basis of Design - Bobrick: B-43944.
      b. Substitutions: Section 016000 - Product Requirements.

C. Soap Dispenser: Liquid soap dispenser, wall-mounted, surface, with stainless steel cover and horizontal stainless steel tank and working parts; push type soap valve, check valve, and window gauge refill indicator, tumbler lock.
   1. Minimum Capacity: 48 ounces (1.5 liters).
   2. Products:
      a. Basis of Design - Bobrick, surface-mounted B-40.
      b. Substitutions: Section 016000 - Product Requirements.

D. Mirrors: Stainless-steel framed, 1/4 inch (6 mm) thick annealed float glass; ASTM C1036.
   1. Products:
      a. Glacier Bay; Beveled edge bath mirror.
      b. Bobrick; B-165 series
      c. Bradley Corp; model 780
      d. Substitutions: Section 016000 - Product Requirements.

E. Seat Cover Dispenser: Stainless steel, surface-mounted, reloading by concealed opening at base, tumbler lock.
   1. Minimum capacity: 250 seat covers.
   2. Products:
      a. Bobrick; B-221.
      b. Substitutions: Section 016000 - Product Requirements.

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. 42", 36" & 18" vertical straight
      e. Products:
         1) Basis of Design - Bobrick; B-6806 series.
         2) Substitutions: Section 016000 - Product Requirements.

G. Sanitary Napkin Disposal Unit: Stainless steel, surface-mounted, self-closing door, locking bottom panel with full-length stainless steel piano-type hinge, removable receptacle.
   1. Products:
      a. Bobrick; B-35139.
      b. Substitutions: Section 016000 - Product Requirements.

2.04 UNDER-LAVATORY PIPE AND SUPPLY COVERS

A. Under-Lavatory Pipe and Supply Covers:
   1. Insulate exposed drainage piping, including hot, cold, and tempered water supplies under lavatories or sinks to comply with ADA Standards.
   2. Exterior Surfaces: Smooth non-absorbent, non-abrasive surfaces.
   3. Construction: 1/8 inch (3.2 mm) flexible PVC.
   4. Color: White.
   5. Products:
      a. Plumberex Specialty Products, Inc; Plumberex Handy-Shield Maxx: www.plumberex.com/#sle.
      b. Plumberex Specialty Products, Inc; Plumberex Trap Gear: www.plumberex.com/#sle.
      c. Plumberex Specialty Products, Inc; Plumberex Pro-Extreme: www.plumberex.com/#sle.
      d. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify exact location of accessories for installation.

C. For electrically-operated accessories, verify that electrical power connections are ready and in the correct locations.

D. Verify that field measurements are as indicated on drawings.

E. See Drawings for installation of blocking, reinforcing plates, and concealed anchors in walls and ceilings.

3.02 PREPARATION

A. Deliver inserts and rough-in frames to site for timely installation.

B. Provide templates and rough-in measurements as required.

3.03 INSTALLATION

A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.

B. Install plumb and level, securely and rigidly anchored to substrate.

C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.
   1. Grab Bars: As indicated on drawings.
   2. Other Accessories: As indicated on drawings.

3.04 PROTECTION

A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION 102800

SECTION 104416
FIRE EXTINGUISHERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

B. Related Requirements:
   1. Section 10 4413 "Fire Protection Cabinets."

1.03 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review methods and procedures related to fire extinguishers including, but not limited to, the following:
      a. Schedules and coordination requirements.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

B. Shop Drawings: Show all fire extinguisher locations and types.

C. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function. Use same designations indicated on Drawings.

1.05 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.07 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure of hydrostatic test according to NFPA 10.
      b. Faulty operation of valves or release levers.
   2. Warranty Period: Six years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
   1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.02 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Amerex Corporation.
      b. Ansul Incorporated.
      c. JL Industries, Inc.; a division of the Activar Construction Products Group.
      d. Larsens Manufacturing Company.
      e. Potter Roemer LLC.
   2. Valves: Nickel-plated, polished-brass body.
   3. Handles and Levers: Stainless steel.
   4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.

B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:80-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.03 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.
   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. Amerex Corporation.
      b. Ansul Incorporated.
      c. Guardian Fire Equipment, Inc.
      d. JL Industries, Inc.; a division of the Activar Construction Products Group.
      e. Larsens Manufacturing Company.
      f. Potter Roemer LLC.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
   1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
      a. Orientation: Vertical.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged fire extinguishers.

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

3.02 INSTALLATION

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
   1. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 104416

Table of Contents Generated by MasterWorks: 11/14/2024

Division	Section Title	Pages
	SPECIFICATIONS GROUP	
	Facility Services Subgroup	
DIVISION 22 - PLUMBING		
220500	COMMON WORK RESULTS FOR PLUMBING	13
220523	GENERAL-DUTY VALVES FOR PLUMBING PIPING	44
220529	HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT	14
220548	VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT	21
220548.13	VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT	25
220553	IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT	8
220593	TESTING, ADJUSTING, AND BALANCING FOR PLUMBING	11
220716	PLUMBING EQUIPMENT INSULATION	23
220719	PLUMBING PIPING INSULATION	34
220800	COMMISSIONING OF PLUMBING	8
221123.21	INLINE, DOMESTIC-WATER PUMPS	8
221316	SANITARY WASTE AND VENT PIPING	19
221319.13	SANITARY DRAINS	7
223300	ELECTRIC, DOMESTIC-WATER HEATERS	11
224200	COMMERCIAL PLUMBING FIXTURES	9
224700	DRINKING FOUNTAINS AND WATER COOLERS	10

END OF TABLE OF CONTENTS

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Motors.
2. Sleeves with waterstop.
3. Sleeve-seal systems.
4. Grout.
5. Escutcheons.
6. Pressure gauges, dial type, lead free.
7. Test-plug kits, lead free.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of the plumbing equipment Sections.

   a. Include construction details, material descriptions, and dimensions of individual components, and finishes.
   b. Include operating characteristics and furnished accessories.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of gauge to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Domestic water for plumbing piping intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.

C. Capability: Provide products and installations to accommodate maximum axial movement as scheduled or indicated on Drawings.

2.2 SLEEVES AND SLEEVE SEALS

A. Sleeves with Waterstop:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Advance Products & Systems, LLC.
   b. CALPICO, Inc.
   c. GPT; a division of EnPRO Industries.
   d. Metraflex Company (The).

2. Description: Manufactured [**PVC/HDPE**] [**steel**] [**stainless steel**] [**galvanized-steel**], sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

B. Sleeve-Seal Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Advance Products & Systems, LLC.
   b. GPT; a division of EnPRO Industries.
   c. Metraflex Company (The).
   d. Proco Products, Inc.

2. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

   a. Hydrostatic Seal: 20 psig minimum.
   b. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   c. Pressure Plates: [**Carbon steel**] [**Composite plastic**] [**Stainless steel**] [**Stainless steel, Type 316**].
   d. Connecting Bolts and Nuts: [**Carbon steel, with zinc coating, ASTM B633**] [**Stainless steel**] [**Stainless steel, Type 316**] of length required to secure pressure plates to sealing elements.

C. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: 5000 psi, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

2.3 ESCUTCHEONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. BrassCraft Manufacturing Co.; a Masco company.
2. Dearborn Brass.
3. Jones Stephens Corp.
4. ProFlo; a Ferguson Enterprises, Inc. brand.

B. Escutcheon Types:
1. One-Piece, Stainless Steel Type: With polished stainless steel finish.
2. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.
3. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
4. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed and exposed-rivet hinge; and spring-clip fasteners.

C. Floor Plates:

1. Split Floor Plates: Cast brass with concealed hinge.

2.4 METERS AND GAUGES FOR PLUMBING PIPING

A. Pressure Gauges, Dial Type, Lead Free - Direct Mounted, Metal Case:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ametek U.S. Gauge.
b. Ashcroft Inc.
c. Blue Ribbon Corp.
d. Ernst Flow Industries.
e. Flo Fab Inc.

2. Source Limitations: Provide dial-type, lead-free, direct-mounted, metal-case pressure gauges from single manufacturer.
3. Standard: ASME B40.100.
4. Case: [**Liquid-filled**] [**Sealed**] [**Open-front, pressure-relief**] [**Solid-front, pressure-relief**] <**Insert type**> type(s); [**cast aluminum or drawn steel**] <**Insert material**>; [**4-1/2-inch**] [**6-inch**] <**Insert dimension**> nominal diameter.
5. Pressure-Element Assembly: Lead-free Bourdon tube.
6. Pressure Connection: Lead-free brass, with [**NPS 1/4**] [**NPS 1/4 or NPS 1/2**] [**NPS 1/2**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi**] [**psi and kPa**].
9. Pointer: Dark-colored metal.
10. Window: [**Glass**] [**Safety glass**] [**or**] [**plastic**] <**Insert material**>.
11. Ring: [**Metal**] [**Brass**] [**Stainless steel**] <**Insert material**>.
12. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**] [**Grade B, plus or minus 2 percent of middle half of**] [**Grade C, plus or minus 3 percent of middle half of**] [**Grade D, plus or minus 5 percent of whole**] span.

B. Pressure Gauges, Dial Type, Lead Free - Direct Mounted, Plastic Case:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ametek U.S. Gauge.
   b. Ashcroft Inc.
   c. Flo Fab Inc.

2. Source Limitations: Provide dial-type, lead-free, direct-mounted, plastic-case pressure gauges from a single manufacturer.
3. Standard: ASME B40.100.
4. Case: [**Sealed**] <**Insert type**> type; [**plastic**] <**Insert material**>; [**4-1/2-inch**] [**6-inch**] <**Insert dimension**> nominal diameter.
5. Pressure-Element Assembly: Lead-free Bourdon tube.
6. Pressure Connection: Lead-free brass, with [**NPS 1/4**] [**NPS 1/4 or NPS 1/2**] [**NPS 1/2**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi**] [**psi and kPa**].
9. Pointer: Dark-colored metal.
10. Window: [**Glass**] [**Safety glass**] [**or**] [**acrylic plastic**] <**Insert material**>.
11. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**] [**Grade B, plus or minus 2 percent of middle half of**] [**Grade C, plus or minus 3 percent of middle half of**] [**Grade D, plus or minus 5 percent of whole**] span.

C. Pressure Gauges, Dial Type, Lead Free - Remote Mounted, Metal Case:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ametek U.S. Gauge.
   b. Ashcroft Inc.
   c. Ernst Flow Industries.
   d. Flo Fab Inc.
   e. Marsh Bellofram.

2. Source Limitations: Provide dial-type, lead-free, remote-mounted, metal-case pressure gauges from a single manufacturer.
3. Standard: ASME B40.100.
4. Case: [**Liquid-filled**] [**Sealed**] <**Insert type**> type; [**cast aluminum or drawn steel**] [**metal**] <**Insert material**>; [**4-1/2-inch**] [**6-inch**] <**Insert dimension**> nominal diameter with [**back**] [**front**] flange and holes for panel mounting.
5. Pressure-Element Assembly: Lead-free Bourdon tube.

D. Pressure Gauges, Dial Type, Lead Free - Remote Mounted, Plastic Case:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ashcroft Inc.
   b. Flo Fab Inc.
   c. Miljoco Corporation.

2. Source Limitations: Provide dial-type, lead-free, remote-mounted, plastic-case pressure gauges from single manufacturer.
3. Standard: ASME B40.100.
4. Case: [**Sealed**] <**Insert type**> type; [**plastic**] <**Insert material**>; [**4-1/2-inch**] [**6-inch**] <**Insert dimension**> nominal diameter with [**back**] [**front**] flange and holes for panel mounting.
5. Pressure-Element Assembly: Lead-free Bourdon tube.
6. Pressure Connection: Lead-free brass, with [**NPS 1/4**] [**NPS 1/4 or NPS 1/2**] [**NPS 1/2**], ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanent scale markings graduated in [**psi**] [**psi and kPa**].
9. Pointer: Dark-colored metal.
10. Window: [**Glass**] [**Safety glass**] [**or**] [**acrylic plastic**] <**Insert material**>.
11. Accuracy: [**Grade A, plus or minus 1 percent of middle half of**] [**Grade B, plus or minus 2 percent of middle half of**] [**Grade C, plus or minus 3 percent of middle half of**] [**Grade D, plus or minus 5 percent of whole**] span.

E. Gauge Attachments, Lead Free:

1. Snubbers: ASME B40.100, lead-free brass; with [**NPS 1/4**] [**NPS 1/4 or NPS 1/2**] [**NPS 1/2**], ASME B1.20.1 pipe threads and [**piston**] [**porous-metal**]-type surge-dampening device. Include extension for use on insulated piping.
2. Valves: [**Lead-free brass ball**] [**Lead-free brass or stainless steel needle**], with [**NPS 1/4**] [**NPS 1/4 or NPS 1/2**] [**NPS 1/2**], ASME B1.20.1 pipe threads.

F. Test-Plug Kits, Lead Free:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Blue Ribbon Corp.
   b. Peterson Equipment Co., Inc.

2. Source Limitations: Provide lead-free test-plug kits from single manufacturer.
3. Furnish [**one**] <**Insert number**> test-plug kit(s) containing [**one**] [**two**] thermometer(s), one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes are to be of diameter to fit test plugs and of length to project into piping.
4. Low-Range Thermometer, Lead Free: Small, bimetallic insertion type with [**1- to 2-inch-**] <**Insert dimension**> diameter dial and tapered-end sensing element. Dial range is to be at least [**25 to 125 deg F**] <**Insert temperature range**>.
5. Pressure Gauge, Lead Free: Small, lead-free Bourdon-tube insertion type with [**2- to 3-inch-**] <**Insert dimension**> diameter dial and probe. Dial range is to be at least [**0 to 200 psig**] <**Insert range**>.
6. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.1 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Attach guides to pipe, and secure guides to building structure.

C. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

D. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9.
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-58, Type 24; U bolts bolted to anchor.

E. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
3. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

3.2 INSTALLATION OF SLEEVES - GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide [**1-inch**] [**2-inch**] <**Insert dimension**> annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas [**2 inches**] <**Insert dimension**> above finished floor level.

3. Using [**grout**] [**or**] [**silicone sealant**], seal the space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.3 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width of concrete slab or wall.

C. Secure nailing flanges to wooden concrete forms.

D. Using grout, seal space around outside of sleeves. Select to maintain fire resistance of floor/slab/wall.

3.4 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.5 INSTALLATION OF ESCUTCHEONS

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

3.6 INSTALLATION OF METERS AND GAUGES

A. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at most readable position.

B. Install remote-mounted pressure gauges on panel.

C. Install valve and snubber in piping for each pressure gauge for fluids.

D. Install test plugs in piping tees.

E. Install pressure gauges in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.

3.7 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

3.8 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gauges to proper angle for best visibility.

3.9 FIELD QUALITY CONTROL

A. Sleeves and Sleeve Seals:

1. Perform the following tests and inspections:

a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

2. Prepare test and inspection reports.

B. Escutcheons:

1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.10 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [**1-inch**] <**Insert dimension**> annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [**1-inch**] <**Insert dimension**> annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

a. [**Sleeves with waterstops**] [**or**] [**stack-sleeve fittings**].

4. Interior Wall and Partitions:

a. Sleeves without waterstops.

3.11 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping and Relocated Existing Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Chrome-Plated Piping: One piece, [**steel**] [**cast brass**][**or split-casting brass**] with polished, chrome-plated finish.
3. Insulated Piping:

   a. One piece, stainless steel with polished stainless steel finish.

4. Bare Piping at Wall and Floor Penetrations in Finished Spaces:

   a. One piece, stainless steel with polished stainless steel finish.

5. Bare Piping at Ceiling Penetrations in Finished Spaces:

   a. One piece, stainless steel with polished stainless steel finish.

6. Bare Piping in Unfinished Service Spaces:

   a. One piece, steel with polished, chrome-plated finish.

7. Bare Piping in Equipment Rooms:

   a. One piece, steel with polished, chrome-plated finish.

B. Install floor plates for piping penetrations of equipment-room floors.

C. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: One piece, floor plate.

3.12 PRESSURE-GAUGE APPLICATION

A. Pressure gauges at discharge of each water service into building are to be the following:

1. [**Liquid filled**] [**Sealed**] [**Open front, pressure relief**] [**Solid front, pressure relief**] <**Insert type**>, [**direct**] [**remote**] mounted, metal case.
2. [**Sealed**] <**Insert type**>, [**direct**] [**remote**] mounted, plastic case.
3. Test plug with [**chlorosulfonated polyethylene synthetic**] [**EPDM**] self-sealing rubber inserts.

B. Pressure gauges at inlet and outlet of each water pressure-reducing valve are to be the following:

1. [**Liquid filled**] [**Sealed**] [**Open front, pressure relief**] [**Solid front, pressure relief**] <**Insert type**>, [**direct**] [**remote**] mounted, metal case.
2. [**Sealed**] <**Insert type**>, [**direct**] [**remote**] mounted, plastic case.

3. Test plug with [**chlorosulfonated polyethylene synthetic**] [**EPDM**] self-sealing rubber inserts.

C. Pressure gauges at suction and discharge of each domestic water pump are to be the following:

1. [**Liquid filled**] [**Sealed**] [**Open front, pressure relief**] [**Solid front, pressure relief**] <**Insert type**>, [**direct**] [**remote**] mounted, metal case.
2. [**Sealed**] <**Insert type**>, [**direct**] [**remote**] mounted, plastic case.
3. Test plug with [**chlorosulfonated polyethylene synthetic**] [**EPDM**] self-sealing rubber inserts.

END OF SECTION 220500

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ball valves.
2. Butterfly valves.
3. Check valves.
4. Chainwheels.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene-diene terpolymer.

C. FKM: Fluoroelastomer.

D. NBR: Nitrile butadiene rubber (also known as Buna-N).

E. NRS: Nonrising stem.

F. OS&Y: Outside screw and yoke.

G. PTFE: Polytetrafluoroethylene.

H. RPTFE: Reinforced polytetrafluoroethylene.

I. RS: Rising stem.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include material descriptions and dimensions of individual components.
b. Include operating characteristics and furnished accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooved ends, press ends, solder ends, and weld ends.

3. Set ball valves open to minimize exposure of functional surfaces.
4. Set butterfly valves closed or slightly open.
5. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Standards:

1. Domestic-water piping valves intended to convey or dispense water for human consumption must comply with the U.S. Safe Drinking Water Act (SDWA), requirements of authorities having jurisdiction, and NSF 61/NSF 372; or to be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast-copper solder-joint connections.
6. ASME B16.22 for wrought-copper solder-joint connections.
7. ASME B16.34 for flanged- and threaded-end connections.
8. ASME B16.51 for press joint connections.
9. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Bypass and Drain Connections: MSS SP-45.

H. Valve Actuator Type:

1. Gear Actuator: For quarter-turn ball valves [**NPS 4**] <**Insert pipe size**> and larger.
2. Hand Lever: For quarter-turn ball valves smaller than [**NPS 4**] <**Insert pipe size**>.

I. Valves in Insulated Piping:

1. Provide 2-inch extended neck stems.
2. Provide extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Provide memory stops that are fully adjustable after insulation is applied.

2.3 BALL VALVES, LEAD FREE

A. Ball Valves, Lead Free, Threaded Ends - Brass, One Piece:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: 400 psig.
4. Body Design: One piece.
5. Body Material: Forged brass or bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Brass or stainless steel.
9. Ball: Chrome-plated brass or stainless steel.
10. Port: Reduced.

B. Ball Valves, Lead Free, Threaded or Soldered Ends - Brass, Two Piece with Full Port and Brass Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Two piece.
5. Body Material: Forged brass.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Brass.
9. Ball: Chrome-plated brass.
10. Port: Full.

C. Ball Valves, Lead Free, Press Ends - Brass, Two Piece with Full Port and Brass Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110, MSS SP-145, IAPMO/ANSI Z1157.
3. CWP Rating: Minimum 200 psig.
4. Body Design: Two piece.
5. Body Material: Forged brass.

6. Ends: Press.
7. Press-End Connections Rating: Minimum 200 psig.
8. Seats: PTFE or RPTFE.
9. Stem: Brass.
10. Ball: Chrome-plated brass.
11. Port: Full.
12. O-Ring Seal: NBR or EPDM.

D. Ball Valves, Lead Free, Threaded or Soldered Ends - Brass, Two Piece with Full Port and Stainless Steel Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Two piece.
5. Body Material: Forged brass.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

E. Ball Valves, Lead Free, Press Ends - Brass, Two Piece with Full Port and Stainless Steel Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110, MSS SP-145, and IAPMO/ANSI Z1157.
3. CWP Rating: Minimum 200 psig.
4. Body Design: Two piece.
5. Body Material: Forged brass.
6. Ends: Press.
7. Press-End Connections Rating: Minimum 200 psig.
8. Seats: PTFE or RPTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel, vented.
11. Port: Full.
12. O-Ring Seal: NBR or EPDM.

F. Ball Valves, Lead Free, Threaded or Soldered Ends - Brass, Two Piece with Regular Port and Brass Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Two piece.
5. Body Material: Forged brass.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Brass.
9. Ball: Chrome-plated brass.
10. Port: Regular.

G. Ball Valves, Lead Free, Threaded or Soldered Ends - Brass, Two Piece with Regular Port and Stainless Steel Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Two piece.
5. Body Material: Brass or bronze.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Regular.

H. Ball Valves, Lead Free, Threaded or Soldered Ends - Brass, Three Piece with Full Port and Brass Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Three piece.
5. Body Material: Forged brass.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Brass.
9. Ball: Chrome-plated brass.
10. Port: Full.

I. Ball Valves, Lead Free, Threaded or Soldered Ends - Brass, Three Piece with Full Port and Stainless Steel Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Three piece.
5. Body Material: Forged brass.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

J. Ball Valves, Lead Free, Threaded Ends - Bronze, One Piece with Bronze Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: 400 psig.
4. Body Design: One piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Bronze.
9. Ball: Chrome-plated brass.
10. Port: Reduced.

K. Ball Valves, Lead Free, Threaded Ends - Bronze, One Piece with Stainless Steel Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110 and MSS SP-145.

3. CWP Rating: 600 psig.
4. Body Design: One piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Reduced.

L. Ball Valves, Lead Free, Threaded or Soldered Ends - Bronze, Two Piece with Full Port and Bronze or Brass Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Bronze or brass.
9. Ball: Chrome-plated brass.
10. Port: Full.

M. Ball Valves, Lead Free, Press Ends - Bronze, Two Piece with Full Port and Bronze or Brass Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110, MSS SP-145, and IAPMO/ANSI Z1157.
3. CWP Rating: Minimum 200 psig.
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Press.
7. Press-End Connections Rating: Minimum 200 psig.
8. Seats: PTFE or RTPFE.
9. Stem: Bronze or brass.
10. Ball: Chrome-plated brass.
11. Port: Full.
12. O-Ring Seal: EPDM or NBR.

N. Ball Valves, Lead Free, Threaded or Soldered Ends - Bronze, Two Piece with Full Port and Stainless Steel Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

O. Ball Valves, Lead Free, Threaded Ends - Bronze, Two Piece with Regular Port and Bronze or Brass Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Bronze or brass.
9. Ball: Chrome-plated brass.
10. Port: Regular.

P. Ball Valves, Lead Free, Threaded Ends - Bronze, Two Piece with Regular Port and Stainless Steel Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Regular.

Q. Ball Valves, Lead Free, Threaded Ends - Bronze, Three Piece with Full Port and Bronze or Brass Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Three piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Bronze or brass.
9. Ball: Chrome-plated brass.
10. Port: Full.

R. Ball Valves, Lead Free, Threaded Ends - Bronze, Three Piece with Full Port and Stainless Steel Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Three piece.
5. Body Material: Bronze.
6. Ends: Threaded.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

S. Ball Valves, Lead Free, Threaded or Soldered Ends - Bronze, Three Piece with Regular Port and Bronze or Brass Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Three piece.
5. Body Material: Bronze.
6. Ends: Threaded or soldered.
7. Seats: PTFE.
8. Stem: Bronze.
9. Ball: Chrome-plated brass.
10. Port: Regular.

T. Ball Valves, Lead Free, Threaded or Soldered Ends - Bronze, Three Piece with Regular Port and Stainless Steel Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Three piece.
5. Body Material: Bronze.
6. Ends: Threaded or soldered.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Regular.

U. Ball Valves, Lead Free, Flanged or Threaded Ends - Steel, with Full Port, Class 150:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-72 and MSS SP-110.
3. CWP Rating: 285 psig.
4. Body Design: Split body.
5. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
6. Ends: Flanged or threaded. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

V. Ball Valves, Lead Free, Flanged or Threaded Ends - Steel, with Regular Port, Class 150:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-72 and MSS SP-110.
3. CWP Rating: 285 psig.
4. Body Design: Uni-body.
5. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
6. Ends: Flanged or threaded. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Regular.

W. Ball Valves, Lead Free, Flanged or Threaded Ends - Iron, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-72, MSS SP-110, and MSS SP-145.

3. CWP Rating: 200 psig.
4. Body Design: Split body.
5. Body Material: ASTM A126, gray iron.
6. Ends: Flanged or threaded. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel.
10. Port: Full.

X. Ball Valves, Lead Free, Threaded or Flanged Ends - Stainless Steel, Two Piece with Full Port:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: 200 psig.
4. Body Design: Split body.
5. Body Material: Type 316 stainless steel.
6. Ends: Threaded or flanged. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Type 316 stainless steel.
9. Ball: Type 316 stainless steel.
10. Port: Full.

Y. Ball Valves, Lead Free, Press Ends - Stainless Steel, Two Piece with Full Port:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110, MSS SP-145, IAPMO PS-117, and ICC-ES LC1002.
3. CWP Rating: Minimum 200 psig.
4. Body Design: Split body.
5. Body Material: Type 316 stainless steel.
6. Ends: Press.
7. Press-End Connections Rating: Minimum 200 psig.
8. Seats: PTFE.
9. Stem: Type 316 stainless steel.
10. Ball: Type 316 stainless steel.
11. Port: Full.
12. O-Ring Seal: EPDM or NBR.

Z. Ball Valves - CPVC, Union Type:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-122.
3. Pressure Rating and Temperature: 125 psig, 150 psig, or other pressure at 73 deg F or other temperature. See Part 3 ball valve schedule articles.
4. Body Material: CPVC.
5. Body Design: Union type.
6. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 ball valve schedule articles.
7. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket, socket or threaded, threaded, or flanged. See Part 3 ball valve schedule articles.
8. Ball: CPVC, full port.
9. Seals: PTFE or EPDM-rubber O-rings.
10. Handle: Tee shaped.

AA. Ball Valves - CPVC, Non-Union Type:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-122.
3. Pressure Rating and Temperature: 125 psig, 150 psig, or other pressure at 73 deg F. See Part 3 ball valve schedule articles.
4. Body Material: CPVC.
5. Body Design: Non-union type.
6. End Connections: Socket or threaded.
7. Ball: CPVC, full or reduced port.
8. Seals: PTFE or EPDM-rubber O-rings.
9. Handle: Tee shaped.

BB. Ball Valves - PVC, Union Type:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-122.
3. Pressure Rating and Temperature: 125 psig, 150 psig, or other pressure at 73 deg F or other temperature. See Part 3 ball valve schedule articles.
4. Body Material: PVC.
5. Body Design: Union type.
6. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 ball valve schedule articles.
7. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable union with socket, socket or threaded, threaded, or flanged. See Part 3 ball valve schedule articles.
8. Ball: PVC, full port.
9. Seals: PTFE or EPDM-rubber O-rings.
10. Handle: Tee shaped.

CC. Ball Valves - PVC, Non-Union Type:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-122.
3. Pressure Rating and Temperature: 125 psig, 150 psig, or other pressure at 73 deg F or other temperature.
4. Body Material: PVC.
5. Body Design: Non-union type.
6. End Connections: Socket or threaded.
7. Ball: PVC, full or reduced port.
8. Seals: PTFE or EPDM-rubber O-rings.
9. Handle: Tee shaped.

2.4 BALL VALVES, GENERAL PURPOSE

A. Ball Valves, Threaded or Soldered Ends - Brass, Two Piece with Full Port and Brass Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-110.
3. SWP Rating: 150 psig.
4. CWP Rating: 600 psig.
5. Body Design: Two piece.
6. Body Material: Forged brass.
7. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
8. Seats: PTFE.
9. Stem: Brass.

10. Ball: Chrome-plated brass.
11. Port: Full.

B. Ball Valves, Threaded or Soldered Ends - Brass, Two Piece with Full Port and Stainless Steel Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-110.
3. SWP Rating: 150 psig.
4. CWP Rating: 600 psig.
5. Body Design: Two piece.
6. Body Material: Forged brass.
7. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
8. Seats: PTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel, vented.
11. Port: Full.

C. Ball Valves, Threaded or Soldered Ends - Brass, Three Piece with Full Port and Brass Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-110.
3. SWP Rating: 150 psig.
4. CWP Rating: 600 psig.
5. Body Design: Three piece.
6. Body Material: Forged brass.
7. Ends: Threaded or soldered ends. See Part 3 ball valve schedule articles.
8. Seats: PTFE.
9. Stem: Brass.
10. Ball: Chrome-plated brass.
11. Port: Full.

D. Ball Valves, Threaded or Soldered Ends - Brass, Three Piece with Full Port and Stainless Steel Trim:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-110.
3. SWP Rating: 150 psig.
4. CWP Rating: 600 psig.
5. Body Design: Three piece.
6. Body Material: Forged brass.
7. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
8. Seats: PTFE.
9. Stem: Stainless steel.
10. Ball: Stainless steel, vented.
11. Port: Full.

E. Ball Valves, Threaded Ends - Bronze, Two Piece, Safety Exhaust:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: 200 psig or other pressure. See Part 3 ball valve schedule articles.
4. Body Design: Two piece.
5. Body Material: Bronze, ASTM B584, Alloy C844.
6. Ends: Threaded.

7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Chrome-plated brass, with exhaust vent opening for pneumatic applications.
10. Port: Full.

F. Ball Valves, Flanged Ends - Steel, with Full Port and Stainless Steel Trim, Class 150:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-72.
3. CWP Rating: 285 psig.
4. Body Design: Split body.
5. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
6. Ends: Flanged.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

G. Ball Valves, Flanged Ends - Steel, with Full Port and Stainless Steel Trim, Class 300:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-72.
3. CWP Rating: 720 psig.
4. Body Design: Split body.
5. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
6. Ends: Flanged.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

H. Ball Valves, Flanged Ends - Iron, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-72.
3. CWP Rating: 200 psig.
4. Body Design: Split body.
5. Body Material: ASTM A126, gray iron.
6. Ends: Flanged.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel.
10. Port: Full.

I. Ball Valves, Threaded or Flanged Ends - Stainless Steel, Two Piece with Full Port:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-110.
3. CWP Rating: 200 psig.
4. Body Design: Split body.
5. Body Material: Type 316 stainless steel.
6. Ends: Threaded or flanged. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Type 316 stainless steel.
9. Ball: Type 316 stainless steel.

10. Port: Full.

2.5 BUTTERFLY VALVES, LEAD FREE

A. Butterfly Valves, Lead Free, Single Flange (Lug Type) - Iron, with Aluminum-Bronze Disc:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-67, Type I.
3. CWP Rating: 150 psig, or 200 psig. See Part 3 butterfly valve schedule articles.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
7. Stem: One- or two-piece stainless steel.
8. Disc: Aluminum bronze.

B. Butterfly Valves, Lead Free, Single Flange (Lug Type) - Iron, with Ductile-Iron Disc:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-67, Type I.
3. CWP Rating: 150 psig, or 200 psig. See Part 3 butterfly valve schedule articles.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
7. Stem: One- or two-piece stainless steel.
8. Disc: Nickel-plated[**or -coated**] ductile iron.

C. Butterfly Valves, Lead Free, Single Flange (Lug Type) - Iron, with Stainless Steel Disc:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-67, Type I.
3. CWP Rating, NPS 12 (DN 300) and Smaller: 150 psig or 200 psig. See Part 3 butterfly valve schedule articles.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
7. Stem: One- or two-piece stainless steel.
8. Disc: Stainless steel.

D. Butterfly Valves, Lead Free, Flangeless (Wafer Type) - Iron, with Aluminum-Bronze Disc:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-67, Type I.
3. CWP Rating: 150 psig or 200 psig. See Part 3 butterfly valve schedule articles.
4. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
7. Stem: One- or two-piece stainless steel.
8. Disc: Aluminum bronze.

E. Butterfly Valves, Lead Free, Flangeless (Wafer Type) - Iron, with Ductile-Iron Disc:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-67, Type I.
3. CWP Rating: 150 psig or 200 psig. See Part 3 butterfly valve schedule articles.
4. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
7. Stem: One- or two-piece stainless steel.
8. Disc: Nickel-plated[**or -coated**] ductile iron.

F. Butterfly Valves, Lead Free, Flangeless (Wafer Type) - Iron, with Stainless Steel Disc:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-67, Type I.
3. CWP Rating: 150 psig or 200 psig. See Part 3 butterfly valve schedule articles.
4. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.
7. Stem: One- or two-piece stainless steel.
8. Disc: Stainless steel.

G. Butterfly Valves, Lead Free, Grooved End - Ductile Iron, 175 CWP:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-67, Type I.
3. CWP Rating: 175 psig.
4. Body Material: Coated, ductile iron.
5. Ends: Grooved.
6. Stem: Two-piece stainless steel.
7. Disc: Coated, ductile iron.
8. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.

H. Butterfly Valves, Lead Free, Grooved End - Ductile Iron, 300 CWP:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-67, Type I.
3. CWP Rating, NPS 8 (DN 200) and Smaller: 300 psig.
4. Body Material: Coated, ductile iron.
5. Ends: Grooved.
6. Stem: Two-piece stainless steel.
7. Disc: Coated, ductile iron.
8. Seat: EPDM or NBR. See Part 3 butterfly valve schedule articles.

I. Butterfly Valves, Lead Free, Grooved End - Stainless Steel:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-67, Type I.
3. CWP Rating, NPS 8 (DN 200) and Smaller: 300 psig.
4. CWP Rating, NPS 10 (DN 250) and Larger: 200 psig.
5. Body Material: Type 316 stainless steel, ASTM A743/A743M.
6. Ends: Grooved.
7. Stem: Type 416 stainless steel.
8. Disc: Type 316 stainless steel or ductile iron, encapsulated with Grade "EN" EPDM.
9. Seat: EDPM.

J. Butterfly Valves - CPVC:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Pressure Rating and Temperature: 125 psig, 150 psig, or other pressure at 73 deg F or other temperature. See Part 3 butterfly valve schedule articles.
3. Body Material: CPVC.
4. Body Design: Flangeless (wafer) type.
5. Seat: EPDM rubber.
6. Seals: PTFE or EPDM-rubber O-rings.
7. Disc: CPVC.
8. Stem: Stainless steel.
9. Handle: Lever.

K. Butterfly Valves - PVC:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Pressure Rating and Temperature: 125 psig, 150 psig, or other pressure at 73 deg F or other temperature. See Part 3 butterfly valve schedule articles.
3. Body Material: PVC.
4. Body Design: Flangeless (wafer) type.
5. Seat: EPDM rubber.
6. Seals: PTFE or EPDM-rubber O-rings.
7. Disc: PVC.
8. Stem: Stainless steel.
9. Handle: Lever.

2.6 BUTTERFLY VALVES, GENERAL PURPOSE

A. Butterfly Valves, Single Flange (Lug Type) - Iron, with Aluminum-Bronze Disc:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-67, Type I.
3. CWP Rating: 150 psig or 200 psig. See Part 3 butterfly valve schedule articles.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: NBR.
7. Stem: One- or two-piece stainless steel.
8. Disc: Aluminum bronze.

B. Butterfly Valves, Single Flange (Lug Type) - Iron, with Ductile-Iron Disc:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-67, Type I.
3. CWP Rating: 150 psig or 200 psig. See Part 3 butterfly valve schedule articles.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: NBR.
7. Stem: One- or two-piece stainless steel.
8. Disc: Nickel-plated[**or -coated**] ductile iron.

C. Butterfly Valves, Single Flange (Lug Type) - Iron, with Stainless Steel Disc:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-67, Type I.
3. CWP Rating: 150 psig or 200 psig. See Part 3 butterfly valve schedule articles.
4. Body Design: Single flange (lug type), suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: NBR.
7. Stem: One- or two-piece stainless steel.
8. Disc: Stainless steel.

D. Butterfly Valves, Flangeless (Wafer Type) - Iron, with Aluminum-Bronze Disc:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-67, Type I.
3. CWP Rating: 150 psig or 200 psig. See Part 3 butterfly valve schedule articles.
4. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: NBR.
7. Stem: One- or two-piece stainless steel.
8. Disc: Aluminum bronze.

E. Butterfly Valves, Flangeless (Wafer Type) - Iron, with Ductile-Iron Disc:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-67, Type I.
3. CWP Rating: 150 psig or 200 psig. See Part 3 butterfly valve schedule articles.
4. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: NBR.
7. Stem: One- or two-piece stainless steel.
8. Disc: Nickel-plated[**or -coated**] ductile iron.

F. Butterfly Valves, Flangeless (Wafer Type) - Iron, with Stainless Steel Disc:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-67, Type I.
3. CWP Rating: 150 psig or 200 psig. See Part 3 butterfly valve schedule articles.
4. Body Design: Flangeless (wafer type), suitable for bidirectional dead-end service at rated pressure.
5. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
6. Seat: NBR.
7. Stem: One- or two-piece stainless steel.
8. Disc: Stainless steel.

G. Butterfly Valves, Grooved End - Ductile Iron, 175 CWP:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-67, Type I.
3. CWP Rating: 175 psig.
4. Body Material: Coated, ductile iron.
5. Ends: Grooved.
6. Stem: Two-piece stainless steel.
7. Disc: Coated, ductile iron.

8. Seat: NBR.

H. Butterfly Valves, Grooved End - Ductile Iron, 300 CWP:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-67, Type I.
3. CWP Rating, NPS 8 (DN 200) and Smaller: 300 psig.
4. Body Material: Coated, ductile iron
5. Ends: Grooved.
6. Stem: Two-piece stainless steel.
7. Disc: Coated, ductile iron.
8. Seat: NBR.

I. Butterfly Valves, Grooved End - Stainless Steel:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-67, Type I.
3. CWP Rating, NPS 8 (DN 200) and Smaller: 300 psig.
4. Body Material: Type 316 stainless steel, ASTM A743/A743M.
5. Ends: Grooved.
6. Stem: Type 416 stainless steel.
7. Disc: Type 316 stainless steel.
8. Seat: NBR.

2.7 CHECK VALVES, LEAD FREE

A. Check Valves, Lead Free, Swing Type, Threaded or Soldered Ends - Bronze, with Bronze Disc, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-80, Type 3.
3. CWP Rating: 200 psig.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered. See Part 3 check valve schedule articles.
7. Disc: Bronze.

B. Check Valves, Lead Free, Swing Type, Threaded or Soldered Ends - Bronze, with Nonmetallic Disc, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-80, Type 4.
3. CWP Rating: 200 psig.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered. See Part 3 check valve schedule articles.
7. Disc: PTFE.

C. Check Valves, Lead Free, Swing Type, Threaded or Soldered Ends - Bronze, with Bronze Disc, Class 150:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-80, Type 3.

3. CWP Rating: 300 psig.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered. See Part 3 check valve schedule articles.
7. Disc: Bronze.

D. Check Valves, Lead Free, Swing Type, Threaded or Soldered Ends - Bronze, with Nonmetallic Disc, Class 150:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-80, Type 4.
3. CWP Rating: 300 psig.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered. See Part 3 check valve schedule articles.
7. Disc: PTFE.

E. Check Valves, Lead Free, Swing Type, Press Ends - Bronze:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: MSS SP-80 and MSS SP-139.
3. CWP Rating: Minimum 200 psig.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B584, bronze.
6. Ends: Press.
7. Press-End Connections Rating: Minimum 200 psig.
8. Disc: Brass or bronze.

F. Check Valves, Lead Free, Swing Type, Flanged or Threaded Ends - Iron, with Metal Seats, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-71, Type I.
3. CWP Rating: 200 psig.
4. Body Design: Clear or full waterway.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged or threaded. See Part 3 check valve schedule articles.
7. Trim: Bronze.
8. Gasket: Asbestos free.

G. Check Valves, Lead Free, Swing Type, Flanged or Threaded Ends - Iron, with Nonmetallic-to-Metal Seats, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-71, Type I.
3. CWP Rating: 200 psig.
4. Body Design: Clear or full waterway.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged or threaded. See Part 3 check valve schedule articles.
7. Trim: Composition.
8. Seat Ring: Bronze.
9. Disc Holder: Bronze.
10. Disc: PTFE.
11. Gasket: Asbestos free.

H. Check Valves, Lead Free, Swing Type, Flanged or Threaded Ends - Iron, with Metal Seats, Class 250:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-71, Type I.
3. CWP Rating: 500 psig.
4. Body Design: Clear or full waterway.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged or threaded. See Part 3 check valve schedule articles.
7. Trim: Bronze.
8. Gasket: Asbestos free.

I. Check Valves, Lead Free, Swing Type, Flanged or Threaded Ends - Iron, with Lever- and Spring-Closure Control, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-71, Type I.
3. CWP Rating: 200 psig.
4. Body Design: Clear or full waterway.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged or threaded. See Part 3 check valve schedule articles.
7. Trim: Bronze.
8. Gasket: Asbestos free.
9. Closure Control: Factory-installed exterior lever and weight.

J. Check Valves, Lead Free, Swing Type, Flanged or Threaded Ends - Iron, with Lever- and Weight-Closure Control, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-71, Type I.
3. CWP Rating: 200 psig.
4. Body Design: Clear or full waterway.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged or threaded. See Part 3 check valve schedule articles.
7. Trim: Bronze.
8. Gasket: Asbestos free.
9. Closure Control: Factory-installed exterior lever and weight.

K. Check Valves, Lead Free, Swing Type, Grooved Ends - Iron, 300 CWP:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. CWP Rating: 300 psig.
3. Body Material: ASTM A536, ductile iron.
4. Seat: EPDM.
5. Disc: Spring operated, ductile iron or stainless steel.

L. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Metal Seat, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-125.
3. CWP Rating: 200 psig.
4. Body Material: ASTM A126, gray iron.
5. Style: Compact wafer, spring loaded.
6. Seat: Bronze.

M. Check Valves, Lead Free, Center Guided - Iron, Globe, with Metal Seat, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-125.
3. CWP Rating: 200 psig.
4. Body Material: ASTM A126, gray iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: Bronze.

N. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Metal Seat, Class 150:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-125.
3. CWP Rating: 300 psig.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Compact wafer, spring loaded.
6. Seat: Bronze.

O. Check Valves, Lead Free, Center Guided - Iron, Globe, with Metal Seat, Class 150:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-125.
3. CWP Rating: 300 psig.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: Bronze.

P. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Metal Seat, Class 250:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-125.
3. CWP Rating: 400 psig.
4. Body Material: ASTM A126, gray iron.
5. Style: Compact wafer, spring loaded.
6. Seat: Bronze.

Q. Check Valves, Lead Free, Center Guided - Iron, Globe, with Metal Seat, Class 250:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-125.
3. CWP Rating: 400 psig.
4. Body Material: ASTM A126, gray iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: Bronze.

R. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Metal Seat, Class 300:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-125.
3. CWP Rating: 500 psig.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Compact wafer, spring loaded.

6. Seat: Bronze.

S. Check Valves, Lead Free, Center Guided - Iron, Globe, with Metal Seat, Class 300:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-125.
3. CWP Rating: 500 psig.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: Bronze.

T. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Resilient Seat, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-125.
3. CWP Rating: 200 psig.
4. Body Material: ASTM A126, gray iron.
5. Style: Compact wafer, spring loaded.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

U. Check Valves, Lead Free, Center Guided - Iron, Globe, with Resilient Seat, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-125.
3. CWP Rating: 200 psig.
4. Body Material: ASTM A126, gray iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

V. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Resilient Seat, Class 150:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-125.
3. CWP Rating: 300 psig.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Compact wafer, spring loaded.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

W. Check Valves, Lead Free, Center Guided - Iron, Globe, with Resilient Seat, Class 150:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-125.
3. CWP Rating: 300 psig.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

X. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Resilient Seat, Class 250:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-125.

3. CWP Rating: 400 psig.
4. Body Material: ASTM A126, gray iron.
5. Style: Compact wafer, spring loaded.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

Y. Check Valves, Lead Free, Center Guided - Iron, Globe, with Resilient Seat, Class 250:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-125.
3. CWP Rating: 400 psig.
4. Body Material: ASTM A126, gray iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

Z. Check Valves, Lead Free, Center Guided - Iron, Compact Wafer, with Resilient Seat, Class 300:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-125.
3. CWP Rating: 500 psig.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Compact wafer, spring loaded.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

AA. Check Valves, Lead Free, Center Guided - Iron, Globe, with Resilient Seat, Class 300:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-125.
3. CWP Rating: 500 psig.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Globe, spring loaded.
6. Ends: Flange.
7. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

BB. Check Valves, Lead Free, Dual-Plate Type - Iron, with Metal Seat, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: API 594.
3. CWP Rating: 200 psig.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A126, gray iron.
6. Seat: Bronze.

CC. Check Valves, Lead Free, Dual-Plate Type - Iron, with Metal Seat, Class 150:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: API 594.
3. CWP Rating: 300 psig.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
6. Seat: Bronze.

DD. Check Valves, Lead Free, Dual-Plate Type - Iron, with Metal Seat, Class 250:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: API 594.
3. CWP Rating: 400 psig.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A126, gray iron.
6. Seat: Bronze.

EE. Check Valves, Lead Free, Dual-Plate Type - Iron, with Metal Seat, Class 300:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: API 594.
3. CWP Rating: 500 psig.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
6. Seat: Bronze.

FF. Check Valves, Lead Free, Single-Plate Type - Iron, with Resilient Seat, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: API 594.
3. CWP Rating: 200 psig.
4. Body Design: Wafer, single spring-loaded plate.
5. Body Material: ASTM A126, gray iron.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

GG. Check Valves, Lead Free, Dual-Plate Type - Iron, with Resilient Seat, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: API 594.
3. CWP Rating: 200 psig.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A126, gray iron.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

HH. Check Valves, Lead Free, Dual-Plate Type - Iron, with Resilient Seat, Class 150:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: API 594.
3. CWP Rating: 300 psig.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

II. Check Valves, Lead Free, Single-Plate Type - Iron, with Resilient Seat, Class 250:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: API 594.
3. CWP Rating: 400 psig.
4. Body Design: Wafer, single spring-loaded plate.
5. Body Material: ASTM A126, gray iron.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

JJ. Check Valves, Lead Free, Dual-Plate Type - Iron, with Resilient Seat, Class 250:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: API 594.
3. CWP Rating: 400 psig.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A126, gray iron.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

KK. Check Valves, Lead Free, Dual-Plate Type - Iron, with Resilient Seat, Class 300:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: API 594.
3. CWP Rating: 500 psig.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
6. Seat: EPDM or NBR. See Part 3 check valve schedule articles.

LL. Check Valves, Lead Free - CPVC, Union-Type Ball Check:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Pressure Rating and Temperature: 125 psig, 150 psig, or other pressure at 73 deg F or other temperature. See Part 3 check valve schedule articles.
3. Body Material: CPVC.
4. Body Design: Union-type ball check.
5. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 check valve schedule articles.
6. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket, socket or threaded, threaded, flanged. See Part 3 check valve schedule articles.
7. Ball: CPVC.
8. Seals: EPDM- or FKM-rubber O-rings.

MM. Check Valves, Lead Free - PVC, Union-Type Ball Check:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Pressure Rating and Temperature: 125 psig, 150 psig, or other pressure at 73 deg F or other temperature. See Part 3 check valve schedule articles.
3. Body Material: PVC.
4. Body Design: Union-type ball check.
5. End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket or threaded. See Part 3 check valve schedule articles.
6. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, [**socket**] [**socket or threaded**] [**threaded**] [**flange**].
7. Ball: PVC.
8. Seals: EPDM- or FKM-rubber O-rings.

2.8 CHECK VALVES, GENERAL PURPOSE

A. Check Valves, Lift Type, Threaded or Soldered Ends - Bronze, with Bronze Disc, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-80, Type 1.
3. CWP Rating: 200 psig.
4. Body Design: Vertical flow.
5. Body Material: ASTM B61 or ASTM B62, bronze.
6. Ends: Threaded or soldered ends. See Part 3 check valve schedule articles.

7. Disc: Bronze.

B. Check Valves, Lift Type, Threaded or Soldered Ends - Bronze, with Nonmetallic Disc, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-80, Type 2.
3. CWP Rating: 200 psig.
4. Body Design: Vertical flow.
5. Body Material: ASTM B61 or ASTM B62, bronze.
6. Ends: Threaded or soldered ends. See Part 3 check valve schedule articles.
7. Disc: NBR or PTFE.

C. Check Valves, Swing Type, Threaded or Soldered Ends - Bronze, with Bronze Disc, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-80, Type 3.
3. CWP Rating: 200 psig.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered ends. See Part 3 check valve schedule articles.
7. Disc: Bronze.

D. Check Valves, Swing Type, Threaded or Soldered Ends - Bronze, with Nonmetallic Disc, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-80, Type 4.
3. CWP Rating: 200 psig.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered ends. See Part 3 check valve schedule articles.
7. Disc: PTFE.

E. Check Valves, Swing Type, Threaded or Soldered Ends - Bronze, with Bronze Disc, Class 150:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-80, Type 3.
3. CWP Rating: 300 psig.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered ends. See Part 3 check valve schedule articles.
7. Disc: Bronze.

F. Check Valves, Swing Type, Threaded or Soldered Ends - Bronze, with Nonmetallic Disc, Class 150:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-80, Type 4.
3. CWP Rating: 300 psig.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered ends. See Part 3 check valve schedule articles.
7. Disc: PTFE.

G. Check Valves, Swing Type, Flanged Ends - Iron, with Metal Seats, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-71, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 psig.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): 150 psig.
5. Body Design: Clear or full waterway.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Bronze.
9. Gasket: Asbestos free.

H. Check Valves, Swing Type, Flanged Ends - Iron, with Nonmetallic-to-Metal Seats, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-71, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 psig.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): 150 psig.
5. Body Design: Clear or full waterway.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Composition.
9. Seat Ring: Bronze.
10. Disc Holder: Bronze.
11. Disc: PTFE.
12. Gasket: Asbestos free.

I. Check Valves, Swing Type, Flanged Ends - Iron, with Metal Seats, Class 250:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-71, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 500 psig.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): 300 psig.
5. Body Design: Clear or full waterway.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Bronze.
9. Gasket: Asbestos free.

J. Check Valves, Swing Type, Flanged Ends - Iron, with Lever- and Spring-Closure Control, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-71, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 psig.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): 150 psig.
5. Body Design: Clear or full waterway.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Bronze.
9. Gasket: Asbestos free.
10. Closure Control: Factory-installed, exterior lever and spring.

K. Check Valves, Swing Type, Flanged Ends - Iron, with Lever- and Weight-Closure Control, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: MSS SP-71, Type I.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 psig.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): 150 psig.
5. Body Design: Clear or full waterway.
6. Body Material: ASTM A126, gray iron with bolted bonnet.
7. Ends: Flanged.
8. Trim: Bronze.
9. Gasket: Asbestos free.
10. Closure Control: Factory-installed, exterior lever and weight.

L. Check Valves, Swing Type, Grooved Ends - Iron, 300 CWP:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. CWP Rating: 300 psig.
3. Body Material: ASTM A536, ductile iron.
4. Seat: NBR.
5. Disc: Spring operated, ductile iron or stainless steel.

M. Check Valves, Dual-Plate Type - Iron, with Metal Seat, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 psig.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): 150 psig.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A126, gray iron.
7. Seat: Bronze.

N. Check Valves, Dual-Plate Type - Iron, with Metal Seat, Class 150:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 300 psig.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): 250 psig.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Seat: Bronze.

O. Check Valves, Dual-Plate Type - Iron, with Metal Seat, Class 250:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 400 psig.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): 300 psig.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A126, gray iron.
7. Seat: Bronze.

P. Check Valves, Dual-Plate Type - Iron, with Metal Seat, Class 300:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 500 psig.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): 400 psig.

5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Seat: Bronze.

Q. Check Valves, Single-Plate Type - Iron, with Resilient Seat, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 psig.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): 150 psig.
5. Body Design: Wafer, single spring-loaded plate.
6. Body Material: ASTM A126, gray iron.
7. Seat: NBR.

R. Check Valves, Dual-Plate Type - Iron, with Resilient Seat, Class 125:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 psig.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): 150 psig.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A126, gray iron.
7. Seat: NBR.

S. Check Valves, Dual-Plate Type - Iron, with Resilient Seat, Class 150:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 300 psig.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): 250 psig.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Seat: NBR.

T. Check Valves, Single-Plate Type - Iron, with Resilient Seat, Class 250:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 400 psig.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): 300 psig.
5. Body Design: Wafer, single spring-loaded plate.
6. Body Material: ASTM A126, gray iron.
7. Seat: NBR.

U. Check Valves, Dual-Plate Type - Iron, with Resilient Seat, Class 250:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 400 psig.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): 300 psig.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A126, gray iron.
7. Seat: NBR.

V. Check Valves, Dual-Plate Type - Iron, with Resilient Seat, Class 300:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: API 594.
3. CWP Rating, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 500 psig.
4. CWP Rating, NPS 14 to NPS 24 (DN 350 to DN 600): 400 psig.
5. Body Design: Wafer, spring-loaded plates.
6. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
7. Seat: NBR.

2.9 CHAINWHEELS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Valve actuation assembly with sprocket rim, chain guides, chain[**, and attachment brackets for mounting chainwheels directly to handwheels**].

1. Sprocket Rim with Chain Guides: [**Ductile iron**] [**Ductile or cast iron**] [**Cast iron**] [**Aluminum**] [**Bronze**], of type and size required for valve.[**Include zinc or epoxy coating.**]
2. Chain: [**Hot-dip, galvanized steel**] [**Brass**] [**Stainless steel**], of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Examine press fittings to verify they have been properly pressed.

F. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.

D. For valves in horizontal piping, install valves with stem at or above center of pipe.

E. Install valves in position that does not project into aisles or block access to other equipment.

F. Install valves in position to allow full stem and actuator or manual operator movement.

G. Verify that joints of each valve have been properly installed and sealed to assure there is no leakage or damage.

H. Chainwheels: Install chainwheels on manual operators for [**butterfly**] [**globe**] [**and**] [**gate**] valves [**NPS 4**] <**Insert pipe size**> and larger and more than [**96 inches**] <**Insert dimension**> above floor. Extend chains to [**60 inches**] <**Insert dimension**> above finished floor.

I. Install check valves for proper direction of flow and as follows:

1. Check Valves: [**Center-guided type**] [**and**] [**plate type**], in horizontal or vertical position, between flanges.
2. Check Valves, Swing Type: In horizontal position with hinge pin level.
3. Check Valves, Lift Type: With stem upright and plumb.

J. Valve Tags: Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

K. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's written recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
7. For Stainless Steel Piping, NPS 2 (DN 50) and Smaller: [**Threaded**] [**Press**] ends.

8. For Stainless Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends.
9. For Grooved-End Copper Tubing: Valve ends may be grooved.
10. For Grooved-End Steel Piping: Valve ends may be grooved.
11. Wafer-Type Valves: Flanged connections.

3.5 LOW-PRESSURE, COMPRESSED-AIR BALL VALVE SCHEDULE - 150 PSIG (1035 kPa) OR LESS

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, threaded or soldered ends - brass, three piece with full port and brass trim; [**threaded**] [**soldered**] ends.
2. Ball valves, threaded or soldered ends - brass, three piece with full port and stainless steel trim; [**threaded**] [**soldered**] ends.
3. Ball valves, threaded or soldered ends - brass, two piece with full port and brass trim; [**threaded**] [**soldered**] ends.
4. Ball valves, threaded or soldered ends - brass, two piece with full port and stainless steel trim; [**threaded**] [**soldered**] ends.
5. Ball valves, threaded or flanged ends - stainless steel, two piece with full port; [**threaded**] [**flanged**] ends.
6. Ball valves, threaded ends - bronze, two piece, safety exhaust; [**200 psig**] <**Insert pressure**>.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.
2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.
3. Ball valves, flanged ends - iron, Class 125.
4. Ball valves, threaded or flanged ends - stainless steel, two piece with full port; [**threaded**] [**flanged**] ends.

3.6 HIGH-PRESSURE, COMPRESSED-AIR BALL VALVE SCHEDULE - 150 TO 200 PSIG (1035 TO 1380 kPa)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, threaded or soldered ends - brass, three piece with full port and brass trim; [**threaded**] [**soldered**] ends.
2. Ball valves, threaded or soldered ends - brass, three piece with full port and stainless steel trim; [**threaded**] [**soldered**] ends.
3. Ball valves, threaded or soldered ends - brass, two piece with full port and brass trim; [**threaded**] [**soldered**] ends.
4. Ball valves, threaded or soldered ends - brass, two piece with full port and stainless steel trim; [**threaded**] [**soldered**] ends.
5. Ball valves, threaded or flanged ends - stainless steel, two piece with full port; [**threaded**] [**flanged**] ends.
6. Ball valves, threaded ends - bronze, two piece, safety exhaust; [**200 psig**] <**Insert pressure**>.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.

2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.
3. Ball valves, flanged ends - iron, Class 125.
4. Ball valves, threaded or flanged ends - stainless steel, two piece with full port; [**threaded**] [**flanged**] ends.

3.7 DOMESTIC HOT- AND COLD-WATER BALL VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, lead free, threaded ends - brass, one piece.
2. Ball valves, lead free, threaded or soldered ends - brass, two piece with full port and brass trim; [**threaded**] [**soldered**] ends.
3. Ball valves, lead free, threaded or soldered ends - brass, two piece with full port and stainless steel trim; [**threaded**] [**soldered**] ends.
4. Ball valves, lead free, threaded or soldered ends - brass, two piece with regular port and brass trim; [**threaded**] [**soldered**] ends.
5. Ball valves, lead free, threaded or soldered ends - brass, two piece with regular port and stainless steel trim; [**threaded**] [**soldered**] ends.
6. Ball valves, lead free, threaded or soldered ends - brass, three piece with full port and brass trim; [**threaded**] [**soldered**] ends.
7. Ball valves, lead free, threaded or soldered ends - brass, three piece with full port and stainless steel trim; [**threaded**] [**soldered**] ends.
8. Ball valves, lead free, threaded ends - bronze, one piece with bronze trim.
9. Ball valves, lead free, threaded ends - bronze, one piece with stainless steel trim.
10. Ball valves, lead free, threaded or soldered ends - bronze, two piece with full port and bronze or brass trim; [**threaded**] [**soldered**] ends.
11. Ball valves, lead free, threaded or soldered ends - bronze, two piece with full port and stainless steel trim; [**threaded**] [**soldered**] ends.
12. Ball valves, lead free, threaded ends - bronze, two piece with regular port and bronze or brass trim.
13. Ball valves, lead free, threaded ends - bronze, two piece with regular port and stainless steel trim.
14. Ball valves, lead free, threaded ends - bronze, three piece with full port and bronze or brass trim.
15. Ball valves, lead free, threaded ends - bronze, three piece with full port and stainless steel trim.
16. Ball valves, lead free, threaded or soldered ends - bronze, three piece with regular port and bronze or brass trim; [**threaded**] [**soldered**] ends.
17. Ball valves, lead free, threaded or soldered ends - bronze, three piece with regular port and stainless steel trim; [**threaded**] [**soldered**] ends.
18. Ball valves, lead free, threaded or flanged ends - stainless steel, two piece with full port; [**threaded**] [**flanged**] ends.
19. Ball valves, lead free, press ends - brass, two piece with full port and brass trim.
20. Ball valves, lead free, press ends - brass, two piece with full port and stainless steel trim.
21. Ball valves, lead free, press ends - bronze, two piece with full port and bronze or brass trim.
22. Ball valves, lead free, press ends - stainless steel, two piece with full port.
23. Ball valves, lead free, flanged or threaded ends - steel, with full port, Class 150; [**threaded**] [**flanged**] ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, lead free, flanged or threaded ends - iron, Class 125; [**flanged**] [**threaded**] ends.

2. Ball valves, lead free, flanged or threaded ends - steel, with full port, Class 150; [**flanged**] [**threaded**] ends.
3. Ball valves, lead free, flanged or threaded ends - steel, with regular port, Class 150; [**flanged**] [**threaded**] ends.
4. Ball valves, threaded or flanged ends - stainless steel, two piece with full port; [**threaded**] [**flanged**] ends.

C. For CPVC Pipe:

1. CPVC Union-Type Ball Check Valve: [**NPS 2 and smaller**] [**NPS 4 and smaller**] [**125 psig**] [**150 psig**] <**Insert pressure**> at [**73 deg F**] <**Insert temperature**>.

   a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**] [**or**] [**threaded**].
   b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**] [**Socket or threaded**] [**Threaded**] [**Flanged**].

D. For PVC Pipe:

1. PVC Union-Type Ball Check Valve: [**NPS 2 and smaller**] [**NPS 4 and smaller**] [**125 psig**] [**150 psig**] <**Insert pressure**> at [**73 deg F**] <**Insert temperature**>.

   a. End Connections for Valves NPS 2 (DN 50) and Smaller: [**Socket**] [**or**] [**threaded**].
   b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [**Socket**] [**Socket or threaded**] [**Threaded**] [**Flanged**].

3.8 LOW-PRESSURE, COMPRESSED-AIR BUTTERFLY VALVE SCHEDULE - 150 PSIG (1035 kPa) OR LESS

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - iron, with aluminum-bronze disc; [**150**] [**200**] CWP, NBR seat.
2. Butterfly valves, single flange (lug type) - iron, with ductile-iron disc; [**150**] [**200**] CWP, NBR seat.
3. Butterfly valves, single flange (lug type) - iron, with stainless steel disc; [**150**] [**200**] CWP, NBR seat.
4. Butterfly valves, flangeless (wafer type) - iron, with aluminum-bronze disc; [**150**] [**200**] CWP, NBR seat.
5. Butterfly valves, flangeless (wafer type) - iron, with ductile-iron disc; [**150**] [**200**] CWP, NBR seat.
6. Butterfly valves, flangeless (wafer type) - iron, with stainless steel disc; [**150**] [**200**] CWP, NBR seat.
7. Butterfly valves, grooved end - ductile iron, 175 CWP; NBR seat.
8. Butterfly valves, grooved end - ductile iron, 300 CWP; NBR seat.
9. Butterfly valves, grooved end - stainless steel; NBR seat.

3.9 HIGH-PRESSURE, COMPRESSED-AIR BUTTERFLY VALVE SCHEDULE - 150 TO 200 PSIG (1035 TO 1380 kPa)

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, single flange (lug type) - iron, with aluminum-bronze disc; 200 CWP, NBR seat.
2. Butterfly valves, single flange (lug type) - iron, with ductile-iron disc; 200 CWP, NBR seat.
3. Butterfly valves, single flange (lug type) - iron, with stainless steel disc; 200 CWP, NBR seat.
4. Butterfly valves, flangeless (wafer type) - iron, with aluminum-bronze disc; 200 CWP, NBR seat.
5. Butterfly valves, flangeless (wafer type) - iron, with ductile-iron disc; 200 CWP, NBR seat.
6. Butterfly valves, flangeless (wafer type) - iron, with stainless steel disc; 200 CWP, NBR seat.
7. Butterfly valves, grooved end - ductile iron, 175 CWP; NBR seat.
8. Butterfly valves, grooved end - ductile iron, 300 CWP; NBR seat.
9. Butterfly valves, grooved end - stainless steel; NBR seat.

3.10 DOMESTIC HOT- AND COLD-WATER BUTTERFLY VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, lead free, single flange (lug type) - iron, with aluminum-bronze disc; [**150**] [**200**] CWP, [**EPDM**] [**NBR**] seat.
2. Butterfly valves, lead free, single flange (lug type) - iron, with ductile-iron disc; [**150**] [**200**] CWP, [**EPDM**] [**NBR**] seat.
3. Butterfly valves, lead free, single flange (lug type) - iron, with stainless steel disc; [**150**] [**200**] CWP, [**EPDM**] [**NBR**] seat.
4. Butterfly valves, lead free, flangeless (wafer type) - iron, with aluminum-bronze disc; [**150**] [**200**] CWP, [**EPDM**] [**NBR**] seat.
5. Butterfly valves, lead free, flangeless (wafer type) - iron, with ductile-iron disc; [**150**] [**200**] CWP, [**EPDM**] [**NBR**] seat.
6. Butterfly valves, lead free, flangeless (wafer type) - iron, with stainless steel disc; [**150**] [**200**] CWP, [**EPDM**] [**NBR**] seat.
7. Butterfly valves, lead free, grooved end - ductile iron, 175 CWP; [**EPDM**] [**NBR**] seat.
8. Butterfly valves, lead free, grooved end - ductile iron, 300 CWP; [**EPDM**] [**NBR**] seat.

B. For CPVC Pipe: CPVC butterfly valve for [**NPS 2-1/2**] [**NPS 5**] and larger.

C. For PVC Pipe: PVC butterfly valve for [**NPS 2-1/2**] [**NPS 5**] and larger.

D. For Stainless Steel Pipe: Stainless steel, grooved-end butterfly valve for NPS 2-1/2 and larger.

3.11 LOW-PRESSURE, COMPRESSED-AIR CHECK VALVE SCHEDULE - 150 PSIG (1035 kPa) OR LESS

A. Pipe NPS 2 (DN 50) and Smaller:

1. Vertical, Upflow Applications Only:

   a. Check valves, lift type, threaded or soldered ends - bronze, with bronze disc, Class 125; [**threaded**] [**soldered**] ends.
   b. Check valves, lift type, threaded or soldered ends - bronze, with nonmetallic disc, Class 125; [**threaded**] [**soldered**] ends.

2. Horizontal and Vertical Applications:

a. Check valves, swing type, threaded or soldered ends - bronze, with bronze disc, Class 125; [**threaded**] [**soldered**] ends.
b. Check valves, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 125; [**threaded**] [**soldered**] ends.
c. Check valves, swing type, threaded or soldered ends - bronze, with bronze disc, Class 150; [**threaded**] [**soldered**] ends.
d. Check valves, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 150; [**threaded**] [**soldered**] ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, swing type, flanged ends - iron, with metal seats, Class 125.
2. Check valves, swing type, flanged ends - iron, with nonmetallic-to-metal seats, Class 125.
3. Check valves, swing type, flanged ends - iron, with metal seats, Class 250.
4. Check valves, swing type, grooved ends - iron, 300 CWP.
5. Check valves, dual-plate type - iron, with metal seat, Class 125.
6. Check valves, dual-plate type - iron, with metal seat, Class 150.
7. Check valves, dual-plate type - iron, with metal seat, Class 250.
8. Check valves, dual-plate type - iron, with metal seat, Class 300.
9. Check valves, dual-plate type - iron, with resilient seat, Class 125.
10. Check valves, dual-plate type - iron, with resilient seat, Class 150.
11. Check valves, dual-plate type - iron, with resilient seat, Class 250.
12. Check valves, dual-plate type - iron, with resilient seat, Class 300.
13. Check valves, single-plate type - iron, with resilient seat, Class 125; NBR seat.
14. Check valves, single-plate type - iron, with resilient seat, Class 250; NBR seat.

3.12 HIGH-PRESSURE, COMPRESSED-AIR CHECK VALVE SCHEDULE - 150 TO 200 PSIG (1035 TO 1380 kPa)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Vertical, Upflow Applications Only:

a. Check valves, lift type, threaded or soldered ends - bronze, with bronze disc, Class 125; [**threaded**] [**soldered**] ends.
b. Check valves, lift type, threaded or soldered ends - bronze, with nonmetallic disc, Class 125; [**threaded**] [**soldered**] ends.

2. Horizontal and Vertical Applications:

a. Check valves, swing type, threaded or soldered ends - bronze, with bronze disc, Class 125; [**threaded**] [**soldered**] ends.
b. Check valves, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 125; [**threaded**] [**soldered**] ends.
c. Check valves, swing type, threaded or soldered ends - bronze, with bronze disc, Class 150; [**threaded**] [**soldered**] ends.
d. Check valves, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 150; [**threaded**] [**soldered**] ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, swing type, flanged ends - iron, with metal seats, Class 125.

2. Check valves, swing type, flanged ends - iron, with nonmetallic-to-metal seats, Class 125.
3. Check valves, swing type, flanged ends - iron, with metal seats, Class 250.
4. Check valves, swing type, grooved ends - iron, 300 CWP.
5. Check valves, dual-plate type - iron, with metal seat, Class 125.
6. Check valves, dual-plate type - iron, with metal seat, Class 150.
7. Check valves, dual-plate type - iron, with metal seat, Class 250.
8. Check valves, dual-plate type - iron, with metal seat, Class 300.
9. Check valves, dual-plate type - iron, with resilient seat, Class 125.
10. Check valves, dual-plate type - iron, with resilient seat, Class 150.
11. Check valves, dual-plate type - iron, with resilient seat, Class 250.
12. Check valves, dual-plate type - iron, with resilient seat, Class 300.
13. Check valves, single-plate type - iron, with resilient seat, Class 125; NBR seat.
14. Check valves, single-plate type - iron, with resilient seat, Class 250; NBR seat.

3.13 DOMESTIC HOT- AND COLD-WATER CHECK VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, lead free, swing type, threaded or soldered ends - bronze, with bronze disc, Class 125; [**threaded**] [**soldered**] ends.
2. Check valves, lead free, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 125; [**threaded**] [**soldered**] ends.
3. Check valves, lead free, swing type, threaded or soldered ends - bronze, with bronze disc, Class 150; [**threaded**] [**soldered**] ends.
4. Check valves, lead free, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 150; [**threaded**] [**soldered**] ends.
5. Check valves, lead free, swing type, press ends - bronze.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, lead free, swing type, flanged or threaded ends - iron, with metal seats, Class 125; [**flanged**] [**threaded**] ends.
2. Check valves, lead free, swing type, flanged or threaded ends - iron, with nonmetallic-to-metal Seats, Class 125; [**flanged**] [**threaded**] ends.
3. Check valves, lead free, swing type, flanged or threaded ends - iron, with metal seats, Class 250; [**flanged**] [**threaded**] ends.
4. Check valves, lead free, swing type, flanged or threaded ends - iron, with lever- and spring-closure control, Class 125; [**flanged**] [**threaded**] ends.
5. Check valves, lead free, swing type, flanged or threaded ends - iron, with lever- and weight-closure control, Class 125; [**flanged**] [**threaded**] ends.
6. Check valves, lead free, swing type, grooved ends - iron, 300 CWP.
7. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 125.
8. Check valves, lead free, center guided - iron, globe, with metal seat, Class 125.
9. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 150.
10. Check valves, lead free, center guided - iron, globe, with metal seat, Class 150.
11. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 250.
12. Check valves, lead free, center guided - iron, globe, with metal seat, Class 250.
13. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 300.
14. Check valves, lead free, center guided - iron, globe, with metal seat, Class 300.
15. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 125; [**EPDM**] [**or**] [**NBR**] seat.
16. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 125; [**EPDM**] [**or**] [**NBR**] seat.

17. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 150; [**EPDM**] [**or**] [**NBR**] seat.
18. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 150; [**EPDM**] [**or**] [**NBR**] seat.
19. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 250; [**EPDM**] [**or**] [**NBR**] seat.
20. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 250; [**EPDM**] [**or**] [**NBR**] seat.
21. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 300; [**EPDM**] [**or**] [**NBR**] seat.
22. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 300; [**EPDM**] [**or**] [**NBR**] seat.
23. Check valves, lead free, dual-plate type - iron, with metal seat, Class 125.
24. Check valves, lead free, dual-plate type - iron, with metal seat, Class 150.
25. Check valves, lead free, dual-plate type - iron, with metal seat, Class 250.
26. Check valves, lead free, dual-plate type - iron, with metal seat, Class 300.
27. Check valves, lead free, single-plate type - iron, with resilient seat, Class 125; [**EPDM**] [**or**] [**NBR**] seat.
28. Check valves, lead free, dual-plate type - iron, with resilient seat, Class 125; [**EPDM**] [**or**] [**NBR**] seat.
29. Check valves, lead free, dual-plate type - iron, with resilient seat, Class 150; [**EPDM**] [**or**] [**NBR**] seat.
30. Check valves, lead free, single-plate type - iron, with resilient seat, Class 250; [**EPDM**] [**or**] [**NBR**] seat.
31. Check valves, lead free, dual-plate type - iron, with resilient seat, Class 250; [**EPDM**] [**or**] [**NBR**] seat.
32. Check valves, lead free, dual-plate type - iron, with resilient seat, Class 300; [**EPDM**] [**or**] [**NBR**] seat.

C. For CPVC Pipe:

1. NPS 2 (DN 50) and Smaller: [**Union**] [**Non-union**] ball valve.
2. NPS 4 (DN 100) and Smaller: [**Union**] [**Non-union**] ball valve.

D. For PVC Pipe:

1. NPS 2 (DN 50) and Smaller: [**Union**] [**Non-union**] ball valve.
2. NPS 4 (DN 100) and Smaller: [**Union**] [**Non-union**] ball valve.

3.14 PUMP-DISCHARGE CHECK VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, lead free, swing type, threaded or soldered ends - bronze, with bronze disc, Class 125; [**threaded**] [**soldered**] ends.
2. Check valves, lead free, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 125; [**threaded**] [**soldered**] ends.
3. Check valves, lead free, swing type, threaded or soldered ends - bronze, with bronze disc, Class 150; [**threaded**] [**soldered**] ends.
4. Check valves, lead free, swing type, threaded or soldered ends - bronze, with nonmetallic disc, Class 150; [**threaded**] [**soldered**] ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger for Domestic Water Pumps:

1. Check valves, lead free, swing type, flanged or threaded ends - iron, with lever- and spring-closure control, Class 125; [**flanged**] [**threaded**] ends.
2. Check valves, lead free, swing type, flanged or threaded ends - iron, with lever- and weight-closure control, Class 125; [**flanged**] [**threaded**] ends.
3. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 125.
4. Check valves, lead free, center guided - iron, globe, with metal seat, Class 125.
5. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 150.
6. Check valves, lead free, center guided - iron, globe, with metal seat, Class 150.
7. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 250.
8. Check valves, lead free, center guided - iron, globe, with metal seat, Class 250.
9. Check valves, lead free, center guided - iron, compact wafer, with metal seat, Class 300.
10. Check valves, lead free, center guided - iron, globe, with metal seat, Class 300.
11. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 125; [**EPDM**] [**or**] [**NBR**] seat.
12. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 125; [**EPDM**] [**or**] [**NBR**] seat.
13. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 150; [**EPDM**] [**or**] [**NBR**] seat.
14. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 150; [**EPDM**] [**or**] [**NBR**] seat.
15. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 250; [**EPDM**] [**or**] [**NBR**] seat.
16. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 250; [**EPDM**] [**or**] [**NBR**] seat.
17. Check valves, lead free, center guided - iron, compact wafer, with resilient seat, Class 300; [**EPDM**] [**or**] [**NBR**] seat.
18. Check valves, lead free, center guided - iron, globe, with resilient seat, Class 300; [**EPDM**] [**or**] [**NBR**] seat.

C. Pipe NPS 2-1/2 (DN 65) and Larger for Sanitary Waste and Storm Drainage:

1. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.
2. Check valves, swing type, flanged ends - iron, with lever- and weight-closure control, Class 125.

3.15 LOW-PRESSURE, COMPRESSED-AIR GATE VALVE SCHEDULE - 150 PSIG (1035 kPa) OR LESS

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, threaded or soldered ends - bronze, NRS, Class 125; [**threaded**] [**soldered**] ends.
2. Gate valves, threaded or soldered ends - bronze, RS, Class 125; [**threaded**] [**soldered**] ends.
3. Gate valves, threaded ends - bronze, NRS, Class 150.
4. Gate valves, threaded ends - bronze, RS, Class 150.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, flanged ends - iron, NRS, Class 125.
2. Gate valves, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, flanged ends - iron, NRS, Class 250.
4. Gate valves, flanged ends - iron, OS&Y, Class 250.

3.16 HIGH-PRESSURE, COMPRESSED-AIR GATE VALVE SCHEDULE - 150 TO 200 PSIG (1035 TO 1380 kPa)

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, threaded or soldered ends - bronze, NRS, Class 125; [**threaded**] [**or**] [**soldered**] ends.
2. Gate valves, threaded or soldered ends - bronze, RS, Class 125; [**threaded**] [**or**] [**soldered**] ends.
3. Gate valves, threaded ends - bronze, NRS, Class 150.
4. Gate valves, threaded ends - bronze, RS, Class 150.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, flanged ends - iron, NRS, Class 125.
2. Gate valves, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, flanged ends - iron, NRS, Class 250.
4. Gate valves, flanged ends - iron, OS&Y, Class 250.

3.17 DOMESTIC HOT- AND COLD-WATER GATE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, lead free, threaded or soldered ends - bronze, NRS, Class 125; [**threaded**] [**or**] [**soldered**] ends.
2. Gate valves, lead free, threaded or soldered ends - bronze, RS, Class 125; [**threaded**] [**or**] [**soldered**] ends.
3. Gate valves, lead free, threaded ends - bronze, NRS, Class 150.
4. Gate valves, lead free, threaded ends - bronze, RS, Class 150.
5. Gate valves, lead free, press ends - bronze.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, lead free, flanged ends - iron, NRS, Class 125.
2. Gate valves, lead free, flanged ends - iron, OS&Y, Class 125.
3. Gate valves, lead free, flanged ends - iron, NRS, Class 250.
4. Gate valves, lead free, flanged ends - iron, OS&Y, Class 250.

C. For CPVC Pipe:

1. NPS 2 (DN 50) and Smaller: [**Union**] [**Non-union**] gate valve.
2. NPS 4 (DN 100) and Smaller: [**Union**] [**Non-union**] gate valve.

D. For PVC Pipe:

1. NPS 2 (DN 50) and Smaller: [**Union**] [**Non-union**] gate valve.
2. NPS 4 (DN 100) and Smaller: [**Union**] [**Non-union**] gate valve.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports - metal.
2. Pipe hangers - metal, trapeze type.
3. Pipe hangers - FRP.
4. Strut support systems - metal, rod type.
5. Strut support systems - FRP.
6. Thermal hanger-shield inserts.
7. Fastener systems.
8. Pipe-positioning systems.
9. Equipment supports.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 220500 "Common Work Results for Plumbing" for pipe guides and anchors.
3. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for recycled content.>

C. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Metal strut support systems.
3. Rooftop-mounted strut support systems.
4. FRP strut support systems.
5. Pipe stands.
6. Equipment supports.

D. Delegated Design Submittals: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication/assembly and design calculations for trapeze hangers.
2. Detail fabrication/assembly and design calculations for each type of strut support system, by the manufacturer's technical representative.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

B. Pipe Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for plumbing piping and equipment are to withstand the effects of gravity loads and stresses within limits and under conditions indicated in accordance with ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

2.2 PIPE HANGERS AND SUPPORTS - METAL

A. Pipe Hangers and Supports - Carbon Steel:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
3. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
4. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
5. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**carbon steel**] [**stainless steel**] <**Insert material**>.

B. Pipe Hangers and Supports - Stainless Steel:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

3. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**stainless steel**] <**Insert material**>.

C. Pipe/Tube Hangers and Supports - Copper:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: MSS SP-58, Types 1 through 58, copper-plated-steel, factory-fabricated components.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**copper-plated steel**] [**stainless steel**] <**Insert material**>.

2.3 PIPE HANGERS - METAL, TRAPEZE TYPE

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 PIPE HANGERS - FRP

A. Pipe Hangers - FRP, Clevis Type:

1. Description: Similar to MSS SP-58, Type 1 factory-fabricated steel pipe hanger, except hanger is made of fiberglass-reinforced plastic resin.
2. Hanger Rods: Continuous-thread stainless steel rod, washer, and nuts made of stainless steel.
3. Flammability: ASTM D635, ASTM E84, UL 94.

B. Pipe Hangers - FRP, Strap Type:

1. Description: Similar to MSS SP-58, Type 9 or Type 10 steel pipe hanger, except hanger is made of fiberglass-reinforced plastic resin.

   a. Flammability: ASTM D635, ASTM E84, UL 94.

2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

2.5 STRUT SUPPORT SYSTEMS - METAL, ROD TYPE

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Factory-fabricated pipe-support assembly, made of steel channels, vertical metal support rods, accessories, fittings, and other components for supporting multiple parallel pipes.

C. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.

D. Struts: Continuous slotted [**carbon-steel**] [**stainless steel, Type 304**] [**stainless steel, Type 316**] [**extruded-aluminum**] <**Insert material**> [**channel with inturned lips**] [**or**] [**angle**] <**Insert strut type**>.

E. Strut Width: Selected for applicable load criteria.

F. Strut Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

G. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**carbon steel**] [**stainless steel**] <**Insert material**>.

H. Metallic Coating: [**Plain**] [**Pregalvanized G90**] [**Electroplated zinc**] [**Hot-dip galvanized**] [**Gold (yellow zinc dichromate) galvanized**].

I. Paint Coating: [**Green epoxy, acrylic, or urethane**] <**Insert paint type**>.

J. Plastic Coating: [**PVC**] <**Insert plastic type**>.

1. Combination Coating: <**Insert combination coating**>.

2.6 STRUT SUPPORT SYSTEMS - FRP

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Structural-grade, factory-formed, glass-fiber-resin channels and angles for supporting multiple parallel pipes.

1. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
2. Struts: Continuous slotted fiberglass-reinforced plastic channel with inturned lips.
3. Strut Width: Selected for applicable load criteria.
4. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
5. Fitting and Accessory Materials: Same as those for channels and angles[**, except metal items may be stainless steel**].
6. Rated Strength: Selected to suit applicable load criteria.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.7 THERMAL HANGER-SHIELD INSERTS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Insulation-Insert Material for Cold Piping: [**ASTM C552, Type II cellular glass with 100 psig**] [**or**] [**ASTM C591, Type VI, Grade 1 polyisocyanurate with 125 psig**] minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: [**Water-repellent-treated, ASTM C533, Type I calcium silicate with 100 psig**] [**ASTM C552, Type II cellular glass with 100 psig**] [**or**] [**ASTM C591, Type VI, Grade 1 polyisocyanurate with 125 psig**] minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield are to cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield are to cover bottom 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.8 FASTENER SYSTEMS

A. Fastener System - Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities required for supported loads and building materials where used.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Fastener System - Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities required for supported loads and building materials where used.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Indoor Applications: [**Zinc-plated**] [**or**] [**stainless**] steel.
3. Outdoor Applications: Stainless steel.

2.9 PIPE-POSITIONING SYSTEMS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.10 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.11 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000 psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination is to include weight of supported components plus [**200 lb**] <**Insert value**>.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

B. Install lateral bracing with pipe hangers and supports to prevent swaying.

C. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, [**NPS 2-1/2**] <**Insert pipe size**> and larger[**and at changes in direction of piping**]. Coordinate location of concrete inserts before concrete is placed.

D. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

E. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

F. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Thermal-hanger shield inserts may be used as an option. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields are to span an arc of 180 degrees.

a. Thermal-hanger shield inserts may be used as an option. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches long and 0.048 inch thick.
b. NPS 4 (DN 100): 12 inches long and 0.06 inch thick.
c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches long and 0.06 inch thick.
d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches long and 0.075 inch thick.
e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

G. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

H. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
2. Field fabricate in accordance with ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel in accordance with AWS D1.1/D1.1M.

I. FRP Pipe-Hanger Installation: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.

J. Strut System Installation: [**Metal**] [**FRP**]; arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

K. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

L. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick after concrete is placed and cured. Use installers that are licensed by powder-actuated tool manufacturer.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners in accordance with manufacturer's written instructions.
3. Install lag screw wood fasteners in accordance with manufacturer's written instructions.
4. Install fasteners in accordance with manufacturer's written instructions.

M. Pipe Stand Installation:

1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

N. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

O. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

P. Equipment Support Installation:

1. Fabricate from welded-structural-steel shapes.
2. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
3. Grouting: Place grout under supports for floor-mounted equipment, and make bearing surface smooth.
4. Provide lateral bracing, to prevent swaying.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for [**trapeze pipe hangers**] [**and**] [**equipment supports**].

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to [**1-1/2 inches**] <**Insert dimension**>.

3.5 PAINTING

A. Touchup:

1. Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

   a. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

2. Comply with requirements in Section 099123 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
3. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel [**pipe hangers and supports**] [**metal trapeze pipe hangers**] [**and**] [**metal framing systems**] and attachments for general service applications.

F. Use [**stainless steel pipe hangers**] [**FRP pipe hangers**] [**and**] [**FRP strut systems**] and [**stainless steel**] [**or**] [**corrosion-resistant**] attachments for hostile environment applications.

G. Use copper-plated pipe hangers and [**copper**] [**or**] [**stainless steel**] attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal hanger-shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction occurs.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Use [**powder-actuated fasteners**] [**or**] [**mechanical-expansion anchors**] instead of building attachments where required in concrete construction.

R. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220548 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient support.
9. Resilient pipe guides.
10. Air-spring isolators.
11. Restrained-air-spring isolators.
12. Elastomeric hangers.
13. Spring hangers.
14. Snubbers.
15. Restraints - rigid type.
16. Restraints - cable type.
17. Restraint accessories.
18. Post-installed concrete anchors.
19. Concrete inserts.
20. Vibration isolation equipment bases.

B. Related Requirements:

1. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for non-structural components.
2. Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" specifies devices for fire-suppression equipment and systems.
3. Section 230548 "Vibration and Seismic Controls for HVAC" specifies devices for HVAC equipment and systems.

1.2 DEFINITIONS

A. Designated Seismic System: An architectural, mechanical, electrical, plumbing, or fire-protection system and its components for which the component importance factor is greater than 1.0 when determined in accordance with Section 018123 "Facility Seismic and Wind Criteria."

B. IBC: International Building Code.

C. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

1.3 DELEGATED DESIGN SERVICES

A. Delegated Design Professional: Engage qualified professional structural engineer to design, sign/seal, seismic and wind restraints.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
b. Include load rating for each seismic-[**and wind-**]restraint device.
c. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-[**and wind-**]restraint component.
d. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by [**ICC-ES product listing**] [**UL product listing**] [**FM Approvals**] [**an evaluation service member of ICC-ES**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**].
e. Annotate to indicate application of each product submitted and compliance with requirements.
f. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
3. Show coordination of seismic [**and wind**] restraints for components with other systems and equipment in the vicinity, including other supports and other seismic restraints.

C. Delegated Design Submittal:

1. All delegated design and submittals for [**seismic**] [**and**] [**wind**] restraints must be signed and sealed by a qualified professional structural engineer responsible for their preparation. Structural engineer is to possess qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering, including design of seismic and wind restraints, equipment hangers and supports, and concrete attachments.
2. For each seismic-restraint device, including [**seismic-restrained mounting,**] [**pipe-riser resilient support,**] [**snubber,**] [**seismic restraint,**] [**seismic-restraint accessory,**] [**and**] [**concrete anchor and insert,**] that is required by this Section or is indicated on Drawings, submit the following:

a. Seismic Restraint, Vibration Isolator, and Vibration Isolation Base Selection: Select and submit seismic restraints [**and**] vibration isolators [**, and vibration isolation bases**] complying with performance requirements, design criteria, and analysis data.
b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification by

professional engineer that riser system was examined for excessive stress and that none exists.

c. Post-Installed Concrete Anchors and Concrete Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by an NRTL for reinforcement use.

d. Seismic Design Calculations: Submit all input data and loading calculations.

3. For each wind-restraint device, including [**restraint - rigid,**] [**restraint - cable,**] [**restraint accessory,**] [**concrete anchor,**] [**and**] [**concrete insert**] that is required by this Section or is indicated on Drawings, submit the following:

   a. Wind Restraints: Select and submit wind restraints complying with performance requirements, design criteria, and analysis data.
   b. Post-Installed Concrete Anchors and Inserts: Include calculations showing wind-restraint criteria. Include certification that device is approved by qualified testing laboratory for reinforcement use.
   c. Wind-Restraint Design Calculations: Submit all input data and loading calculations.

4. Seismic- and Wind-Restraint Detail Drawing:

   a. Design Analysis: To support selection and arrangement of seismic[**and wind**] restraints. Include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
   c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.

5. Product Listing, Preapproval, and Evaluation Documentation: By [**an evaluation service member of ICC-ES**] [**UL**] [**FM Approvals**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**], showing maximum ratings of restraint items and the basis for approval (tests or calculations).
6. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
7. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation [**and wind-**] and seismic-restraint devices for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For [**professional engineer**] [**and**] [**testing agency**].

C. Welding certificates.

D. Air-Spring Isolator Performance Certification: Include natural frequency, load, and damping test data[**performed by an independent agency**].

E. Field quality-control reports:

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [**air-spring isolators**] [**and**] [**restrained-air-spring isolators**] to include in operation and maintenance manuals.

1.7 REGULATORY AGENCY APPROVALS

A. Delegated design submittals and Shop Drawings requiring approval by authorities having jurisdiction must be signed by qualified structural professional engineer responsible for their preparation. [**Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.**] [**Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.**]

1.8 QUALIFICATIONS

A. Professional Structural Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering, including design of seismic and wind restraints, equipment hangers and supports, and concrete foundations.

1.9 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage qualified professional structural engineer to prepare seismic- and wind-restraint calculations in accordance with criteria specified in Section 018123 "Facility Seismic and Wind Criteria."

B. Seismic- and Wind-Restraint-Device Load Ratings: Devices must be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices are must be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: [**ICC-ES product listing**] [**UL product listing**] [**FM Approvals**] [**an evaluation service member of ICC-ES**] [**an agency acceptable to authorities having jurisdiction**].

C. Consequential Damage: Provide additional seismic[**and wind**] restraints for suspended components or anchorage of floor-, roof-, or wall-mounted components so that failure of a nonessential or essential component will not cause failure of any other essential building component.

D. Fire/Smoke Resistance: Seismic- and wind-restraint devices that are not constructed of ferrous metals are to have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by qualified testing laboratory in accordance with ASTM E84 or UL 723 and be labeled as such.

E. Component Supports:

1. Load ratings, features, and applications of reinforcement components are to be based on testing standards of qualified testing laboratory.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain elastomeric isolation pads from single manufacturer.
3. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
4. Size: Factory or field cut to match requirements of supported equipment.
5. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
6. Surface Pattern: Smooth, ribbed, or waffle pattern.
7. Infused nonwoven cotton or synthetic fibers.
8. Load-bearing metal plates adhered to pads.
9. Sandwich-Core Material: [**Resilient**] [**and**] [**elastomeric**] <**Insert compound**>.

    a. Surface Pattern: Smooth, ribbed, or waffle pattern.
    b. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain double-deflection, elastomeric isolation mounts from single manufacturer.
3. Mounting Plates:

    a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded[**with threaded studs or bolts**].
    b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

4. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain restrained elastomeric isolation mounts from single manufacturer.
3. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

   a. Housing: Cast-ductile iron or welded steel.
   b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain freestanding, laterally stable, open-spring isolators from single manufacturer.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
8. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.6 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain freestanding, laterally stable, housed, open-spring isolators from single manufacturer.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.

b. Top housing with [**attachment and leveling bolt**] [**threaded mounting holes and internal leveling device**] [**elastomeric pad**].

2.7 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain restrained-spring isolators from single manufacturer.
3. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

   a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
   b. Top plate with [**threaded mounting holes**] [**elastomeric pad**].
   c. Internal leveling bolt that acts as blocking during installation.

4. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
5. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
6. Minimum Additional Travel: 50 percent of the required deflection at rated load.
7. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
8. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain freestanding, open-spring isolators with vertical-limit stop restraints from single manufacturer.
3. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with [**adjustable**] [**nonadjustable**] snubbers to limit vertical movement.

   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
   b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 PIPE-RISER RESILIENT SUPPORT

A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-Inch- (13-mm-) Thick Neoprene <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain resilient pipe-riser supports from single manufacturer.
3. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch-thick neoprene.
4. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
5. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.10 RESILIENT PIPE GUIDES

A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-Inch- (13-mm-) Thick Neoprene <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain resilient pipe guides from single manufacturer.
3. Description: resilient pipe guide with telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene.
4. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.11 AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain air-spring isolators from single manufacturer.
3. Arrangement: [**Single**] [**or**] [**multiple**].
4. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
5. Maximum Natural Frequency: 3 Hz.
6. Operating Pressure Range: 25 to 100 psig.
7. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
8. Automatic leveling valve.

2.12 RESTRAINED-AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain restrained-air-spring isolators from single manufacturer.
3. Arrangement: [**Single**] [**or**] [**multiple**].

4. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

    a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
    b. Top plate with [**threaded mounting holes**] [**elastomeric pad**].
    c. Internal leveling bolt that acts as blocking during installation.

5. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
6. Minimum Additional Travel: 50 percent of the required deflection at rated load.
7. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
8. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
9. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
10. Maximum Natural Frequency: [**3 Hz**] <**Insert frequency**>.
11. Operating Pressure Range: 25 to 100 psig.
12. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
13. Automatic leveling valve.

2.13 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain elastomeric hangers from a single manufacturer.
3. Description: Elastomeric hanger mounted in a steel frame with upper and lower steel hanger rods.
4. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
5. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.

2.14 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain spring hangers from single manufacturer.
3. Description: Combination coil-spring and elastomeric-insert hanger.
4. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
5. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
6. Minimum Additional Travel: 50 percent of the required deflection at rated load.
7. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
8. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

9. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
10. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
11. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.15 SNUBBERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain snubbers from single manufacturer.

C. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with [**ACI 318-08 Appendix D for 2009 IBC**] [**ACI 318-11 Appendix D for 2012 IBC**] [**ACI 318-14, Ch. 17 for 2015 or 2018 IBC**]. Preset concrete inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
2. Anchors in Masonry: Design in accordance with TMS 402.
3. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
4. Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch thick.

2.16 RESTRAINTS - RIGID TYPE

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain rigid-type restraints from single manufacturer.

C. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.17 RESTRAINTS - CABLE TYPE

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain cable-type restraints from single manufacturer.

C. Seismic- and Wind-Restraint Cables: [**ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel**] [**ASTM A492 stainless steel**] cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

D. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge type end fittings do not comply and are unacceptable.

2.18 RESTRAINT ACCESSORIES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain restraint accessories from single manufacturer.

C. Hanger-Rod Stiffener: [**Steel tube or steel slotted-support-system sleeve with internally bolted connections**] [**Reinforcing steel angle clamped**] to hanger rod. Non-metallic stiffeners are unacceptable.

D. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to [**rigid channel bracings**] [**and**] [**restraint cables**].

E. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

F. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.19 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain mechanical anchor bolts from single manufacturer.
3. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain adhesive anchor bolts from single manufacturer.
3. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in seismic applications. Post-installed concrete anchors must comply with all requirements of [**ASCE/SEI 7-05, Ch. 13**] [**ASCE/SEI 7-10, Ch. 13**] [**ASCE/SEI 7-16, Ch. 13**].

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp, which is not vibration isolated.

1. Undercut expansion anchors are permitted.

2.20 CONCRETE INSERTS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain concrete inserts from single manufacturer.

C. Provide preset concrete inserts, which are seismically prequalified in accordance with ICC-ES AC466 testing.

D. Comply with ANSI/MSS 58.

2.21 VIBRATION ISOLATION EQUIPMENT BASES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain vibration isolation equipment bases from single manufacturer.

C. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

D. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

E. Concrete Inertia Base: [**Factory-fabricated**] [**or**] [**field-fabricated**], welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- [**and wind-**]restraint devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by [**an evaluation service member of ICC-ES**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**].

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support Assemblies: Where not specifically indicated otherwise, select sizes of components so strength is adequate to carry static[**, wind load,**] and seismic load within specified loading limits.

3.3 INSTALLATION OF VIBRATION CONTROLS AND SEISMIC RESTRAINTS FOR PLUMBING PIPING AND EQUIPMENT

A. Provide seismic-[**and wind-**]restraint devices and vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules, where indicated on Drawings, or where the Specifications indicate they are to be installed on specific equipment and systems.

B. Provide seismic-restraint [**and wind-restraint**]devices for systems and equipment where indicated in Equipment Schedules or Seismic-Restraint Devices Schedules, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

D. Installation of vibration isolators[**, wind-restraints,**] and seismic restraints must not cause any stresses, misalignment, or change of position of equipment or piping.

E. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

F. Equipment Restraints:

1. Install snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint[**and wind-restraint**] devices using methods approved by [**an evaluation service member of ICC-ES**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

G. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of [**40 feet**] <**Insert dimension**> o.c., and longitudinal supports a maximum of [**80 feet**] <**Insert dimension**> o.c.
3. Brace a change of direction longer than 12 feet.

H. Install seismic-[**and wind-**]restraint cables so they do not bend across edges of adjacent equipment or building structure.

I. Install seismic-[**and wind-**]restraint devices using methods approved by [**an evaluation service member of ICC-ES**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

L. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

M. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify Project structural engineer if reinforcing steel or other embedded items are

encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Mechanical Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 INSTALLATION OF AIR-SPRING ISOLATORS

A. Independent Isolator Installation:

1. Install automatic leveling valve into each air isolator.
2. Inflate each isolator to [**height**] [**and**] [**pressure**] specified on Drawings.

B. Pressure-Regulated Isolator Installation:

1. Coordinate the constant pressure-regulated air supply to air springs with the requirements for piping and connections specified in Section 221513 "General-Service Compressed-Air Piping."
2. Connect all pressure regulators to a single dry, filtered [**facility**] [**constant**] air supply.
3. Inflate isolators to [**height**] [**and**] [**or**] [**pressure**] specified on Drawings.

3.5 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 221116 "Domestic Water Piping" and Section 221119 "Domestic Water Piping Specialties" for piping flexible connections.

3.6 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate dimensions of steel equipment rails, bases, and concrete inertia bases, with requirements of isolated equipment specified in this and other Sections. Where dimensions of bases are indicated on Drawings, they may require adjustment to accommodate actual isolated equipment.

3.7 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:

1. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].
2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
5. Test at least [**four**] <**Insert number**> of each type and size of installed anchors and fasteners selected by Architect.
6. Test to 90 percent of rated proof load of device.
7. Measure isolator restraint clearance.
8. Measure isolator deflection.
9. Verify snubber minimum clearances.
10. Test and adjust restrained-air-spring isolator controls and safeties.

D. Remove and replace malfunctioning units and retest as specified above.

E. Units will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 220548

SECTION 220548.13 - VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient support.
9. Resilient pipe guides.
10. Air-spring isolators.
11. Restrained-air-spring isolators.
12. Elastomeric hangers.
13. Spring hangers.
14. Snubbers.
15. Restraints - rigid type.
16. Restraints - cable type.
17. Restraint accessories.
18. Post-installed concrete anchors.
19. Concrete inserts.
20. Vibration isolation equipment bases.

B. Related Requirements:

1. Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.
2. Section 230548.13 "Vibration Controls for HVAC" for devices for HVAC equipment and systems.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

2. Include load rating for each wind-load-restraint fitting and assembly.
3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device [**and wind-load-restraint**]component.
4. Annotate to indicate application of each product submitted and compliance with requirements.
5. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal:

1. For each wind-load protection device that is required by this Section or is indicated on Drawings, submit the following:

a. Vibration Isolator and Wind-Load-Restraint Selection: Select vibration isolators and wind-load restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
c. Concrete Anchors and Inserts: Include calculations showing anticipated wind loads.
d. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.
1) Qualified Professional Engineer: All designated-design submittals for wind-restraint calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.
e. Wind-Restraint Detail Drawings:

1) Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.
2) Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during wind events. Indicate association with vibration isolation devices.

3) Coordinate vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.

f. All delegated-design submittals for wind-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.

g. Product Listing, Preapproval, and Evaluation Documentation: By [**an evaluation service member of ICC-ES**] [**UL**] [**FM Approvals**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**], showing maximum ratings of restraint items and basis for approval (tests or calculations).

2. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
3. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation [**and wind-load reinforcement**]device installation for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For [**professional engineer**] [**and**] [**testing agency**].

C. Welding certificates.

D. Air-Spring Mounting System Performance Certification: Include natural frequency, load, and damping test data[**performed by an independent agency**].

E. Field quality-control reports.

F. Wind-Load Performance Certification: Provide special certification for plumbing components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-load performance certification.

1. Provide equipment manufacturer's written certification for each designated plumbing device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
2. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.
3. The following plumbing systems and components require special certification for high wind performance. Written special certification of resistance to the effects of high wind load and impact damage must be provided by manufacturer.

   a. <**Insert list**>.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [**air-spring mounts**] [**and**] [**restrained-air-spring mounts**] to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7 and be acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Wind-Load-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: [**ICC-ES product listing**] [**UL product listing**] [**FM Approvals**] [**an evaluation service member of ICC-ES**] [**an agency acceptable to authorities having jurisdiction**].

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design system.

1. Wind-Load Performance: Equipment and systems shall withstand the effects of high wind events determined in accordance with [**ASCE/SEI 7-05**] [**ASCE/SEI 7-10**] [**ASCE/SEI 7-16**] <**Insert requirement**>.

B. Wind-Load Design Calculations:
1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in [**ASCE/SEI 7-05**] [**ASCE/SEI 7-10**] [**ASCE/SEI 7-16**] <**Insert ASCE/SEI 7 edition or other wind-load calculation method required by authorities having jurisdiction**>. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.

a. Factors indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
b. Coordinate design wind-load calculations with vibration isolator calculations for equipment requiring both vibration isolation and wind-load reinforcement. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.

2. Design wind pressure "p" for external sidewall-mounted equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:

a. PART 1: Low-Rise Buildings.
b. PART 2: Low-Rise Buildings (Simplified).
c. PART 3: Buildings with "h" less than 60 feet.
d. PART 4: Buildings with "h" greater than 60 feet and less than 160 feet.
e. PART 5: Open Buildings.

3. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
   a. Risk Category: [**I**] [**II**] [**III**] [**IV**] [**V**].
   b. h = Mean Roof Height: <**Insert value**>.
   c. V = Basic Wind Speed: <**Insert value**>.
   d. K_d = Wind Directionality Factor: <**Insert factor**>.
   e. Exposure Category: [**B**] [**C**] [**D**].
   f. K_{zt} = Topographic Factor: <**Insert factor**>.
   g. K_e = Ground Elevation Factor: <**Insert factor**>.
   h. K_z = Velocity Pressure Exposure Coefficient (Evaluated at Height z): <**Insert coefficient**>.
   i. K_h = Velocity Pressure Exposure Coefficient (Evaluated at Height h): <**Insert coefficient**>.
   j. q_z = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
   k. q_h = Velocity Pressure: Value calculated by delegated wind-load design contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
   l. G = Gust-Effect Factor: [**0.85**] <**Insert factor**>.
   m. Enclosure Classification: <**Insert classification**>.
   n. GC_{pi} = Internal Pressure Coefficient: <**Insert coefficient**>.
4. Design wind pressure "p" for external sidewall-mounted equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-10, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:

   a. PART 1: Low-Rise Buildings.
   b. PART 2: Low-Rise Buildings (Simplified).
   c. PART 3: Buildings with "h" greater than 60 feet.
   d. PART 4: Buildings with "h" less than 160 feet.
   e. PART 5: Open Buildings.

5. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-10, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
   a. Risk Category: [**I**] [**II**] [**III**] [**IV**] [**V**].
   b. h = Mean Roof Height: <**Insert value**>.
   c. V = Basic Wind Speed: <**Insert value**>.
   d. K_d = Wind Directionality Factor: <**Insert factor**>.
   e. Exposure Category: [**B**] [**C**] [**D**].
   f. K_{zt} = Topographic Factor: <**Insert factor**>.
   g. K_z = Velocity Pressure Exposure Coefficient (Evaluated at Height z): <**Insert coefficient**>.
   h. K_h = Velocity Pressure Exposure Coefficient (Evaluated at Height h): <**Insert coefficient**>.
   i. q_z = Velocity Pressure at Height z: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
   j. q_h = Velocity Pressure at Height h: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
   k. G = Gust-Effect Factor: [**0.85**] <**Insert factor**>.
   l. Enclosure Classification: <**Insert classification**>.
   m. GC_{pi} = Internal Pressure Coefficient: <**Insert coefficient**>.

6. Design wind load "F" for rooftop equipment and external sidewall-mounted equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-05, Ch. 6.
   a. I = Importance Factor: <**Insert factor**>.
   b. h = Mean Roof Height: <**Insert value**>.
   c. V = Basic Wind Speed: <**Insert value**>.
   d. K_d = Wind Directionality Factor: <**Insert factor**>.
   e. Exposure Category: [**B**] [**C**] [**D**].
   f. K_{zt} = Topographic Factor: <**Insert factor**>.
   g. K_z = Velocity Pressure Exposure Coefficient (Evaluated at Height z): <**Insert coefficient**>.
   h. K_h = Velocity Pressure Exposure Coefficient (Evaluated at Height h): <**Insert coefficient**>.
   i. q_z = Velocity Pressure at Height z: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.
   j. q_h = Velocity Pressure at Roof Height h: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.
   k. G = Gust-Effect Factor: [**0.85**] <**Insert factor**>.
   l. GC_{pi} = Internal Pressure Coefficient: <**Insert coefficient**>.
   m. GC_p = External Pressure Coefficient: <**Insert coefficient**>.
   n. C_f = Force Coefficient: Value determined by delegated wind-load design Contractor from ASCE/SEI 7-05, Figures 6-21 through 6-23 or other source approved by authorities having jurisdiction.
   o. A_f = Projected Area Normal to the Wind: Except where C_f is specified for the actual surface area. Value determined by delegated wind-load design Contractor from equipment submittal or manufacturer.

C. Consequential Damage: Provide additional restraints for suspended fire-suppression system components or anchorage of floor-, roof-, or wall-mounted fire-suppression system components as indicated in [**ASCE/SEI 7-05**] [**ASCE/SEI 7-10**] [**ASCE/SEI 7-16**] so that failure of a non-essential or essential fire-suppression system component will not cause failure of any other essential architectural, mechanical, or electrical building component.

D. Fire/Smoke Resistance: All components that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

E. Component Supports:

1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.
2. All component support attachments must comply with force and displacement resistance requirements of [**ASCE/SEI 7-05 Section 13.6**] [**ASCE/SEI 7-10 Section 13.6**] [**ASCE/SEI 7-16 Section 13.6**].

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Minimum deflection as indicated on Drawings.
5. Pad Material: Oil- and water-resistant rubber.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: [**Resilient**] [**and**] [**elastomeric**] <**Insert compound**>.
   a. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Elastomeric Isolation Mounts: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Mounting Plates:

   a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded[**with threaded studs or bolts**].
   b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

3. Minimum deflection as indicated on Drawings.
4. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Description: All-directional isolator with restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

   a. Housing: Cast-ductile iron or welded steel.
   b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

3. Minimum deflection as indicated on Drawings.

2.5 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psi.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
8. Minimum deflection as indicated on Drawings.

2.6 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Minimum deflection as indicated on Drawings.
7. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

    a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psi.
    b. Top housing with [**attachment and leveling bolt**] [**threaded mounting holes and internal leveling device**] [**elastomeric pad**].

2.7 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

    a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psi.
    b. Top plate with [**threaded mounting holes**] [**elastomeric pad**].
    c. Internal leveling bolt that acts as blocking during installation.

3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Minimum deflection as indicated on Drawings.

2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with [**adjustable**] [**non-adjustable**] snubbers to limit vertical movement.

   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psi.
   b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Minimum deflection as indicated on Drawings.

2.9 PIPE-RISER RESILIENT SUPPORT

A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch-Thick Neoprene: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
3. Maximum Load Per Support: 500 psi on isolation material providing equal isolation in all directions.
4. Minimum deflection as indicated on Drawings.

2.10 RESILIENT PIPE GUIDES

A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-inch-Thick Neoprene: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.11 AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
3. Maximum Natural Frequency: 3 Hz.
4. Operating Pressure Range: 25 to 100 psi.
5. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
6. Minimum deflection as indicated on Drawings.
7. Automatic leveling valve.

2.12 RESTRAINED-AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

   a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psi.
   b. Top plate with [**threaded mounting holes**] [**elastomeric pad**].
   c. Internal leveling bolt that acts as blocking during installation.

3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
4. Minimum deflection as indicated on Drawings.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
9. Maximum Natural Frequency: 3 Hz.
10. Operating Pressure Range: 25 to 100 psi.
11. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
12. Automatic leveling valve.

2.13 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.
4. Minimum deflection as indicated on Drawings.

2.14 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Minimum deflection as indicated on Drawings.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
9. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
10. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.15 SNUBBERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be prequalified in accordance with ACI 355.2 testing and designated in accordance with [**ACI 318-08 Appendix D for 2009 IBC**] [**ACI 318-11 Appendix D for 2012 IBC**] [**ACI 318-14 Ch. 17 for 2015 or 2018 IBC]**
2. Preset Concrete Inserts: Prequalified in accordance with ICC-ES AC446 testing.
3. Anchors in Masonry: Design in accordance with TMS 402.
4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
5. Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch thick.

2.16 RESTRAINTS - RIGID TYPE

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.17 RESTRAINTS - CABLE TYPE

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Restraint Cables: [**ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel**] [**ASTM A492 stainless steel**] cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.

C. Restraint cable assembly and cable fittings must comply with [**ASCE/SEI 19-10**] [**ASCE/SEI 19-16**]. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.18 RESTRAINT ACCESSORIES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Hanger-Rod Stiffener: [**Steel tube or steel slotted-support-system sleeve with internally bolted connections**] [**Reinforcing steel angle clamped**] to hanger rod.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to [**rigid channel bracings**] [**and**] [**restraint cables**].

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.19 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in wind-load applications. Post-installed concrete anchors must comply with all requirements of [**ASCE/SEI 7-05, Ch. 13**] [**ASCE/SEI 7-10, Ch. 13**] [**ASCE/SEI 7-16, Ch. 13**].

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp that is not vibration isolated.

1. Undercut expansion anchors are permitted.

2.20 CONCRETE INSERTS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Provide preset concrete inserts that are prequalified in accordance with ICC-ES AC466 testing.

C. Comply with ANSI/MSS SP-58.

2.21 VIBRATION ISOLATION EQUIPMENT BASES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.

   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

D. Concrete Inertia Base: [**Factory-fabricated**] [**or**] [**field-fabricated**], welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation [**and wind-load control**]devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by [**an evaluation service member of ICC-ES**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**].

B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to wind load forces.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static [**and wind-load**]forces within specified loading limits.

3.3 INSTALLATION OF VIBRATION-CONTROL [**AND WIND-LOAD CONTROL**]DEVICES

A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules, where indicated on Drawings, or where the Specifications indicate they are to be installed on specific equipment and systems.

B. Provide wind-load control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

D. Installation of vibration isolators[**and wind-load restraints**] must not cause any stresses, misalignment or change of position of equipment or piping.

E. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

F. Equipment Restraints:

1. Install snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install wind-load-restraint devices using methods approved by [**an evaluation service member of ICC-ES**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

G. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of [**40 feet**] <**Insert dimension**> o.c., and longitudinal supports a maximum of [**80 feet**] <**Insert dimension**> o.c.
3. Brace a change of direction longer than 12 feet.

H. Install wind-load-restraint cables so they do not bend across edges of adjacent equipment or building structure.

I. Install wind-load-restraint devices using methods approved by [**an evaluation service member of ICC-ES**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

L. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

M. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify Project structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 INSTALLATION OF AIR-SPRING ISOLATORS

A. Independent Isolator Installation:

1. Install automatic leveling valve into each air isolator.
2. Inflate each isolator to [**height**] [**and**] [**pressure**] specified on Drawings.

B. Pressure-Regulated Isolator Installation:

1. Coordinate the constant pressure-regulated air supply to air springs with requirements for piping and connections specified in Section 221513 "General-Service Compressed-Air Piping."
2. Connect all pressure regulators to a single dry, filtered [**facility**] [**constant**] air supply.
3. Inflate isolators to [**height**] [**and**] [**or**] [**pressure**] specified on Drawings.

3.5 ACCOMMODATION OF DIFFERENTIAL MOTION

A. Provide flexible connections in piping systems where they cross structural joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 221116 "Domestic Water Piping" and Section 221119 "Domestic Water Piping Specialties" for piping flexible connections.

3.6 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate dimensions of steel equipment rails, bases, and concrete inertia bases, with requirements of isolated equipment specified in this and other Sections. Where dimensions of

base are indicated on Drawings, they may require adjustment to accommodate actual isolated equipment.

3.7 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:
1. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].
2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
5. Test no fewer than [**four**] <**Insert number**> of each type and size of installed anchors and fasteners selected by Architect.
6. Test to 90 percent of rated proof load of device.
7. Measure isolator restraint clearance.
8. Measure isolator deflection.
9. Verify snubber minimum clearances.
10. Test and adjust restrained-air-spring isolator controls and safeties.

D. Remove and replace malfunctioning units and retest as specified above.

A. Units will be considered defective if they do not pass tests and inspections.

B. Prepare test and inspection reports.

END OF SECTION 220548.13

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Warning tape.
4. Pipe labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

B. Related Requirements:

1.2 ACTION SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve-numbering scheme.

E. Valve Schedules: For each piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Brady Corporation.
   b. Carlton Industries, LP.
   c. Champion America.
2. Material and Thickness: [**Brass, 0.032-inch**] [**stainless steel, 0.025-inch**] [**aluminum, 0.032-inch**] [**anodized aluminum, 0.032-inch**] minimum thickness, with predrilled or stamped holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.

4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Brady Corporation.
   b. Carlton Industries, LP.
   c. Champion America.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, [**1/16 inch**] [**1/8 inch**] <**Insert dimension**> thick, with predrilled holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Carlton Industries, LP.
3. Champion America.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, [**1/16 inch**] [**1/8 inch**] <**Insert dimension**> thick, with predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E[**, and other applicable codes and standards**].

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 WARNING TAPE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Craftmark Pipe Markers.
3. National Marker Company.

B. Material: Vinyl.

C. Minimum Thickness: 0.005 inch.

D. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.

E. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.

F. Maximum Temperature: 160 deg F.

G. Minimum Width: 4 inches.

2.4 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Carlton Industries, LP.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on main distribution piping. Arrows may be either integral with label or applied separately.
3. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

2.5 STENCILS

A. Stencils for Piping:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Craftmark Pipe Markers.
   b. Kolbi Pipe Marker Co.
   c. Marking Services Inc.
2. Lettering Size: Size letters in accordance with ASME A13.1 for piping.
3. Stencil Material: Aluminum, brass, or fiberboard.
4. Stencil Paint: Exterior, gloss, [**alkyd enamel**] [**acrylic enamel**] <**Insert paint type**> in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
5. Identification Paint: Exterior, [**alkyd enamel**] [**acrylic enamel**] <**Insert paint type**> in colors in accordance with ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
6. Letter and Background Color: As indicated for specific application under Part 3.

2.6 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Carlton Industries, LP.

B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: [**Brass, 0.04-inch**] [**stainless steel, 0.024-inch**] [**aluminum, 0.031-inch**] [**or**] [**anodized aluminum, 0.031-inch**] minimum thickness, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass [**wire**] [**link chain**] [**or**] [**beaded chain**] [**or**] [**S-hook**].

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Include valve-tag schedule in operation and maintenance data.

2.7 WARNING TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Champion America.
3. Craftmark Pipe Markers.

B. Description: Preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.

1. Size: [**3 by 5-1/4 inches minimum**] [**Approximately 4 by 7 inches**] <**Insert size**>.
2. Fasteners: [**Brass grommet and wire**] [**Reinforced grommet and wire or string**].
3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Letter and Background Color: As indicated for specific application under Part 3.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of plumbing equipment.

B. Sign and Label Colors.

1. White letters on an ANSI Z535.1 safety-green background.

C. Locate equipment labels where accessible and visible.

D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where are-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

3.4 INSTALLATION OF WARNING TAPE

A. Warning Tape Color and Pattern: Yellow background with black diagonal stripes.

B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than 6 ft. of clearance.

C. Locate tape so as to be readily visible from the point of normal approach.

3.5 INSTALLATION OF PIPE LABELS

A. Piping Color Coding: Painting of piping is specified in Section 099123 "Interior Painting."

B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

C. Stenciled Pipe Label Option: Stenciled labels showing service and flow direction may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1,[**with painted, color-coded bands or rectangles**] on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

D. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within 3 ft. of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within 3 ft. of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of [**25 ft.**] <**Insert dimension**> along each run. Reduce intervals to [**10 ft.**] <**Insert dimension**> in areas of congested piping and equipment.

E. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

F. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

G. Pipe-Label Color Schedule:
1. Domestic Cold-Water Piping: White letters on an ANSI Z535.1 safety-green background.
2. Domestic Hot-Water Piping: White letters on an ANSI Z535.1 safety-green background

3. Domestic Hot-Water Return Piping White letters on an ANSI Z535.1 safety-green background.
4. Sanitary Waste Piping: White letters on a black background.

3.6 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:

1. Valve-Tag Size and Shape:

a. Domestic Cold Water: 2 inches, round.
b. Domestic Hot Water: 1-1/2 inches, round.
c. Domestic Hot-Water Return: 1-1/2 inches, round.

2. Valve-Tag Colors:

a. For each piping system, use the same lettering and background coloring system on valve tags as used in the piping system labels and background.

3.7 INSTALLATION OF WARNING TAGS

A. Warning Tag Color: Black letters on an ANSI Z535.1 safety-yellow background.

B. Attach warning tags, with proper message, to equipment and other items.

END OF SECTION 220553

SECTION 220593 - TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

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. TAB of domestic water system.
2. TAB of plumbing equipment:

    a. Domestic hot-water in-line circulation pumps.

3. Pipe-leakage test verification.

1.3 DEFINITIONS

A. TAB: Testing, adjusting, and balancing.

B. TABB: Testing, Adjusting, and Balancing Bureau.

C. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

D. TDH: Total dynamic head.

1.4 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

    a. The Contract Documents examination report.
    b. The TAB plan.
    c. Needs for coordination and cooperation of trades and subcontractors.
    d. Proposed procedures for documentation and communication flow.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within [**30**] [**60**] [**90**] <**Insert number**> days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within [**30**] [**60**] [**90**] <**Insert number**> days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.

C. Strategies and Procedures Plan: Within [**30**] [**60**] [**90**] <**Insert number**> days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.

D. System Readiness Checklists: Within [**30**] [**60**] [**90**] <**Insert number**> days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.6 QUALITY ASSURANCE

A. TAB Specialists Qualifications, Certified by AABC:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC.

B. TAB Specialists Qualifications, Certified by [**NEBB**] [**or**] [**TABB**]:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by [**NEBB**] [**or**] [**TABB**].
2. TAB Technician: Employee of the TAB specialist and certified by [**NEBB**] [**or**] [**TABB**].

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

D. ASHRAE 111 Compliance: Requirements in ASHRAE 111 applicable to analogous domestic water system and plumbing equipment balancing.

E. ASHRAE 188 Compliance: Comply with balancing and report requirements, Section 8.3 "Balancing."

F. Code and Authorities Having Jurisdiction Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.7 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

A. Subject to compliance with requirements, [**engage one of the following**] [**available TAB specialists that may be engaged include, but are not limited to, the following**]:

1. <**Insert TAB specialist's name**>.

3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves and fittings. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine approved submittals for plumbing systems and equipment.

D. Examine design data, including plumbing system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about plumbing system and equipment controls.

E. Examine equipment performance data, including pump curves.

1. Relate performance data to Project conditions and requirements, including pump system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate pump system-effect factors to reduce performance ratings of plumbing equipment when installed under conditions different from the conditions used to rate equipment performance. Compare results with the design data and installed conditions.

F. Examine system and equipment installations, and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine plumbing equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

I. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainers are installed and clean.

J. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

K. Examine system pumps to ensure absence of entrained air in the suction piping.

L. Examine operating safety interlocks and controls on plumbing equipment.

M. 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.

3.3 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of plumbing systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Domestic Water System:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed in accordance with applicable code and authority having jurisdiction.
b. Water heaters are installed and functioning.
c. Piping is complete and all points of outlet are installed.
d. Water treatment is complete.
e. Systems are flushed, filled, and air purged.
f. Strainers are clean.
g. Control valves are functioning in accordance with the sequence of operation.
h. Shutoff and balance valves are 100 percent open.
i. Hot-water circulating pumps are operational and proper rotation is verified.
j. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
k. Suitable access to balancing devices and equipment is provided.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in [**AABC's "National Standards for Total System Balance"**] [**ASHRAE 111**] [**NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems"**] and in this Section.

B. Cut insulation, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.

1. Where holes for probes are required in piping or equipment, install pressure and temperature test plugs to seal systems.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 220716 "Plumbing Equipment Insulation" and Section 220719 "Plumbing Piping Insulation."

C. Mark equipment and balancing devices, including valve position indicators and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in [**inch-pound (IP**] [**and**] [**metric (SI)**] units.

3.5 GENERAL PROCEDURES FOR PLUMBING EQUIPMENT

A. Test, adjust, and balance plumbing equipment indicated on Drawings, including, but not limited to, the following:

1. Domestic water in-line pumps.
2. Domestic water heaters.

3.6 PROCEDURES FOR DOMESTIC WATER SYSTEMS

A. Prepare test reports for pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.

B. Prepare schematic diagrams of systems' Record drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:

1. Check expansion tank for proper setting.
2. Check water heater for proper discharge temperature setting.
3. Check remotest point of outlet for adequate pressure.
4. Check flow-control valves for proper position.
5. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
6. Verify that motor controllers are equipped with properly sized thermal protection.
7. Check that air has been purged from the system.

D. Measure and record upstream and downstream pressure of each piece of equipment.

E. Measure and record upstream and downstream pressure of pressure-reducing valves.

F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

G. Check settings and operation of each safety valve. Record settings.

3.7 PROCEDURES FOR DOMESTIC HOT-WATER CIRCULATING INLINE PUMP

A. Balance system with manual or automatic balancing valves by setting at design flow.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

B. Adjust pump to deliver total design flow.

1. Measure pump TDH as follows:

a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
c. Convert pressure to head and correct for differences in gauge heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.

2. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
3. Mark final settings and verify that all memory stops have been set.
4. Verify final system conditions as follows:

a. Re-measure and confirm that total flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
c. Mark final settings.

3.8 PROCEDURES FOR WATER HEATERS

A. Electric Water Heaters:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Measure and record pressure drop.
4. [**Measure and**]Record relief valve(s) pressure setting.
5. Capacity: Calculate in Btu/h of heating output.
6. Efficiency: Calculate operating efficiency for comparison to submitted equipment.

3.9 TOLERANCES

A. Set plumbing system's flow rates within the following tolerances:

1. Domestic Water Flow Rate: Plus or minus 10 percent. If design value is less than 10 gpm, within 10 percent.

3.10 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to plumbing systems and general construction to allow access for performance-measuring and -balancing devices.

B. Status Reports: Prepare [**weekly**] [**biweekly**] [**monthly**] <**Insert time interval**> progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.11 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
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 supervisor 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. Notes to explain why certain final data in the body of reports vary from indicated values.
14. Test conditions for pump performance forms, including the following:

a. Variable-frequency controller settings for variable-flow hydronic systems.
b. Settings for pressure controller(s).
c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of distribution systems. Present each system with single-line diagram and include the following:

1. Flow rates.
2. Pipe and valve sizes and locations.
3. Balancing stations.
4. Position of balancing devices.

E. Electric Water Heater Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Model number and unit size.
d. Manufacturer's serial number.
e. Output capacity in Btu/h.
f. Number of stages.
g. Connected volts, phase, and hertz.
h. Rated amperage.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. High-temperature-limit setting in deg F.
e. Operating set point in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

F. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.

g. Water-pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump speed.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

G. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.12 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of [**Architect**] [**Owner**] [**Construction Manager**] [**Commissioning Authority**].

B. [**Architect**] [**Owner**] [**Construction Manager**] [**Commissioning Authority**] shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either [**10**] <**Insert number**> percent of the total measurements recorded or the extent of measurements that can be accomplished in [**a normal 8-hour business day**] <**Insert value**>.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than [**10**] [**20**] <**Insert number**> percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
2. If the second final inspection also fails, Owner may pursue other Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.13 ADDITIONAL TESTS

A. Within [**90**] <**Insert number**> days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION 220593

SECTION 220716 - PLUMBING EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following plumbing equipment that is not factory insulated:

1. Domestic water, hot-water pumps.

B. Related Sections:

1. Section 220719 "Plumbing Piping Insulation."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for recycled content.>
2. <Double click to insert sustainable design text for adhesives, mastics, and sealants submittals.>

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail removable insulation at equipment connections.
2. Detail application of field-applied jackets.
3. Detail application at linkages of control devices.
4. Detail field application for each equipment type.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Sheet Form Insulation Materials: 12 inches square.
2. Sheet Jacket Materials: 12 inches square.
3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program[**, certified by the Department of Labor, Bureau of Apprenticeship and Training**].

B. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Equipment Mockups:

a. One tank or vessel.
b. One pump.
c. <**Insert mockup**>.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect [**seven**] <**Insert number**> days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include, the name of the manufacturer, fabricator, type, description, and size[**, as well as ASTM standard designation, and maximum use temperature**].

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

A. Comply with requirements in "Domestic Water Boiler Breeching Insulation Schedule" and "Indoor Equipment Insulation Schedule" articles for where insulating materials are to be applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Calcium Silicate: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I or Type II.

1. Prefabricated Fitting Covers: Comply with ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>

G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Block Insulation: Type I.
3. Special-Shaped Insulation: Type III.
4. Board Insulation: Type IV.

5. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
6. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Flexible Elastomeric: Closed-cell or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534/C534M, Type II for sheet materials.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

I. Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 450 deg F in accordance with ASTM C411). Comply with ASTM C553, Type II, and ASTM C1290, [**Type I, unfaced**] [**Type II, with factory-applied vinyl jacket**] [**Type III, with factory-applied FSK jacket**]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

J. High-Temperature, Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to 1000 deg F. Comply with ASTM C553, Type V.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

K. Mineral Wool Blanket: Basalt volcanic rock-derived fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to 1200 deg F in accordance with ASTM C447. Comply with ASTM C553.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

L. Glass-Fiber Board: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 250 deg F for jacketed and between 35 deg F and 450 deg F for unfaced in accordance with ASTM C411. Comply with ASTM C612, Type IA or Type IB. Provide insulation [**unfaced**] [**with factory-applied ASJ**] [**with factory-applied FSK jacket**]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

M. High-Temperature, Glass-Fiber Board: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 1000 deg F in accordance with ASTM C411. Comply with ASTM C612, Type III, unfaced.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

N. Mineral Wool Board: Basalt volcanic rock-derived fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 1100 deg F in accordance with ASTM C411. Comply with ASTM C612, Type III, unfaced.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

O. Glass-Fiber, Pipe and Tank: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 850 deg F, in accordance with ASTM C411. Comply with ASTM C1393.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Semirigid board material with factory-applied [**ASJ**] [**FSK**] jacket.
3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

P. Mineral Wool, Pipe and Tank: Mineral wool fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 1000 deg F, in accordance with ASTM C411. Comply with ASTM C1393.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Semirigid board material with factory-applied [**ASJ**] [**FSK**] jacket.
3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

Q. Polyolefin: Polyethylene thermal plastic insulation. Comply with ASTM C534/C534M or ASTM C1427, Type II, Grade 1 for sheet materials.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.3 INSULATING CEMENTS

A. Glass-Fiber and Mineral Wool Insulating Cement: Comply with ASTM C195.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

C. Glass-Fiber and Mineral Wool, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.4 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for calcium silicate adhesive VOC content.>
3. <Double click to insert sustainable design text for adhesives.>

C. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for cellular glass adhesive VOC Content.>
3. <Double click to insert sustainable design text for adhesives.>

D. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for adhesive for flexible elastomeric and polyolefin VOC content.>
3. <Double click to insert sustainable design text for adhesives.>
4. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.
5. Wet Flash Point: Below 0 deg F
6. Service Temperature Range: 40 to 200 deg F.
7. Color: [**Black**] <**Insert color**>.

E. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for mineral fiber adhesive VOC content>
3. <Double click to insert sustainable design text for adhesives.>

F. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for adhesive for ASJ, FSK, and PVDC jackets VOC content.>
3. <Double click to insert sustainable design text for adhesives.>

G. PVC Jacket Adhesive: Compatible with PVC jacket.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for adhesive for PVC jacket>
3. <Double click to insert sustainable design text for adhesives.>

2.5 MASTICS AND COATINGS

A. Materials are compatible with insulation materials, jackets, and substrates.

1. <Double click to insert sustainable design text for insulation mastics VOC content.>
2. <Double click to insert sustainable design text for low-emitting mastics VOC content.>

B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: [**0 to plus 180 deg F**] [**Minus 20 to plus 180 deg F**].
4. Comply with MIL-PRF-19565C, Type II, for permeance requirements[**, with supplier listing on DOD QPD - Qualified Products Database**].
5. Color: [**White**] <**Insert color**>.

C. Vapor-Retarder Mastic, Solvent Based, Indoor Use: Suitable for indoor use on below-ambient services.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: 0 to 180 deg F.
4. Color: [**White**] <**Insert color**>.

D. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Color: [**White**] <**Insert color**>.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
3. Service Temperature Range: [**0 to plus 180 deg F**] [**Minus 20 to plus 180 deg F**].
4. Color: [**White**] <**Insert color**>.

2.6 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and be compatible with insulation materials, jackets, and substrates.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for lagging adhesives.>
3. <Double click to insert sustainable design text for low emitting adhesives.>
4. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over insulation.
5. Service Temperature Range: [**20 to plus 180 deg F**] [**0 to plus 180 deg F**].
6. Color: White.

2.7 SEALANTS

A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: [**Minus 150 to plus 250 deg F**] [**Minus 100 to plus 300 deg F**].
4. Color: White or gray.
5. <Double click to insert sustainable design text for sealant.>
6. <Double click to insert sustainable design text for sealants.>

C. FSK and Metal Jacket Flashing Sealants:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.
5. <Double click to insert sustainable design text for aealants for FSK and metal jacket flashing VOC content.>

6. <Double click to insert sustainable design text for sealants.>

D. ASJ Flashing Sealants and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. <Double click to insert sustainable design text for ASJ, vinyl, PVDC, and PVC flashing products VOC content.>
6. <Double click to insert sustainable design text for sealants.>

2.8 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C1136, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: [**White**] [**Color-code jackets based on system. Color as selected by Architect**].
4. Factory-fabricated tank heads and tank side panels.

D. Metal Jacket:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

   a. [**Sheet and roll stock ready for shop or field sizing**] [**Factory cut and rolled to size**].
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: [**1-mil-thick, heat-bonded polyethylene and kraft paper**] [**3-mil-thick, heat-bonded polyethylene and kraft paper**] [**2.5-mil-thick polysurlyn**].

d. Moisture Barrier for Outdoor Applications: [**3-mil-thick, heat-bonded polyethylene and kraft paper**] [**2.5-mil-thick polysurlyn**].
e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Stainless Steel Jacket: ASTM A240/A240M.

a. [**Sheet and roll stock ready for shop or field sizing**] [**Factory cut and rolled to size**].
b. Material, finish, and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: [**1-mil-thick, heat-bonded polyethylene and kraft paper**] [**3-mil-thick, heat-bonded polyethylene and kraft paper**] [**2.5-mil-thick polysurlyn**].
d. Moisture Barrier for Outdoor Applications: [**3-mil-thick, heat-bonded polyethylene and kraft paper**] [**2.5-mil-thick polysurlyn**].
e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Self-Adhesive Outdoor Jacket (Asphaltic): 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with [**white**] [**stucco-embossed**] aluminum-foil facing.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

F. Self-Adhesive Indoor/Outdoor Jacket (Non-Asphaltic): Vapor barrier and waterproofing jacket for installation over insulation located aboveground outdoors or indoors. Specialized jacket has five layers of laminated aluminum and polyester film with low-temperature acrylic pressure-sensitive adhesive. Outer aluminum surface is coated with UV-resistant coating for protection from environmental contaminants.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Permeance: 0.00 perm as tested in accordance with ASTM F1249.
3. Flamespread/Smoke Developed: 25/50 as tested in accordance with ASTM E84.
4. Aluminum Finish: [**Embossed**] [**Smooth**].

G. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested in accordance with ASTM E96/E96M and with a flame-spread index of 10 and a smoke-developed index of 20 when tested in accordance with ASTM E84.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

H. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested in accordance with ASTM E96/E96M and with a flame-spread index of 25 and a smoke-developed index of 50 when tested in accordance with ASTM E84.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

I. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.10 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Mesh: Approximately 4 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering equipment.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Woven Polyester Mesh: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for equipment.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.11 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Cloth: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.12 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Width: [**3 inches**] <**Insert value**>.
3. Thickness: [**11.5 mils**] <**Insert value**>.
4. Adhesion: [**90 ounces force/inch**] <**Insert value**> in width.
5. Elongation: [**2**] <**Insert number**> percent.
6. Tensile Strength: [**40 lbf/inch**] <**Insert value**> in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Width: [**3 inches**] <**Insert value**>.
3. Thickness: [**6.5 mils**] <**Insert value**>.
4. Adhesion: [**90 ounces force/inch**] <**Insert value**>in width.
5. Elongation: [**2**] <**Insert number**> percent.
6. Tensile Strength: [**40 lbf/inch**] <**Insert value**> in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Width: [**2 inches**] <**Insert value**>.
3. Thickness: [**6 mils**] <**Insert value**>.
4. Adhesion: [**64 ounces force/inch**] <**Insert value**> in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Width: [**2 inches**] <**Insert value**>.
3. Thickness: [**3.7 mils**] <**Insert value**>.
4. Adhesion: [**100 ounces force/inch**] <**Insert value**> in width.
5. Elongation: [**5**] <**Insert number**> percent.
6. Tensile Strength: [**34 lbf/inch**] <**Insert value**> in width.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Width: [**3 inches**] <**Insert value**>.
3. Film Thickness: [**6 mils**] <**Insert value**>.
4. Adhesive Thickness: [**1.5 mils**] <**Insert value**>.
5. Elongation at Break: [**145**] <**Insert value**> percent.
6. Tensile Strength: [**55 psi**] <**Insert value**> in width.

F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Width: [**3 inches**] <**Insert value**>.
3. Film Thickness: [**6 mils**] <**Insert value**>.
4. Adhesive Thickness: [**1.5 mils**] <**Insert value**>.
5. Elongation at Break: [**145**] <**Insert number**> percent.
6. Tensile Strength: [**55 psi**] <**Insert value**> in width.

2.13 SECUREMENTS

A. Bands:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Stainless Steel: ASTM A240/A240M, [**Type 304**] [**or**] [**Type 316**]; 0.015 inch thick, [**1/2 inch**] [**3/4 inch**] wide with [**wing seal**] [**or**] [**closed seal**].
3. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, [**1/2 inch**] [**3/4 inch**] wide with [**wing seal**] [**or**] [**closed seal**].
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding; [**0.106-inch-**] [**0.135-inch-**] diameter shank, length to suit depth of insulation indicated.

   a. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding; [**0.106-inch-**] [**0.135-inch-**] diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

   a. <Double click here to find, evaluate, and insert list of manufacturers and products.>

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

   a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: [**Copper- or zinc-coated, low-carbon steel**] [**Aluminum**] [**Stainless steel**], fully annealed, 0.106-inch-diameter shank; length to suit depth of insulation indicated.
   d. Adhesive: Recommended by hanger manufacturer. Use product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

   a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
   b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
   c. Spindle: Nylon, 0.106-inch-diameter shank; length to suit depth of insulation indicated, up to 2-1/2 inches.
   d. Adhesive: Recommended by hanger manufacturer. Use product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: [**Copper- or zinc-coated, low-carbon steel**] [**Aluminum**] [**Stainless steel**], fully annealed; 0.106-inch-diameter shank, length to suit depth of insulation indicated.
d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, [**galvanized-steel**] [**aluminum**] [**stainless steel**] sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

D. Wire: [**0.080-inch nickel-copper alloy**] [**0.062-inch soft-annealed, stainless steel**] [**0.062-inch soft-annealed, galvanized steel**].

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.14 CORNER ANGLES

A. PVC Corner Angles: [**30-mils**] <**Insert dimension**> thick, minimum 1- by 1-inch PVC in accordance with ASTM D1784, Class 16354-C, white or color-coded to match adjacent surface.

B. Aluminum Corner Angles: [**0.040-inch**] <**Insert dimension**> thick, minimum 1- by 1-inch, aluminum in accordance with ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

C. Stainless Steel Corner Angles: [**0.024-inch**] <**Insert dimension**> thick, minimum 1- by 1-inch stainless steel in accordance with ASTM A240/A240M, [**Type 304**] [**or**] [**Type 316**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of equipment, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents[**, unless otherwise approved by the engineer of record**].

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or area of compression in the insulation.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at [**2 inches**] [**4 inches**] o.c.

   a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

O. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Domestic Water Boiler Breechings:

1. Secure single-layer insulation with stainless steel bands at 12-inch intervals, and tighten bands without deforming insulation material.

2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless steel bands at 12-inch intervals.
3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Install in accordance with manufacturer's written installation instructions and ASTM C1710.

B. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:

1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. 33-1/2-inch-circumference limit allows for 2-inch-overlap seal. Using the length of roll allows for longer sections of jacket to be

installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.

2. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.7 FINISHES

A. Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: [**Two**] <**Insert number**> finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless steel jackets.

3.8 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections.

B. Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections [**with the assistance of a factory-authorized service representative**].

E. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to [**one**] <**Insert number**> location(s) for each type of equipment defined in the "Indoor Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

F. All insulation applications will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.9 DOMESTIC WATER BOILER BREECHING INSULATION SCHEDULE

A. Round, exposed breeching and connector insulation are[**one of**] the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Glass-Fiber Blanket: 3 inches thick and 3 lb/cu. ft. nominal density.
3. Mineral Wool Blanket: 3 inches thick and 4 lb/cu. ft. nominal density.

B. Round, concealed breeching and connector insulation are[**one of**] the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Glass-Fiber Blanket: 3 inches thick and 3 lb/cu. ft. nominal density.
3. Mineral Wool Blanket: 3 inches thick and 4 lb/cu. ft. nominal density.

C. Rectangular, exposed breeching and connector insulation are[**one of**] the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Glass-Fiber Blanket: 3 inches thick and 3 lb/cu. ft. nominal density.
3. High-Temperature Glass-Fiber Board: 3 inches thick and [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Mineral Wool Blanket: 3 inches thick and 4 lb/cu. ft. nominal density.
5. Mineral Wool Board: 3 inches thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.

D. Rectangular, concealed breeching and connector insulation are[**one of**] the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Glass-Fiber Blanket: 3 inches thick and 3 lb/cu. ft. nominal density.
3. High-Temperature Glass-Fiber Board: 3 inches thick and [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Mineral Wool Blanket: 3 inches thick and [**4 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Board: 3 inches thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.

3.10 INDOOR EQUIPMENT INSULATION SCHEDULE

A. Domestic hot-water pump insulation is[**one of**] the following:

1. Cellular Glass: [**2 inches**] <**Insert dimension**> thick.
2. Glass-Fiber Blanket: [**1 inch**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
3. Glass-Fiber Board: [**1 inch**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Mineral Wool Blanket: [**1 inch**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Board: [**1 inch**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Supplies and drains for handicap-accessible lavatories and sinks.

B. Related Sections:

1. Section 220716 "Plumbing Equipment Insulation" for equipment insulation.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for recycled content.>
2. <Double click to insert sustainable design text for adhesives, mastics, and sealants submittals.>

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
2. Jacket Materials for Pipe: 12 inches long by NPS 2.
3. Sheet Jacket Materials: 12 inches square.
4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Piping Mockups:

a. One 10-foot section of NPS 2 straight pipe.
b. One each of a 90-degree threaded, welded, and flanged elbow.
c. One each of a threaded, welded, and flanged tee fitting.
d. One NPS 2 or smaller valve and one NPS 2-1/2 or larger valve.
e. Four support hangers, including hanger shield and insert.
f. One threaded strainer and one flanged strainer with removable portion of insulation.
g. One threaded reducer and one welded reducer.
h. One pressure temperature tap.
i. One mechanical coupling.
j. One union.
k. <**Insert mockup**>

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect [**seven**] <**Insert number**> days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

C. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of the manufacturer, fabricator, type, description, and size[**, as well as ASTM standard designation and maximum use temperature**].

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials are applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Preformed Pipe Insulation, Type II, Class 1: Unfaced.
3. Preformed Pipe Insulation, Type II, Class 2: With factory-applied [**ASJ**] [**ASJ-SSL**] [**ASJ+**] [**PSK**] jacket.
4. Fabricated shapes in accordance with ASTM C450, ASTM C585, and ASTM C1639.
5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

G. Flexible Elastomeric: Closed-cell or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534/C534M, Type I for tubular materials.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

H. Glass-Fiber, Preformed Pipe: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 850 deg F in accordance with ASTM C411. Comply with ASTM C547.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Preformed Pipe Insulation: Type I, Grade A[**, unfaced**] [**with factory-applied ASJ**] [**with factory-applied ASJ-SSL**] [**with factory-applied ASJ+ jacket**] [**with factory-applied PSK jacket**].
3. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Mineral Wool, Preformed Pipe: Mandrel-wound mineral wool fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to 1200 deg F in accordance with ASTM C447. Comply with ASTM C547.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Preformed Pipe Insulation: Type II, Grade A[**, unfaced**] [**with factory-applied ASJ**] [**with factory-applied ASJ-SSL**] [**with factory-applied ASJ+ jacket**] [**with factory-applied PSK jacket**].
3. Fabricated shapes in accordance with ASTM C450 and ASTM C585.

J. Phenolic: Fabricated pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C1126, Type III.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Pre-fabricated Pipe Insulation: Type III[**, unfaced**] [**, with factory-applied ASJ**] [**with factory-applied ASJ+ jacket**] [**with factory-applied PSK jacket**].
3. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

K. Polyolefin: Polyethylene thermal plastic insulation. Comply with ASTM C534/C534M or ASTM C1427, Type I, Grade 1, for tubular materials[**, self-seal**].

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.3 INSULATING CEMENTS

A. Glass-Fiber and Mineral Wool Insulating Cement: Comply with ASTM C195.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

C. Glass-Fiber and Mineral Wool Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.4 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for cellular glass adhesive VOC Content.>
3. <Double click to insert sustainable design text for adhesives.>

C. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for adhesive for flexible elastomeric and polyolefin VOC content.>
3. <Double click to insert sustainable design text for adhesives.>
4. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.
5. Wet Flash Point: Below 0 deg F.
6. Service Temperature Range: 40 to 200 deg F.
7. Color: [**Black**] <**Insert color**>.

D. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for mineral fiber adhesive VOC content>
3. <Double click to insert sustainable design text for adhesives.>

E. Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for adhesive for phenolic VOC content.>
3. <Double click to insert sustainable design text for low-emitting adhesives and sealants.>

F. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for adhesive for ASJ and FSK jackets VOC content.>
3. <Double click to insert sustainable design text for low-emitting adhesives and sealants.>

G. PVC Jacket Adhesive: Compatible with PVC jacket.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for adhesive for PVC jacket>
3. <Double click to insert sustainable design text for low-emitting adhesives and sealants.>

2.5 MASTICS AND COATINGS

A. Materials are compatible with insulation materials, jackets, and substrates.

1. <Double click to insert sustainable design text for insulation mastics VOC content.>
2. <Double click to insert sustainable design text for low-emitting mastics VOC content.>

B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: [**0 to plus 180 deg F**] [**Minus 20 to plus 180 deg F**].
4. Comply with MIL-PRF-19565C, Type II, for permeance requirements[**, with supplier listing on DOD QPD - Qualified Products Database**].
5. Color: [**White**] <**Insert color**>.

C. Vapor-Retarder Mastic, Solvent Based, Indoor Use: Suitable for indoor use on below-ambient services.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: 0 to 180 deg F.
4. Color: [**White**] <**Insert color**>.

D. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Color: [**White**] <**Insert color**>.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
3. Service Temperature Range: [**0 to plus 180 deg F**] [**Minus 20 to plus 180 deg F**].
4. Color: [**White**] <**Insert color**>.

2.6 LAGGING ADHESIVES

A. Adhesives comply with MIL-A-3316C, Class I, Grade A, and are compatible with insulation materials, jackets, and substrates.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for lagging adhesives.>
3. <Double click to insert sustainable design text for low emitting adhesives.>
4. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
5. Service Temperature Range: [**20 to plus 180 deg F**] [**0 to plus 180 deg F**].
6. Color: White.

2.7 SEALANTS

A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: [**Minus 58 to plus 176 deg F**] [**Minus 100 to plus 300 deg F**].
4. Color: White or gray.
5. <Double click to insert sustainable design text for sealant.>
6. <Double click to insert sustainable design text for sealants.>

C. FSK and Metal Jacket Flashing Sealants:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.
5. <Double click to insert sustainable design text for aealants for FSK and metal jacket flashing VOC content.>
6. <Double click to insert sustainable design text for sealants.>

D. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. <Double click to insert sustainable design text for ASJ, vinyl, PVDC, and PVC flashing products VOC content.>
6. <Double click to insert sustainable design text for sealants.>

2.8 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
4. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136 Types I, II, III, IV, and VII.
5. PSK Jacket: Aluminum foil fiberglass reinforced scrim with polyethylene backing, complying with ASTM C1136, Type II.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C1136, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: [**White**] [**Color-code jackets based on system. Color as selected by Architect**].
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

   a. [**Sheet and roll stock ready for shop or field sizing**] [**Factory cut and rolled to size**].
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: [**1-mil-thick, heat-bonded polyethylene and kraft paper**] [**3-mil-thick, heat-bonded polyethylene and kraft paper**] [**3-mil-thick polysurlyn**].
   d. Moisture Barrier for Outdoor Applications: [**3-mil-thick, heat-bonded polyethylene and kraft paper**] [**3-mil-thick polysurlyn**].
   e. Factory-Fabricated Fitting Covers:

      1) Same material, finish, and thickness as jacket.
      2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.

7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Stainless Steel Jacket: ASTM A240/A240M.

a. [**Sheet and roll stock ready for shop or field sizing**] [**Factory cut and rolled to size**].
b. Material, finish, and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: [**1-mil-thick, heat-bonded polyethylene and kraft paper**] [**3-mil-thick, heat-bonded polyethylene and kraft paper**] [**3-mil-thick polysurlyn**].
d. Moisture Barrier for Outdoor Applications: [**3-mil-thick, heat-bonded polyethylene and kraft paper**] [**2.5-mil-thick polysurlyn**].
e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane, consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

F. Self-Adhesive Outdoor Jacket (Asphaltic): 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with [**white**] [**stucco-embossed**] aluminum-foil facing.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

G. Self-Adhesive Indoor/Outdoor Jacket (Non-Asphaltic): Vapor barrier and waterproofing jacket for installation over insulation located aboveground outdoors or indoors. Specialized jacket with five layers of laminated aluminum and polyester film with low-temperature acrylic pressure-sensitive adhesive. Outer aluminum surface is coated with UV-resistant coating for protection from environmental contaminants.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Permeance: 0.00 perm as tested in accordance with ASTM F1249.
3. Flamespread/Smoke Developed: 25/50 as tested in accordance with ASTM E84.
4. Aluminum Finish: [**Embossed**] [**Smooth**].

2.10 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Mesh: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Woven Polyester Mesh: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.11 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Cloth: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.12 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Width: [**3 inches**] <**Insert value**>.
3. Thickness: [**11.5 mils**] <**Insert value**>.
4. Adhesion: [**90 ounces force/inch**] <**Insert value**> in width.
5. Elongation: [**2**] <**Insert number**> percent.
6. Tensile Strength: [**40 lbf/inch**] <**Insert value**> in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Width: [**3 inches**] <**Insert value**>.
3. Thickness: [**6.5 mils**] <**Insert value**>.
4. Adhesion: [**90 ounces force/inch**] <**Insert value**> in width.
5. Elongation: [**2**] <**Insert number**> percent.
6. Tensile Strength: [**40 lbf/inch**] <**Insert value**> in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Width: [**2 inches**] <**Insert value**>.
3. Thickness: [**6 mils**] <**Insert value**>.
4. Adhesion: [**64 ounces force/inch**] <**Insert value**> in width.
5. Elongation: [**500**] <**Insert value**> percent.
6. Tensile Strength: [**18 lbf/inch**] <**Insert value**> in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Width: [**2 inches**] <**Insert value**>.
3. Thickness: [**3.7 mils**] <**Insert value**>.
4. Adhesion: [**100 ounces force/inch**] <**Insert value**> in width.
5. Elongation: [**5**] <**Insert number**> percent.
6. Tensile Strength: [**34 lbf/inch**] <**Insert value**> in width.

2.13 SECUREMENTS

A. Bands:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Stainless Steel: ASTM A240/A240M, [**Type 304**] [**or**] [**Type 316**]; 0.015 inch thick, [**1/2 inch**] [**3/4 inch**] wide with [**wing seal**] [**or**] [**closed seal**].
3. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, [**1/2 inch**] [**3/4 inch**] wide with [**wing seal**] [**or**] [**closed seal**].

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: [**0.080-inch nickel-copper alloy**] [**0.062-inch soft-annealed, stainless steel**] [**0.062-inch soft-annealed, galvanized steel**].

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.14 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers, <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: Manufactured plastic wraps for covering plumbing fixture [**hot-water supply**] [**hot- and cold-water supplies**] and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures, <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range of between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents[**, unless otherwise approved by the engineer-of-record**].

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches o.c.

   a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least [**4 inches**] <**Insert value**> beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using [**preformed fitting insulation**] [**or**] [**mitered or routed fittings**] made from same material and density as that of adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with [**preformed fitting insulation**] [**or**] [**sectional pipe insulation**] of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using [**preformed fitting insulation**] [**or**] [**sectional pipe insulation**] of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using [**preformed fitting insulation**] [**or**] [**sectional pipe insulation**] of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation conforms to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered or routed sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated valve covers manufactured of same material as that of pipe insulation when available.
2. When prefabricated valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 INSTALLATION OF GLASS-FIBER AND MINERAL WOOL INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral-wool blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 INSTALLATION OF PHENOLIC INSULATION

A. General Installation Requirements:

1. Secure single-layer insulation with stainless steel bands at 12-inch intervals, and tighten bands without deforming insulation materials.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless steel bands at 12-inch intervals.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

C. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed insulation sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.10 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive[**, or via self-seal mechanism**] to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.11 INSTALLATION OF FIELD-APPLIED JACKETS

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.12 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: [**Two**] <**Insert number**> finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless steel jackets.

3.13 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections.

B. Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

E. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to [**three**] <**Insert number**> locations of straight pipe, [**three**] <**Insert number**> locations of threaded fittings, [**three**] <**Insert number**> locations of welded fittings, [**two**] <**Insert number**> locations of threaded strainers, [**two**] <**Insert number**> locations of welded strainers, [**three**] <**Insert number**> locations of threaded valves, and [**three**] <**Insert number**> locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

F. All insulation applications will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.14 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.15 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. [**NPS 1**] <**Insert pipe size**> and Smaller: Insulation is[**one of**] the following:

a. Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.
b. Flexible Elastomeric: [**1/2 inch**] [**3/4 inch**] [**1 inch**] <**Insert dimension**> thick.
c. Glass-Fiber, Preformed Pipe Insulation, Type I: [**1/2 inch**] [**1 inch**] <**Insert dimension**> thick.
d. Mineral Wool, Preformed Pipe Insulation, Type II: [**1/2 inch**] [**1 inch**] <**Insert dimension**> thick.
e. Phenolic: [**1 inch**] <**Insert dimension**> thick.
f. Polyolefin: [**1/2 inch**] [**3/4 inch**] [**1 inch**] <**Insert dimension**> thick.

2. [**NPS 1-1/4**] <**Insert pipe size**> and Larger: Insulation is[**one of**] the following:

   a. Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.
   b. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
   c. Glass-Fiber, Preformed Pipe Insulation, Type I: [**1 inch**] <**Insert dimension**> thick.
   d. Mineral Wool, Preformed Pipe Insulation, Type II: [**1 inch**] <**Insert dimension**> thick.
   e. Phenolic: [**1 inch**] <**Insert dimension**> thick.
   f. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

B. Domestic Hot and Recirculated Hot Water:

1. [**NPS 1-1/4**] <**Insert pipe size**> and Smaller: Insulation is[**one of**] the following:

   a. Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.
   b. Flexible Elastomeric: [**3/4 inch**] [**1 inch**] <**Insert dimension**> thick.
   c. Glass-Fiber, Preformed Pipe Insulation, Type I: [**1/2 inch**] [**1 inch**] <**Insert dimension**> thick.
   d. Mineral Wool, Preformed Pipe Insulation, Type II: [**1/2 inch**] [**1 inch**] <**Insert dimension**> thick.
   e. Phenolic: [**1 inch**] <**Insert dimension**> thick.
   f. Polyolefin: [**3/4 inch**] [**1 inch**] <**Insert dimension**> thick.

2. [**NPS 1-1/2**] <**Insert pipe size**> and Larger: Insulation is[**one of**] the following:

   a. Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.
   b. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
   c. Glass-Fiber, Preformed Pipe Insulation, Type I: [**1 inch**] <**Insert dimension**> thick.
   d. Mineral Wool, Preformed Pipe Insulation, Type II: [**1 inch**] <**Insert dimension**> thick.
   e. Phenolic: [**1 inch**] <**Insert dimension**> thick.
   f. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

C. Domestic Chilled Water (Potable):

1. All Pipe Sizes: Insulation is[**one of**] the following:

   a. Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.
   b. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
   c. Glass-Fiber, Preformed Pipe Insulation, Type I: [**1 inch**] <**Insert dimension**> thick.
   d. Mineral Wool, Preformed Pipe Insulation, Type II: [**1 inch**] <**Insert dimension**> thick.
   e. Phenolic: [**1 inch**] <**Insert dimension**> thick.
   f. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

D. Stormwater and Overflow:

1. All Pipe Sizes: Insulation is[**one of**] the following:

   a. Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.
   b. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
   c. Glass-Fiber, Preformed Pipe Insulation, Type I: [**1 inch**] <**Insert dimension**> thick.
   d. Mineral Wool, Preformed Pipe Insulation, Type II: [**1 inch**] <**Insert dimension**> thick.

e. Phenolic: [**1 inch**] <**Insert dimension**> thick.
f. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

E. Roof Drain and Overflow Drain Bodies:

1. All Pipe Sizes: Insulation is[**one of**] the following:

a. Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.
b. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
c. Glass-Fiber, Preformed Pipe Insulation, Type I: [**1 inch**] <**Insert dimension**> thick.
d. Mineral Wool, Preformed Pipe Insulation, Type II: [**1 inch**] <**Insert dimension**> thick.
e. Phenolic: [**1 inch**] <**Insert dimension**> thick.
f. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

F. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation is[**one of**] the following:

a. Flexible Elastomeric: [**1/2 inch**] [**3/4 inch**] [**1 inch**] <**Insert dimension**> thick.
b. Glass-Fiber, Preformed Pipe Insulation, Type I: [**1/2 inch**] [**1 inch**] <**Insert dimension**> thick.
c. Mineral Wool, Preformed Pipe Insulation, Type II: [**1/2 inch**] [**1 inch**] <**Insert dimension**> thick.
d. Polyolefin: [**1/2 inch**] [**3/4 inch**] [**1 inch**] <**Insert dimension**> thick.

G. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation is[**one of**] the following:

a. Cellular Glass: [**2 inches**] <**Insert dimension**> thick.
b. Glass-Fiber, Preformed Pipe Insulation, Type I: [**1-1/2 inches**] <**Insert dimension**> thick.
c. Mineral Wool, Preformed Pipe Insulation, Type II: [**1-1/2 inches**] <**Insert dimension**> thick.
d. Phenolic: [**1-1/2 inches**] <**Insert dimension**> thick.

H. Floor Drains, Traps, and Sanitary Drain Piping within [**10 Feet**] <**Insert distance**> of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation is[**one of**] the following:

a. Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.
b. Flexible Elastomeric: [**3/4 inch**] [**1 inch**] <**Insert dimension**> thick.
c. Glass-Fiber, Preformed Pipe Insulation, Type I: [**1/2 inch**] [**1 inch**] <**Insert dimension**> thick.
d. Mineral Wool, Preformed Pipe Insulation, Type II: [**1/2 inch**] [**1 inch**] <**Insert dimension**> thick.
e. Phenolic: [**1 inch**] <**Insert dimension**> thick.
f. Polyolefin: [**3/4 inch**] [**1 inch**] <**Insert dimension**> thick.

I. Hot Service Drains:

1. All Pipe Sizes: Insulation is[**one of**] the following:

    a. Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.
    b. Glass-Fiber, Preformed Pipe Insulation, Type I: [**1 inch**] <**Insert dimension**> thick.
    c. Mineral Wool, Preformed Pipe Insulation, Type II: [**1 inch**] <**Insert dimension**> thick.

J. Hot Service Vents:

1. All Pipe Sizes: Insulation is[**one of**] the following:

    a. Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.
    b. Glass-Fiber, Preformed Pipe Insulation, Type I: [**1 inch**] <**Insert dimension**> thick.
    c. Mineral Wool, Preformed Pipe Insulation, Type II: [**1 inch**] <**Insert dimension**> thick.

3.16 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping:

1. All Pipe Sizes: Insulation is[**one of**] the following:

    a. Cellular Glass: [**2 inches**] <**Insert dimension**> thick.
    b. Flexible Elastomeric: [**2 inches**] <**Insert dimension**> thick.
    c. Glass-Fiber, Preformed Pipe Insulation, Type I: [**2 inches**] <**Insert dimension**> thick.
    d. Mineral Wool, Preformed Pipe Insulation, Type II: [**2 inches**] <**Insert dimension**> thick.
    e. Phenolic: [**2 inches**] <**Insert dimension**> thick.
    f. Polyolefin: [**2 inches**] <**Insert dimension**> thick.

B. Domestic Hot and Recirculated Hot Water:

1. All Pipe Sizes: Insulation is[**one of**] the following:

    a. Cellular Glass: [**2 inches**] <**Insert dimension**> thick.
    b. Flexible Elastomeric: [**2 inches**] <**Insert dimension**> thick.
    c. Glass-Fiber, Preformed Pipe Insulation, Type I: [**2 inches**] <**Insert dimension**> thick.
    d. Mineral Wool, Preformed Pipe Insulation, Type II: [**2 inches**] <**Insert dimension**> thick.
    e. Phenolic: [**2 inches**] <**Insert dimension**> thick.
    f. Polyolefin: [**2 inches**] <**Insert dimension**> thick.

C. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation is[**one of**] the following:

    a. Cellular Glass: [**2 inches**] <**Insert dimension**> thick.
    b. Glass-Fiber, Preformed Pipe Insulation, Type I: [**2 inches**] <**Insert dimension**> thick.
    c. Mineral Wool, Preformed Pipe Insulation, Type II: [**2 inches**] <**Insert dimension**> thick.

d. Phenolic: [**2 inches**] <**Insert dimension**> thick.

D. Hot Service Drains:

1. All Pipe Sizes: Insulation is[**one of**] the following:

a. Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.
b. Glass-Fiber, Preformed Pipe Insulation, Type I: [**1 inch**] <**Insert dimension**> thick.
c. Mineral Wool, Preformed Pipe Insulation, Type II: [**1 inch**] <**Insert dimension**> thick.

E. Hot Service Vents:

1. All Pipe Sizes: Insulation is[**one of**] the following:

a. Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.
b. Glass-Fiber, Preformed Pipe Insulation, Type I: [**1 inch**] <**Insert dimension**> thick.
c. Mineral Wool, Preformed Pipe Insulation, Type II: [**1 inch**] <**Insert dimension**> thick.

3.17 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Sanitary Waste Piping, All Sizes, Where Heat Tracing Is Installed: Cellular glass, [**2 inches**] <**Insert dimension**> thick.

B. Chilled Water, All Sizes: Cellular glass, [**2 inches**] <**Insert dimension**> thick.

3.18 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.
2. [**PVC**] [**PVC, Color-Coded by System**]: [**20 mils**] [**30 mils**] thick.
3. Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] [**0.040 inch**] thick.
4. Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] thick.
5. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth No. 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch**] [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] thick.
6. <**Insert jacket type**>.

D. Piping, Exposed:

1. None.
2. [**PVC**] [**PVC, Color-Coded by System**]: [**20 mils**] [**30 mils**] thick.
3. Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] [**0.040 inch**] thick.

4. Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] thick.
5. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth No. 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch**] [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] thick.
6. <**Insert jacket type**>.

3.19 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.
2. [**PVC**] [**PVC, Color-Coded by System**]: [**20 mils**] [**30 mils**] thick.
3. Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] [**0.040 inch**] thick.
4. Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] thick.
5. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth No. 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch**] [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] thick.
6. <**Insert jacket type**>.

D. Piping, Exposed:

1. PVC: [**20 mils**] [**30 mils**] [**40 mils**] thick.
2. [**Painted**]Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**] [**with Z-Shaped Locking Seam**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] [**0.040 inch**] thick.
3. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth No. 2B Finish**] [**Corrugated**] [**Stucco Embossed**] [**with Z-Shaped Locking Seam**]: [**0.010 inch**] [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] thick.
4. <**Insert jacket type**>.

3.20 UNDERGROUND, FIELD-APPLIED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 220719

SECTION 220800 - COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes Cx process requirements for the following plumbing systems, assemblies, and equipment:

1. Domestic hot- and cold-water piping.
2. Sanitary waste and vent piping.
3. Plumbing pumps.
4. Plumbing equipment.

B. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
2. For construction checklists, comply with requirements in various Division 22 Sections specifying plumbing systems, system components, equipment, and products.

1.2 DEFINITIONS

A. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."

B. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."

C. IAPMO: International Association of Plumbing and Mechanical Officials.

D. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For plumbing testing technician.

B. Construction Checklists:

1. Draft Cx plan, including draft construction checklists to be prepared by CxA under Section 019113 "General Commissioning Requirements." Contractor is to review Construction Checklist in accordance with requirements in Section 019113 "General Commissioning Requirements" and ASHRAE 202 and to resolve any issues with the CxA.
2. Cx plan, including material, installation, and performance construction checklists for systems, assemblies, subsystems, equipment, and components relating to plumbing to be part of the Cx process and in accordance with requirements in Section 019113 "General Commissioning Requirements" and ASHRAE 202.

C. Test Equipment and Instruments: For all test equipment and instruments to be used in conducting Cx tests by Contractor, provide the following:

1. Equipment/instrument identification number.
2. Planned Cx application or use.
3. Manufacturer, make, model, and serial number.
4. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
5. Equipment manufacturers' proprietary instrumentation and tools. For each instrument or tool, identify the following:

   a. Instrument or tool identification number.
   b. Equipment schedule designation of equipment for which the instrument or tool is required.
   c. Manufacturer, make, model, and serial number.
   d. Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

1.4 QUALITY ASSURANCE

A. Plumbing Testing Technician Qualifications: Technicians to perform plumbing Construction Checklist verification tests. Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level with knowledge of plumbing system, electrical concepts, and building operations.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.

B. Testing Equipment and Instrumentation Quality and Calibration:

1. Capable of testing and measuring performance within the specified acceptance criteria.
2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
3. Be maintained in good repair and operating condition throughout duration of use on Project.
4. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

C. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:

   a. Be calibrated by manufacturer with current calibration tags permanently affixed.
   b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.
   c. Plumbing system proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 Cx PROCESS

A. Perform Cx process for plumbing systems in accordance with:

1. [**IgCC, which requires compliance with ASHRAE 202.**]
2. [**ASHRAE 202.**]
3. [**Commissioning standards acceptable to the authority having jurisdiction.**]
4. <**Insert standard**>.

3.2 CONSTRUCTION CHECKLISTS

A. Preliminary detailed construction checklists are to be prepared under Section 019113 "General Commissioning Requirements" for each plumbing system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in [**ASHRAE 202.**] [**IgCC.**] [**IAPMO's "Green Plumbing and Mechanical Code Supplement."**] <**Insert Cx standard.**> Contractor performs the following:

1. Review plumbing preliminary construction checklists and provide written comments on Construction Checklist items where appropriate.
2. Return preliminary Construction Checklist with review comments within [**10**] <**Insert number**> days of receipt.
3. When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."
4. Use only construction checklists marked "Approved for Use, (date)." Mark construction checklists in the appropriate place, as indicated Project events are completed, and provide pertinent details and other information.

B. Prepare preliminary detailed construction checklists for each plumbing system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in [**ASHRAE 202.**] [**IgCC.**] [**IAPMO's "Green Plumbing and Mechanical Code Supplement."**] <**Insert Cx standard.**>

1. Submit preliminary construction checklists to CxA and Designer for review.
2. When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."
3. Use only construction checklists marked "Approved for Use, (date)." Mark construction checklists in the appropriate place as indicated Project events are completed, and provide pertinent details and other information.

C. Systems Required to Be Commissioned under IgCC:

1. Domestic hot-water systems and controls.
2. Water-pumping and -mixing systems over 5 hp and purification systems.
3. Irrigation system performance that uses more than 1000 gal. per day.
4. Renewable energy systems and energy storage systems.

D. Additional Systems Required to Be Commissioned:

1. Facility water-distribution piping, including the following:

    a. Domestic[**and fire-suppression**] water piping, fittings, and specialties outside the building.
    b. Pumps, motors, accessories, and controls.
    c. Sleeves and sleeve seals.
    d. Meters and gauges.
    e. General-duty and specialty valves.
    f. Hangers and supports.
    g. Heat tracing.
    h. Vibration isolation[**and seismic restraints**].

2. Domestic water piping, including the following:

    a. Domestic cold- and hot-water piping, fittings, and specialties inside the building.
    b. Pumps, motors, accessories, and controls.
    c. Sleeves and sleeve seals.
    d. Indoor water-storage tanks.
    e. Meters and gauges.
    f. General-duty and specialty valves.
    g. Hangers and supports.
    h. Heat tracing.
    i. Vibration isolation[**and seismic restraints**].

3. Sanitary waste and vent piping, including the following:

    a. Gravity and forced-main sewerage piping, fittings, and specialties.
    b. Sanitary waste interceptors.
    c. Pumps, motors, accessories, and controls.
    d. Drains.
    e. Sleeves and sleeve seals.
    f. Meters and gauges.
    g. General-duty and specialty valves.
    h. Hangers and supports.
    i. Heat tracing.
    j. Vibration isolation[**and seismic restraints**].

4. Plumbing fixtures, including the following:

    a. Water closets, supports and connections, supplies, and flush valves.
    b. Lavatories, supports, supplies, drain connections, and faucets.
    c. Sinks, supports, supplies, drain connections, and faucets.
    d. Drinking fountains, supplies, and drainage connections.

3.3 Cx TESTING PREPARATION

A. Certify that plumbing systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.

B. Certify that plumbing system instrumentation and control systems have been completed and calibrated, point-to-point checkout has been successfully completed, and systems are operating in accordance with their design sequence of operation, Contract Documents, and approved

submittals. Certify that all sensors are operating within specified accuracy and that all systems are set to and maintaining set points as required by the design documents.

C. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (for example, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

3.4 Cx TEST CONDITIONS

A. Perform tests using design conditions, whenever possible.

1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA, and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

B. If tests cannot be completed because of a deficiency outside the scope of the plumbing system, document the deficiency and report it to Architect. After deficiencies are resolved, reschedule tests.

C. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.5 Cx TESTS COMMON TO PLUMBING SYSTEMS

A. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.

B. Test systems, assemblies, subsystems, equipment, and components for operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response compared to acceptance criteria.

C. Coordinate schedule with, and perform Cx activities at the direction of, CxA.

D. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance test requirements specified in Division 22 Sections specifying plumbing systems and equipment.

E. Provide technicians, instrumentation, tools, and equipment to perform and document the following:

1. Cx Construction Checklist verification tests.
2. Cx Construction Checklist verification test demonstrations.

3.6 CONSTRUCTION CHECKLIST EXAMPLES

A. Vibration Isolation in Plumbing Systems:

1. Prerequisites: Acceptance of results of construction checklists for vibration[**and seismic**] control devices specified in [**Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."**] [**Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."**]
2. Components to Be Tested:

   a. Vibration isolation control devices in plumbing systems.
   b. [**Seismic control devices for proper device selection and mounting.**]
   c. Support systems.

3. Test Purpose: Evaluate effectiveness of vibration isolation[**and proper installation of seismic**] control devices.
4. Test Conditions: Measure vibration of the facility structure at [**three**] <**Insert number**> locations designated by Owner's witness at the following operating conditions:

   a. Maximum speed.
   b. Minimum speed.
   c. Critical speed.

5. Acceptance Criteria: Structure-borne vibration not to exceed specified performance.

B. Plumbing Meter Reporting:

1. Prerequisites: Acceptance of results of construction checklists for plumbing systems specified in the following Sections :

   a. Section 221119 "Domestic Water Piping Specialties."

2. Test Scope:

   a. [**Supervised**] [**Monitored**] plumbing system water meters.

3. Test Purpose:

   a. Verify accuracy of reporting of [**supervised**] [**monitored**] plumbing system water meters at [**building management system**] [**utility management service**] [**other utility consumption management system**] <**Insert system**>.

4. Test Conditions:

   a. Plumbing system water meter recording systems operating in normal, automatic mode.
   b. Compare cumulative consumption data at plumbing system water meter recording systems with independent, calibrated, flow-measuring instrumentation under the following conditions:

      1) Low Flow: [**1**] <**Insert number**> percent of maximum design flow rate for a period of [**four hours**] <**Insert time**>.
      2) High Flow: [**80**] <**Insert number**> percent of maximum design flow rate for a period of [**20 minutes**] <**Insert time**>.

c. Activate [**supervised**] [**monitored**] plumbing alarms, one at a time.

5. Acceptance Criteria:

a. Cumulative flow reported for low-flow condition is within [**5**] <**Insert number**> percent flow recorded by calibrated flow-measuring instrumentation.
b. Cumulative flow reported for high-flow condition is within [**1**] <**Insert number**> percent flow recorded by calibrated flow-measuring instrumentation.

SECTION 221123.21 - INLINE, DOMESTIC-WATER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. In-line, sealless centrifugal pumps.

B. Related Requirements:

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction materials, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for pump controls.>

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Detail pumps and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which pumps will be attached.
2. Size and location of initial access modules for acoustical tile.

B. Seismic Qualification Data: Certificates, for inline, domestic-water pumps, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline 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 and their installation requirements.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For inline, domestic-water pumps to include in operation and maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written instructions for handling.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: UL 778 for motor-operated water pumps.

C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

D. <**Insert local jurisdiction requirement**>.

E. Seismic Performance: Inline, domestic-water pumps shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] <**Insert requirement**>.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**] [**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

C. Capacities and Characteristics:

1. Capacity: 1 gpm.
2. Total Dynamic Head: 10 feet.
3. Inlet and Outlet Size: 1 NPS.
4. Pump Speed: 1400 rpm.

5. Pump Control: Thermostat.
6. Motor Horsepower: 0.1 HP.
7. Electrical Characteristics:

    a. Volts: 120 V.
    b. Phase: Single phase.
    c. Hertz: 60 Hz.
    d. Full-Load Amperes: 2.0 A.

D. Pump Construction:

1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
2. Minimum Working Pressure: [**125 psig**] <**Insert pressure**>.
3. Maximum Continuous Operating Temperature: 120 deg F.
4. Casing: [**Cast iron**] [**Bronze**] [**Stainless steel**], with threaded or companion-flange connections.
5. Impeller: [**Plastic**] [**composite**] [**or**] [**stainless steel**].
6. Motor: Single [**Three**] speed.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220500 "Common Work Results for Plumbing."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 CONTROLS

A. Thermostats: Electric; adjustable for control of [**hot-water circulation**] <**Insert application**> pump.

1. Type: Water-immersion temperature sensor, for installation in piping.
2. Range: 50 to 125 deg F.
3. Enclosure: NEMA 250,.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 24 V ac.
7. Settings: Start pump at 105 deg F and stop pump at 120 deg F.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for domestic-water-piping system to verify actual locations of piping connections before pump installation.

3.2 INSTALLATION OF PUMPS

A. Comply with HI 1.4.

B. Mount pumps in orientation complying with manufacturer's written instructions.

C. Pump Mounting:

1. Install vertically mounted, in-line, close-coupled centrifugal pumps with cast-iron base mounted on concrete base using vibration isolation type and deflection as specified in [**Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."**] [**Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."**] Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Install continuous-thread hanger rods and vibration isolation of size required to support pump weight.

1. Comply with requirements for vibration isolation devices specified in [**Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."**] [**Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."**] Fabricate brackets or supports as required.
2. Comply with requirements for hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

E. Install thermostats in hot-water return piping.

F. Install time-delay relays in piping between water heaters and hot-water storage tanks.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.

C. Connect domestic-water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:

a. Horizontally mounted, in-line, separately coupled centrifugal pumps.
b. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."

D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties." Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."

1. Install pressure gauge[**and snubber**] at suction of each pump and pressure gauge[**and snubber**] at discharge of each pump. Install at integral pressure-gauge tappings where provided or install pressure-gauge connectors in suction and discharge piping around pumps. Comply with requirements for pressure gauges and snubbers specified in Section 220500 "Common Work Results for Plumbing."

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between temperature controllers and devices.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.6 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Set thermostats for automatic starting and stopping operation of pumps.
5. Perform the following startup checks for each pump before starting:

   a. Verify bearing lubrication.
   b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
   c. Verify that pump is rotating in the correct direction.

6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.8 ADJUSTING

A. Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 221123.21

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Galvanized-steel pipe and fittings.
4. Stainless steel drainage pipe and fittings.
5. Ductile-iron pipe and fittings.
6. Copper tube and fittings.
7. ABS pipe and fittings.
8. PVC pipe and fittings.
9. Specialty pipe fittings.
10. Encasement for underground metal piping.

B. Related Requirements:

1. Section 221329 "Sanitary Sewerage Pumps" for effluent and sewage pumps.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for adhesives.>

C. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.

B. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.4 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated:

1. Notify [**Architect**] [**Construction Manager**] [**Owner**] no fewer than [**two**] <**Insert number**> days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without [**Architect's**] [**Construction Manager's**] [**Owner's**] written permission.

1.5 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: [**10 ft. head of water**] <**Insert pressure**>.
2. Waste, Force-Main Piping: [**50 psig**] [**100 psig**] [**150 psig**] <**Insert pressure**>.

B. Seismic Performance: Soil, waste, and vent piping and support and installation to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**] <**Insert requirement**>. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment":

1. 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. Component Importance Factor: [**1.5**] [**1.0**].

C. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 PIPING MATERIALS

A. Piping materials to bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Pipe and Fittings:

1. Marked with CISPI collective trademark.
2. ASTM A74, [**service**] [**and**] [**extra-heavy**] cast iron.

C. Gaskets: ASTM C564, rubber.

D. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Pipe and Fittings:

1. Marked with CISPI collective trademark.
2. ASTM A888 or CISPI 301.

C. Single-Stack Aerator Fittings: ASME B16.45, hubless, cast-iron aerator and deaerator drainage fittings.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

D. CISPI, Hubless-Piping Couplings:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: ASTM C1277 and CISPI 310.
3. Description: Stainless steel corrugated shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

E. Heavy-Duty, Hubless-Piping Couplings:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standards: ASTM C1277 and ASTM C1540. <**Insert standard**>.
3. Description: Stainless steel shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.5 GALVANIZED-STEEL PIPE AND FITTINGS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Galvanized-Steel Pipe: ASTM A53/A53M, Type E, standard-weight cast iron. Include square-cut-grooved or threaded ends matching joining method.

C. Cast-Iron Drainage Fittings: [**Galvanized;**]ASME B16.12, threaded.

D. Steel Pipe Pressure Fittings:

1. Steel Pipe Nipples: [**Galvanized;**]ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Schedule 40, seamless steel pipe. Include ends matching joining method.

2. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Gray-Iron, Threaded Fittings: [**Galvanized;**]ASME B16.4, Class 125, standard pattern.

E. Cast-Iron Flanges: ASME B16.1, Class 125.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

F. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A536, ductile-iron castings; ASTM A47/A47M, malleable-iron castings; ASTM A234/A234M, forged steel fittings; or ASTM A106/A106M, steel pipes with dimensions matching ASTM A53/A53M, steel pipe, and complying with AWWA C606 for grooved ends.
3. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F1476, Type I. Include ferrous housing sections with continuous curved keys, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.

2.6 STAINLESS STEEL DRAINAGE PIPE AND FITTINGS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Comply with requirements of ASME A112.3.1 drainage pattern.

C. Material: [**Type 304 stainless steel**] [**Type 316L stainless steel**] [**Type 304 or 316L stainless steel**].

D. Pipe Construction: Seamless.

E. Internal Sealing Rings: [**EPDM**] [**NBR**] <**Insert material**> [**, marked or color-coded for the application**].

F. Joints: Single or double, socket and spigot ends.

2.7 DUCTILE-IRON PIPE AND FITTINGS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Ductile-Iron, Mechanical-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Ductile-Iron, Push-on-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Gaskets: AWWA C111/A21.11, rubber.

D. Ductile-Iron, Grooved-Joint Piping: AWWA C151/A21.51, with round-cut-grooved ends in accordance with AWWA C606.

E. Ductile-Iron, Grooved-End Pipe Appurtenances:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Grooved-End, Ductile-Iron Fittings: ASTM A536, ductile-iron castings, with dimensions matching AWWA C110/A 21.10, ductile-iron pipe or AWWA C153/A 21.53, ductile-iron fittings, and complying with AWWA C606 for grooved ends.
3. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F1476, Type I. Include ferrous housing sections with continuous curved keys, EPDM-rubber center-leg gasket suitable for hot and cold water, and bolts and nuts.

2.8 COPPER TUBE AND FITTINGS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Copper Type DWV Tube: ASTM B306, drainage tube, drawn temper.

C. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

D. Hard Copper Tube: ASTM B88, Type L and Type M, water tube, drawn temper.

E. Soft Copper Tube: ASTM B88, Type L, water tube, annealed temper.

F. Copper Pressure Fittings:

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

G. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

H. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.

2.9 ABS PIPE AND FITTINGS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. NSF Marking: Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

C. Solid-Wall ABS Pipe: ASTM D2661, Schedule 40.

D. Cellular-Core ABS Pipe: ASTM F628, Schedule 40.

E. ABS Socket Fittings: ASTM D2661, made in accordance with ASTM D3311, drain, waste, and vent patterns.

F. Solvent Cement: ASTM D2235.

1. <Double click to insert sustainable design text for solvent cement.>
2. <Double click to insert sustainable design text for solvent cement.>

2.10 PVC PIPE AND FITTINGS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Comply with NSF 14 for plastic piping components. Include "NSF-dwv" marking for plastic drain, waste, and vent piping and "NSF-sewer" marking for plastic sewer piping.

C. Solid-Wall PVC Pipe: ASTM D2665 drain, waste, and vent.

D. Cellular-Core PVC Pipe: ASTM F891, Schedule 40.

E. PVC Socket Fittings: ASTM D2665, made in accordance with ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

F. Adhesive Primer: ASTM F656.

1. <Double click to insert sustainable design text for adhesive primer.>
2. <Double click to insert sustainable design text for adhesive primer.>

G. Solvent Cement: ASTM D2564.

1. <Double click to insert sustainable design text for solvent cement.>

2.11 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
b. Standard: ASTM C1173.

c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. End Connections: Same size as and compatible with pipes to be joined.
e. Sleeve Materials:

1) For Cast-Iron Soil Pipes: ASTM C564, rubber.
2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926 PVC.
3) For Dissimilar Pipes: ASTM D5926 PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
b. Standard: ASTM C1460.
c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. End Connections: Same size as and compatible with pipes to be joined.

5. Pressure Transition Couplings:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
b. Standard: AWWA C219.
c. Description: Metal sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
d. Center-Sleeve Material: [**Manufacturer's standard**] [**Carbon steel**] [**Stainless steel**] [**Ductile iron**] [**Malleable iron**].
e. Gasket Material: Natural or synthetic rubber.
f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
b. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: [**125 psig minimum at 180 deg F**] [**150 psig**] [**250 psig**] <**Insert pressure**>.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
b. Description:

1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: [**125 psig minimum at 180 deg F**] [**150 psig**] [**175 psig**] [**300 psig**] <**Insert pressure**>.
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
b. Description:

1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: [**150 psig**] <**Insert pressure**>.
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.

5. Dielectric Nipples:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
b. Description:

1) Standard: IAPMO PS 66.
2) Electroplated steel nipple.
3) Pressure Rating: [**300 psig at 225 deg F**] <**Insert pressure and temperature**>.
4) End Connections: Male threaded or grooved.
5) Lining: Inert and noncorrosive, propylene.

2.12 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A674 or AWWA C105/A 21.5.

B. Material: [**Linear low-density polyethylene film of 0.008-inch**] [**or**] [**high-density, cross-laminated polyethylene film of 0.004-inch**] minimum thickness.

C. Form: [**Sheet**] [**or**] [**tube**].

D. Color: [**Black**] [**or**] [**natural**] <**Insert color**>.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in [**Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment"**] [**Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment"**].

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
2. Use long-turn, double Y-branch, and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

a. Reducing size of waste piping in direction of flow is prohibited.

L. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.

2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: Two percent downward in direction of flow for piping NPS 3 and smaller; [**1**] [**2**] <**Insert number**> percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Waste Piping: [**Two**] <**Insert number**> percent downward in direction of flow.
3. Vent Piping: [**One**] <**Insert number**> percent down toward vertical fixture vent or toward vent stack.

N. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping in accordance with ASTM A674 or AWWA C105/A 21.5.

O. Install steel piping in accordance with applicable plumbing code.

P. Install stainless steel piping in accordance with ASME A112.3.1 and applicable plumbing code.

Q. Install aboveground copper tubing in accordance with CDA's "Copper Tube Handbook."

R. Install aboveground ABS piping in accordance with ASTM D2661.

S. Install aboveground PVC piping in accordance with ASTM D2665.

T. Install underground [**ABS**] [**and**] [**PVC**] piping in accordance with ASTM D2321.

U. Install engineered soil and waste and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

V. Install underground, ductile-iron, force-main piping according to AWWA C600.

1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
3. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.

W. Install underground, copper, force-main tubing in accordance with CDA's "Copper Tube Handbook."

1. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.

X. Install force mains at elevations indicated.

Y. Plumbing Specialties:

1. Install backwater valves in sanitary waster gravity-flow piping.

a. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."

2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."

3. Install drains in sanitary waste gravity-flow piping.

a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

Z. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

AA. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

BB. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

CC. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.3 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints:

1. Join hubless, cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

    a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
    c. Do not use pipe sections that have cracked or open welds.

E. Join stainless steel pipe and fittings with gaskets in accordance with ASME A112.3.1.

F. Join copper tube and fittings with soldered joints in accordance with ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.

G. Grooved Joints: Cut groove ends of pipe in accordance with AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

I. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendixes.
3. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendixes.

J. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:

    a. Provide axial restraint for pipe and fittings [**5 inches**] <**Insert dimensions**> and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
    b. Provide rigid sway bracing for pipe and fittings [**4 inches**] <**Insert dimensions**> and larger, upstream and downstream of all changes in direction 45 degrees and greater.
    c. Provide rigid sway bracing for pipe and fittings [**5 inches**] <**Insert dimensions**> and larger, upstream and downstream of all changes in direction and branch openings.

3.4 INSTALLATION OF SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: [**Unshielded**] [**Shielded**], nonpressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.

4. In Underground Force Main Piping:

   a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
   b. NPS 2 (DN 50) and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric [**nipples**] [**unions**].
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric [**flanges**] [**flange kits**] [**nipples**].
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF VALVES

A. General valve installation requirements for general-duty valve installation are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
2. Install [**gate**] [**full-port ball**] valve for piping NPS 2 and smaller.
3. Install [**gate**] <**Insert type**> valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves.[**Use normally closed type unless otherwise indicated.**]
2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in [**Section 220529 "Hangers and Supports for Plumbing Piping and Equipment"**] [**Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment"**].

1. Install [**carbon-steel**] <**Insert material**> pipe hangers for horizontal piping in noncorrosive environments.
2. Install [**stainless steel**] [**fiberglass**] pipe hangers for horizontal piping in corrosive environments.
3. Install [**carbon-steel**] <**Insert material**> pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless steel pipe support clamps for vertical piping in corrosive environments.

5. Vertical Piping: MSS Type 8 or Type 42 clamps.
6. Install individual, straight, horizontal piping runs:

    a. 100 Ft. (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Ft. (30 m): MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Ft. (30 m) if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Ft. (30 m) or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52 spring hangers.

C. Install hangers for [**cast-iron**] [**steel**] [**stainless steel**] [**and**] [**copper**] soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for [**ABS**] [**and**] [**PVC**] piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping and tubing within 12 inches of each fitting[**, valve,**] and coupling.

F. Support vertical runs of [**cast-iron**] [**steel**] [**stainless steel**] [**and**] [**copper**] soil piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support vertical runs of [**ABS**] [**and**] [**PVC**] piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
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 waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves [**with cleanout cover flush with floor**] [**in pit with pit cover flush with floor**] <**Insert description**>.
6. Comply with requirements for [**backwater valves**] [**cleanouts**] [**and**] [**drains**] specified in Section 221319 "Sanitary Waste Piping Specialties."
7. Equipment: Connect waste piping as indicated.

    a. Provide shutoff valve if indicated and union for each connection.

b. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections in accordance with the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 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. 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.

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.

D. Test sanitary waste and vent piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

    a. Close openings in piping system and fill with water to point of overflow, but not less than 10 ft. head of water.
    b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
    c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

    a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1 inch wg.
    b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
    c. Air pressure must remain constant without introducing additional air throughout period of inspection.
    d. Inspect plumbing fixture connections for gas and water leaks.

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 required corrective action.

E. Test force-main piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.

    a. Isolate test source and allow to stand for four hours.
    b. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed Plastic Piping: Protect [**ABS**] [**PVC**] plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller are to be the following:

1. Service cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings[**and hubless, single-stack aerator fittings**]; [**CISPI**] [**heavy-duty**] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless steel pipe and fittings, sealing rings, and gasketed joints.
5. Copper Type DWV tube, copper drainage fittings, and soldered joints.
6. [**Solid-wall**] [**Cellular-core**] ABS pipe, ABS socket fittings, and solvent-cemented joints.
7. [**Solid-wall**] [**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
8. Dissimilar Pipe-Material Couplings: [**Unshielded**] [**Shielded**], nonpressure transition couplings.

C. Aboveground, soil and waste piping NPS 5 (DN 125) and larger are to be the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings [**and hubless, single-stack aerator fittings**]; [**CISPI**] [**heavy-duty**] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless steel pipe and fittings, sealing rings, and gasketed joints.
5. [**Solid-wall**] [**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: [**Unshielded**] [**Shielded**], nonpressure transition couplings.

D. Aboveground, vent piping NPS 4 (DN 100) is to be the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI**] [**heavy-duty**] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless steel pipe and fittings gaskets, and gasketed joints.
5. Copper Type DWV tube, copper drainage fittings, and soldered joints.

   a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2 (DN 65 and DN 90): Hard copper tube, Type M; copper pressure fittings; and soldered joints.

6. [**Solid-wall**] [**Cellular-core**] ABS pipe, ABS socket fittings, and solvent-cemented joints.
7. [**Solid-wall**] [**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
8. Dissimilar Pipe-Material Couplings: [**Unshielded**] [**Shielded**], nonpressure transition couplings.

E. Aboveground, vent piping NPS 5 (DN 125) and larger is to be the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI**] [**heavy-duty**] hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.

4. [**Solid-wall**] [**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: [**Unshielded**] [**Shielded**], nonpressure transition couplings.

F. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller are to be the following:

1. [**Extra-heavy**] [**Service**] cast-iron soil piping; [**gaskets; and gasketed**] [**caulking materials; and caulked**] joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI**] [**heavy-duty**] [**cast-iron**] hubless-piping couplings; and coupled joints.
3. Stainless steel pipe and fittings, gaskets, and gasketed joints.
4. [**Solid-wall**] [**Cellular-core**] ABS pipe, ABS socket fittings, and solvent-cemented joints.
5. [**Solid-wall**] [**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: [**Unshielded**] [**Shielded**], nonpressure transition couplings.

G. Underground, soil and waste piping NPS 5 (DN 125) and larger are to be the following:

1. [**Extra-heavy**] [**Service**], cast-iron soil piping; [**gaskets; and gasketed**] [**caulking materials; and caulked**] joints.
2. Hubless, cast-iron soil pipe and fittings; [**CISPI**] [**heavy-duty**] [**cast-iron**] hubless-piping couplings; coupled joints.
3. [**Solid-wall**] [**Cellular-core**] PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: [**Unshielded**] [**Shielded**], nonpressure transition couplings.

H. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 (DN 40 and DN 50) are to be the following:

1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.

I. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 (DN 65 to DN 150) are to be the following:

1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.
3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

J. Underground sanitary-sewage force mains NPS 4 (DN 100) and smaller are to be the following:

1. [**Hard**] [**Soft**] copper tube, Type L; [**wrought-**]copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.

K. Underground sanitary-sewage force mains NPS 5 (DN 125) and larger are to be the following:

1. Hard copper tube, Type L; [**wrought-**]copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.

3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Pressure transition couplings if dissimilar pipe materials.

END OF SECTION 221316

SECTION 221319.13 - SANITARY DRAINS

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. Floor drains.
2. Floor sinks.
3. Trench drains.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene styrene.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene.

D. PE: Polyethylene.

E. PP: Polypropylene.

F. PVC: Polyvinyl chloride.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains <**Insert drawing designation if any**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: ASME A112.6.3[**with backwater valve**].
3. Pattern: [**Area**] [**Floor**] [**Funnel floor**] [**Sanitary**] <**Insert pattern**> drain.
4. Body Material: [**Gray iron**] <**Insert material**>.
5. Seepage Flange: [**Not required**] [**Required**].
6. Anchor Flange: [**Not required**] [**Required**].
7. Clamping Device: [**Not required**] [**Required**].
8. Outlet: [**Bottom**] [**Side**] <**Insert type**>.
9. Backwater Valve: [**Drain-outlet type**] [**Integral, ASME A112.14.1, swing-check type**] [**Not required**].
10. Coating on Interior and Exposed Exterior Surfaces: [**Acid-resistant enamel**] [**Not required**] <**Insert material**>.
11. Sediment Bucket: [**Not required**] <**Insert description**>.
12. Top or Strainer Material: [**Bronze**] [**Gray iron**] [**Nickel bronze**] [**Stainless steel**] <**Insert material**>.
13. Top of Body and Strainer Finish: [**Nickel bronze**] [**Polished bronze**] [**Rough bronze**] [**Stainless steel**] <**Insert finish**>.
14. Top Shape: [**Round**] [**Square**] <**Insert shape**>.
15. Dimensions of Top or Strainer: <**Insert dimensions and describe body, sump, and grate**>.
16. Top Loading Classification: [**Extra Heavy Duty**] [**Heavy Duty**] [**Light Duty**] [**Medium Duty**] <**Delete if not applicable**>.
17. Funnel: [**Not required**] [**Required**] <**Insert description and dimensions**>.
18. Inlet Fitting: [**Not required**] [**Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection**].
19. Trap Material: [**Bronze**] [**Cast iron**] [**Copper**] [**Not required**] <**Insert material**>.
20. Trap Pattern: [**Deep-seal P-trap**] [**Standard P-trap**] [**Not required**] <**Insert pattern**>.
21. Trap Features: [**Cleanout**] [**Trap-seal primer valve drain connection**] [**Cleanout and trap-seal primer valve drain connection**] [**Not required**] <**Insert type**>.

B. Stainless-Steel Floor Drains, ASME A112.3.1 <**Insert drawing designation if any**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Outlet: [**Bottom**] [**Side**] <**Insert type**>.
3. Top or Strainer Material: [**Stainless steel**] <**Insert material**>.
4. Top Shape: [**Round**] [**Square**] <**Insert shape**>.
5. Dimensions of Top or Strainer: <**Insert dimensions and describe body, sump, and grate**>.
6. Seepage Flange: [**Not required**] [**Required**].
7. Anchor Flange: [**Not required**] [**Required**].
8. Clamping Device: [**Not required**] [**Required**].
9. Trap-Primer Connection: [**Not required**] [**Required**].
10. Trap Material: [**Cast iron**] [**Stainless steel**] [**Not required**] <**Insert material**>.
11. Trap Pattern: [**Deep-seal P-trap**] [**Standard P-trap**] [**Not required**] <**Insert pattern**>.

C. Stainless-Steel Floor Drains, ASME A112.6.3 <**Insert drawing designation if any**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Outlet: [**Bottom**] [**Side**] <**Insert type**>.
3. Top or Strainer Material: [**Stainless steel**] <**Insert material**>.
4. Top Shape: [**Round**] [**Square**] <**Insert shape**>.

5. Dimensions of Top or Strainer: <**Insert dimensions and describe body, sump, and grate**>.
6. Seepage Flange: [**Not required**] [**Required**].
7. Anchor Flange: [**Not required**] [**Required**].
8. Clamping Device: [**Not required**] [**Required**].
9. Trap-Primer Connection: [**Not required**] [**Required**].
10. Trap Material: [**Cast iron**] [**Stainless steel**] [**Not required**] <**Insert material**>.
11. Trap Pattern: [**Deep-seal P-trap**] [**Standard P-trap**] [**Not required**] <**Insert pattern**>.

D. Plastic Floor Drains <**Insert drawing designation if any**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: ASME A112.6.3.
3. Material: [**ABS**] [**or**] [**PVC**] <**Insert material**>.
4. Seepage Flange: [**Not required**] [**Required**].
5. Clamping Device: [**Not required**] [**Required**].
6. Outlet: [**Bottom**] [**Side**] <**Insert type**>.
7. Sediment Bucket: [**Not required**] <**Insert description**>.
8. Top or Strainer Material: [**Bronze**] [**Plastic**] [**Stainless steel**] <**Insert other**>.
9. Top of Body and Strainer Finish: [**Nickel bronze**] [**Polished bronze**] [**Rough bronze**] [**Stainless steel**] <**Insert other**>.
10. Top Shape: [**Round**] [**Square**] <**Insert shape**>.
11. Dimensions of Top or Strainer: <**Insert dimensions and describe body, sump, and grate if required**>.
12. Trap Material: [**Cast iron**] [**Plastic drainage piping**] [**Not required**] <**Insert material**>.
13. Trap Pattern: [**Standard P-trap**] [**Not required**] <**Insert pattern**>.

2.3 FLOOR SINKS

A. Cast-Iron Floor Sinks <**Insert drawing designation if any**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: ASME A112.6.7.
3. Pattern: [**Floor**] [**Funnel floor**] <**Insert pattern**> drain.
4. Body Material: Cast iron.
5. Anchor Flange: [**Not required**] [**Required**][**, with seepage holes**].
6. Clamping Device: [**Not required**] [**Required**].
7. Outlet: Bottom, [**no-hub**] <**Insert type**> connection.
8. Coating on Interior Surfaces: [**Not required**] [**Acid-resistant enamel**] <**Insert coating**>.
9. Sediment Bucket: [**Not required**] <**Insert description**>.
10. Internal Strainer: [**Not required**] [**Dome**] [**Flat**].
11. Internal Strainer Material: [**Aluminum**] <**Insert material**>.
12. Top Grate Material: [**Cast iron**] <**Insert material**>[**, loose**][**, hinged**].
13. Top of Body and Grate Finish: [**Nickel bronze**] [**Acid-resistant enamel**] <**Insert finish**>.
14. Top Shape: [**Round**] [**Square**] <**Insert shape**>.
15. Dimensions of Top Grate: <**Insert dimensions and describe grate pattern**>.
16. Top Loading Classification: [**No traffic**] <**Insert traffic loading**>.
17. Funnel: [**Not required**] [**Required**]. <**Insert material, shape and dimensions**>.
18. <**Insert additional options here**>.

B. Stainless-Steel Floor Sinks, ASME A112.6.7 <**Insert drawing designation if any**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: ASME A112.6.7.

3. Pattern: [**Floor**] [**Funnel floor**] <**Insert pattern**> drain.
4. Body Material: Stainless steel.
5. Anchor Flange: [**Not required**] [**Required**][**, with seepage holes**].
6. Clamping Device: [**Not required**] [**Required**].
7. Outlet: Bottom, [**no-hub**] <**Insert type**> connection.
8. Sediment Bucket: [**Not required**] <**Insert description**>.
9. Internal Strainer: [**Not required**] [**Dome**] [**Flat**].
10. Internal Strainer Material: [**Stainless steel**] <**Insert material**>.
11. Top Grate Material: [**Stainless steel**] <**Insert material**>[**, loose**][**, hinged**].
12. Top of Body and Grate Finish: [**Satin nickel**] [**Stainless steel**] <**Insert finish**>.
13. Top Shape: [**Round**] [**Square**] <**Insert shape**>.
14. Dimensions of Top Grate: <**Insert dimensions and describe grate pattern**>.
15. Top Loading Classification: [**No traffic**] <**Insert traffic loading**>.
16. Funnel: [**Not required**] [**Required**]. <**Insert material, shape and dimensions**>.
17. <**Insert additional options here**>.

C. Plastic Floor Sinks <**Insert drawing designation if any**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: ASME A112.6.7.
3. Pattern: [**Floor**] [**Funnel floor**] <**Insert pattern**> drain.
4. Body Material: PVC.
5. Outlet: Bottom, PVC primer and solvent cement connection.
6. Sediment Bucket: [**Not required**] <**Insert description**>.
7. Internal Strainer: [**Not required**] [**Dome**] [**Flat**].
8. Internal Strainer Material: [**PVC**] <**Insert material**>.
9. Top Grate Material: [**PVC**] <**Insert material**>.
10. Top Shape: [**Round**] [**Square**] <**Insert shape**>.
11. Dimensions of Top Grate: <**Insert dimensions and describe grate pattern**>.
12. Top Loading Classification: [**No traffic**] <**Insert traffic loading**>.
13. Funnel: [**Not required**] [**Required**]. <**Insert material, shape and dimensions**>.
14. <**Insert additional options here**>.

2.4 TRENCH DRAINS

A. Trench Drains <**Insert drawing designation if any**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Standard: ASME A112.6.3 for trench drains.
3. Material: Ductile or gray iron.
4. Flange: [**Anchor**] [**Seepage**] [**Not required**].
5. Clamping Device: [**Not required**] [**Required**].
6. Outlet: [**Bottom**] [**End**] [**Side**] <**Insert location**>.
7. Grate Material: [**Ductile iron**] [**Ductile iron or gray iron**] [**Gray iron**] [**Stainless steel**] <**Insert material**>.
8. Grate Finish: [**Painted**] [**Not required**] <**Insert finish**>.
9. Dimensions of Frame and Grate: <**Insert dimensions and describe body, sump, and grate if required**>.
10. Top Loading Classification: [**Extra Heavy Duty**] [**Heavy Duty**] [**Light Duty**] [**Medium Duty**] <**Delete if not applicable**>.
11. Trap Material: [**Cast iron**] [**Stainless steel**] [**Not required**] <**Insert material**>.
12. Trap Pattern: [**Standard P-trap**] [**Not required**] <**Insert pattern**>.

PART 3 - EXECUTION

3.1 INSTALLATION

A. 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.
3. 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.

4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.

a. Maintain integrity of waterproof membranes where penetrated.

5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

B. Install trench drains at low points of surface areas to be drained.

1. Set grates of drains flush with finished surface, unless otherwise indicated.

C. Comply with ASME A112.3.1 for installation of stainless-steel channel drainage systems.

1. Install on support devices, so that top will be flush with adjacent surface.

D. Install FRP channel drainage system components on support devices, so that top will be flush with adjacent surface.

E. Install plastic channel drainage system components on support devices, so that top will be flush with adjacent surface.

F. Install open drain fittings with top of hub [**1 inch**] [**2 inches**] <**Insert dimension**> above floor.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.

C. Comply with requirements in Section 221323 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.

D. Install piping adjacent to equipment to allow service and maintenance.

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

A. 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 Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

A. Protect drains during 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 221319.13

SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Residential, electric, storage, domestic-water heaters.
2. Domestic-water heater accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for water heaters.>

C. Shop Drawings:

1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Equipment room drawing or BIM model, drawn to scale, on which the items described in this Section are shown and coordinated with all building trades.

B. Seismic Qualification Data: Certificates, for commercial domestic-water heaters, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline 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 and their installation requirements.

C. Product Certificates: For each type of [**commercial**] [**residential**] [**and**] [**tankless**], electric, domestic-water heater.

D. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric, domestic-water heaters to include emergency, operation, and maintenance manuals.

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of electric, domestic-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 Periods: From date of Substantial Completion.

a. Residential, Electric, Storage, Domestic-Water Heaters:

1) Storage Tank: [**Five**] [**Six**] [**10**] <**Insert number**> years.
2) Controls and Other Components: [**Two**] [**Three**] <**Insert number**> years.

b. Expansion Tanks: [**Five**] <**Insert number**> years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

B. Seismic Performance: Commercial, electric, domestic-water heaters to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**] <**Insert requirement**>.

1. 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. Component Importance Factor: [**1.5**] [**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

D. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.2 RESIDENTIAL, ELECTRIC, DOMESTIC-WATER HEATERS

A. Residential, Electric, Storage, Domestic-Water Heaters:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
3. Standard: UL 174.
4. Storage-Tank Construction: Steel.

   a. Tappings: ASME B1.20.1 pipe thread.
   b. Pressure Rating: 150 psig.
   c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.

5. Factory-Installed, Storage-Tank Appurtenances:

   a. Anode Rod: Replaceable magnesium.
   b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
   c. Drain Valve: Corrosion-resistant metal with hose-end connection.
   d. Insulation: Comply with [**ASHRAE/IES 90.1**] [**ASHRAE 90.2**].
   e. Jacket: Steel, cylindrical, with enameled finish or high-impact composite material.
   f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
   g. Heating Elements: Electric, screw-in immersion type.
   h. Temperature Control: Adjustable thermostat.
   i. Safety Control: High-temperature-limit cutoff device or system.
   j. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.

B. Capacity and Characteristics:

1. Capacity: <**Insert gal.** >.
2. Recovery: <**Insert gph**> at [**100 deg F**] <**Insert temperature**> temperature rise.
3. Temperature Setting: [**125 deg F**] <**Insert temperature**>.
4. Power Demand: <**Insert kilowatts**>.
5. Heating Elements: <**Insert kilowatts**>.
6. Electrical Characteristics:

   a. Volts: [**120**] [**240**] <**Insert value**> V.
   b. Phases: [**Single**] [**Three**].
   c. Hertz: 60 Hz.
   d. Full-Load Amperes: <**Insert value**> A.

e. Minimum Circuit Ampacity: <**Insert value**> A.
f. Maximum Overcurrent Protection: <**Insert value**> A.

2.3 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tanks:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain domestic-water expansion tanks from single source from single manufacturer.
3. Description: Steel pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
4. Construction:

a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
c. Air-Charging Valve: Factory installed.

5. Capacity and Characteristics:

a. Working-Pressure Rating: [**100 psig**] [**150 psig**] <**Insert value**>.
b. Capacity Acceptable: [**2 gal.**] [**4 gal.**] [**7 gal.**] [**10 gal.**] <**Insert value**> minimum.
c. Air Precharge Pressure: <**Insert system pressure**>.

B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with [**ASHRAE/IES 90.1**] [**ASHRAE 90.2**].

D. Heat-Trap Fittings: [**ASHRAE/IES 90.1**] [**ASHRAE 90.2**].

E. Manifold Kits: Domestic-water-heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and [**calibrated**] [**memory-stop**] balancing valves to provide balanced flow through each domestic-water heater.

1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."
2. Comply with requirements for balancing valves specified in Section 221119 "Domestic Water Piping Specialties."

F. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig-maximum outlet pressure unless otherwise indicated.

G. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than working-

pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.

H. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than working-pressure rating of domestic-water heater.

I. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.

J. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.

K. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Include dimension that will support bottom of domestic-water heater a minimum of [**18 inches**] <**Insert dimension**> above the floor.

L. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test[**commercial**] domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."

1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
2. Maintain manufacturer's recommended clearances.
3. Arrange units so controls and devices that require servicing are accessible.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.
8. Anchor domestic-water heaters to substrate.

B. Residential, Electric, Domestic-Water Heater Mounting: Install residential, electric, domestic-water heaters [**on floor**] [**on water-heater stand on floor**] [**on domestic-water heater mounting bracket**].

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor domestic-water heaters to substrate.

C. Electric, Tankless, Domestic-Water Heater Mounting: Install electric, tankless, domestic-water heaters[**at least 18 inches above floor**] on wall bracket.

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor domestic-water heaters to substrate.

D. Install electric, domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."

E. Install commercial, electric, domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in [**Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."**] [**Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."**]

F. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

G. Install [**combination temperature-and-**]pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

H. 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 electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

I. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

J. Install thermometers on inlet and outlet piping of residential, solar, electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

K. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping" and comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

L. Install pressure-reducing valve with integral bypass relief valve in electric, domestic-water booster-heater inlet piping and water hammer arrester in booster-heater outlet piping. Set pressure-reducing valve for outlet pressure of [**25 psig**] <**Insert value**>. Comply with requirements for pressure-reducing valves and water hammer arresters specified in Section 221119 "Domestic Water Piping Specialties."

M. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.

N. Fill electric, domestic-water heaters with water.

O. Charge domestic-water expansion tanks with air to required system pressure.

P. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water to contain less than 0.25 percent of lead by weight.

3.2 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial, electric, domestic-water heaters. Training to be a minimum of two hour(s).

END OF SECTION 223300

SECTION 224200 - COMMERCIAL PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Commercial lavatories.
2. Commercial water closets.
3. Flushometer valves.
4. Toilet seats.
5. Fixture carriers.

1.2 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

B. High-Efficiency Flush Volume: 1.28 gal. or less per flush.

C. PMMA: Polymethyl methacrylate; also known as "acrylic."

D. Standard-Efficiency Flush Volume: 1.6 gal. per flush.

E. WaterSense Fixture: Water closet and/or flushometer valve/tank certified by the EPA to meet the WaterSense performance criteria.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions and thicknesses, dimensions of individual components and profiles, and finishes for plumbing fixtures.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Plans, elevations, sections, and [**mounting**] [**attachment**] details.
2. Details of equipment assemblies, including accessories. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, location and size of each field connection, location and size of each cutout, and anchorage provisions and attachment methods. Indicate coordination requirements for adjacent and interfacing Work.
3. Diagrams for power, signal, and control wiring.

C. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for plumbing fixtures.>

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories and/or counter-mounted sinks.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. For lavatories and faucets.

a. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1) Servicing and adjustments of automatic faucets.

2. For shower valves to include in maintenance manuals.
3. For sinks and faucets to include in operation and maintenance manuals.

a. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1) Servicing and adjustments of automatic faucets.

4. For flushometer valves[**and electronic sensors**] to include in operation and maintenance manuals.
5. For wash fountains and components to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Cartridges and O-Rings: Equal to [**5**] <**Insert number**> percent of amount of each type and size installed.
2. Flushometer-Valve Repair Kits: Equal to [**10**] <**Insert number**> percent of amount of each type installed, but no fewer than [**one**] [**six**] <**Insert number**> of each type.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Lavatory faucets, sink faucets, shower valves, and wash fountain spray heads and faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

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.

2.2 COMMERCIAL LAVATORIES

A. Lavatories, Wall Mounted:

1. Lavatories, Wall Mounted - Vitreous China, Rectangular with Back:

a. Manufacturers: Subject to compliance with requirements:

1) American Standard.
2) Kohler Co.
3) Sloan Valve Company.
4) Zurn Industries, LLC.

b. Fixture:

1) Standard: ASME A112.19.2/CSA B45.1.
2) Type: For wall hanging.
3) Nominal Size: Rectangular, 18 by 16 inches.
4) Faucet-Hole Punching: One hole.
5) Faucet-Hole Location: Top.
6) Color: White.
7) Mounting Material: Chair carrier.

c. Support: Lavatory carrier, framing affixed.
d. Lavatory Mounting Height: Accessible in accordance with ICC A117.1.

B. Lavatory Faucets, Automatically Operated:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Standard.
b. Kohler Co.
c. Sloan Valve Company.
d. Zurn Industries, LLC.

2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
3. Operation Type: Battery powered electronic sensor operated.
4. 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.
5. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
6. Body Type: Single hole.
7. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
8. Finish: Polished chrome plate.
9. Maximum Flow Rate: 0.5 gpm.
10. Mounting Type: Deck, concealed.
11. Spout: Rigid type.

12. Spout Outlet: Aerator.
13. Drain: Not part of faucet.

C. Lavatory Supply Fittings:

1. NSF Standards: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.
2. Standard: ASME A112.18.1/CSA B125.1.
3. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless steel wall flange.
4. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
5. Operation: Loose key.

a. Risers Size: NPS 3/8.
b. Risers Material: Chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces.

D. Lavatory Waste Fittings:

1. Standard: ASME A112.18.2/CSA B125.2.
2. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
3. Trap:

a. Size: NPS 1-1/2 by NPS 1-1/4.
b. Material:

1) Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated, brass or steel wall flange.
2) Stainless steel, two-piece trap and swivel elbow with 0.012-inch thick stainless steel tube to wall, and stainless steel wall flange.

2.3 COMMERCIAL WATER CLOSETS

A. Water Closets, Floor Mounted:

1. Water Closets, Floor Mounted - Bottom Outlet, Top Spud:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) American Standard.
2) Kohler Co.
3) Sloan Valve Company.
4) Zurn Industries, LLC.

b. Source Limitations: Obtain water closets from single source from single manufacturer.
c. Standard: ASME A112.19.2/CSA B45.1.
d. Bowl:

1) Material: Vitreous china.
2) Type: Siphon jet.

3) Style: Flushometer valve.
4) Height: Accessible in accordance with ICC A117.1.
5) Rim Contour: Elongated.
6) Water Consumption: 1.6 gal. per flush.
7) Spud Size and Location: NPS 1-1/2; top.
8) Color: White.

2.4 FLUSHOMETER VALVES

A. Flushometer Valves, Manually Operated:

B. Flushometer Valves, Sensor Operated:

1. Flushometer Valves, Sensor Operated - Diaphragm:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Sloan Valve Company.
2) Zurn Industries, LLC.

b. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
c. Standard: ASSE 1037/ASME 112.1037/CSA B125.37.
d. Minimum Pressure Rating: 125 psig.
e. Features: Include integral check stop and backflow-prevention device.
f. Material: Brass body with corrosion-resistant components.
g. Style: Exposed.
h. Exposed Flushometer-Valve Finish: Chrome-plated.
i. Panel Finish: Chrome-plated or stainless steel.
j. Actuator: Side or top mounted; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
k. Trip Mechanism: Battery-powered electronic sensor; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
l. Consumption: 1.6 gal. per flush.
m. Minimum Inlet: NPS 1.
n. Minimum Outlet: NPS 1-1/4.

2.5 TOILET SEATS

A. Toilet Seats - Commercial <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain toilet seat from single source from single manufacturer.
3. Standard: IAPMO/ANSI Z124.5.
4. Material: Plastic.
5. Type: Commercial (heavy duty).
6. Shape: [**Elongated rim, open front**] [**Elongated rim, closed front**] <**Insert shape**>.
7. Hinge: [**Check**] [**Self-sustaining, check**].
8. Hinge Material: Noncorroding metal.
9. Seat Cover: [**Required**] [**Not required**].

10. Color: [**White**] <**Insert color**>.
11. Surface Treatment: [**Antimicrobial**] [**Not required**].

2.6 FIXTURE CARRIERS

A. Fixture Carriers - Lavatory:

1. Manufacturers: Subject to compliance with requirements, [**provide products by the following**] [**provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. Jay R. Smith Mfg Co; a division of Morris Group International.
   b. WATTS; A Watts Water Technologies Company.
   c. Zurn Industries, LLC.

2. Source Limitations: Obtain lavatory carriers from single source from single manufacturer.
3. Standards:

   a. ASME A112.6.1M.
   b. ASME A112.6.2.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine walls and floors for suitable conditions where plumbing fixtures will be installed.

C. Examine counters for suitable conditions where lavatories and sinks will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF COMMERCIAL PLUMBING FIXTURES

A. Lavatory Installation:

1. Install lavatories level and plumb in accordance with roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-mounted lavatories.
3. Install accessible, wall-mounted lavatories at mounting height in accordance with ICC A117.1.
4. Install water-supply piping with stop on each supply to each lavatory faucet. Install stops in locations that are accessible for ease of operation.
5. Install trap and waste piping on each drain outlet of each lavatory to be connected to sanitary drainage system.
6. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply

with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."

7. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
8. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

B. Water Closet Installation:

1. Install water closets level and plumb in accordance with roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height in accordance with ICC A117.1.
4. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
5. Use carrier supports with waste-fitting assembly and seal.
6. Install floor-mounted, back-outlet water closets, attached to building floor substrate, onto waste-fitting seals; and attach to support.
7. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals, and affix to building substrate.
8. Measure support height installation from finished floor, not structural floor.
9. Install flushometer-valve, water-supply fitting on each supply to each water closet.
10. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
11. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
12. Install actuators in locations easily reachable for people with disabilities.
13. Install new batteries in battery-powered, electronic-sensor mechanisms.
14. Install toilet seats on water closets.
15. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Install deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."
16. Seal joints between water closets, walls, and floors using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to water-closet color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 INSTALLATION OF PIPING CONNECTIONS

A. Connect plumbing fixtures with water supplies and soil, waste, and vent piping. Use size fittings required to match plumbing fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil, waste, and vent piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Install protective-shielding pipe covers and enclosures on exposed supplies and waste piping of accessible plumbing fixtures. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

E. Where installing piping adjacent to water closets and urinals, allow space for service and maintenance.

3.4 INSTALLATION OF ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 INSTALLATION OF CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 ADJUSTING

A. Operate and adjust plumbing fixtures and controls. Replace damaged and malfunctioning plumbing fixtures, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

C. Adjust water pressure at shower valves to produce proper flow.

D. Adjust water pressure at flushometer valves to produce proper flow.

E. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.7 CLEANING AND PROTECTION

A. After completing installation of plumbing fixtures, inspect and repair damage to finishes. Replace any fixtures unable to be repaired to the satisfaction of the [**Architect**] [**Owner**].

B. Clean plumbing fixtures and associated faucets, valves, flushometer valves, and fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed plumbing fixtures and associated faucets, valves, flushometer valves, and fittings.

D. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224200

SECTION 224700 - DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Drinking fountains.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
b. Include operating characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and [**mounting**] [**attachment**] details.
2. Include details of fixture assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power wiring.

C. Delegated Design Submittals: For vibration isolation[**and supports,**] [**, and seismic restraints**] 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. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for water consumption.>

1.3 INFORMATIONAL SUBMITTALS

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For drinking fountains, bottle filling stations, to include in maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include servicing and adjustment of electronic-sensor fixtures.

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. Filter Cartridges: Equal to <**Insert number**> percent of quantity installed for each type and size indicated, but no fewer than <**Insert number**> of each.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions for delivery, storage, and handling.

1.7 WARRANTY

A. Manufacturer Warranty: Manufacturer and Installer agree to repair or replace drinking fountains bottle filling stations that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of <**Insert type of failure**>.
b. Deterioration of metals, metal finishes, and other materials beyond normal [**weathering**] [**use**].

B. Warranty Period: [**One**] <**number**> year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Standards:

1. Drinking fountains, water coolers, bottle filling stations, and remote water coolers intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the authority having jurisdiction, and with NSF 61 or NSF 372, or be certified in compliance with NSF 61 or NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Delegated Design:

1. [**Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to**] design vibration isolation[**, supports,**] [**and seismic restraints**], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. [**Product manufacturer's qualified staff**] [**Qualified professional engineer employed by the product manufacturer**] to select and size products to achieve specified performance requirements.

C. Seismic Performance: Remote water coolers are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**] <**Insert requirement**>. See [**Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment"**] <**Insert Section**>.

1. 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. Component Importance Factor: [**1.5**] [**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 DRINKING FOUNTAINS

A. Drinking Fountains - Surface Wall Mounted, Stainless Steel:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Elkay.
   b. Haws Corporation.
   c. Stern-Williams Products, LLC.

2. Source Limitations: Obtain surface wall-mounted, stainless steel drinking fountains from single source from single manufacturer.
3. Standards:

   a. NSF 61.
   b. NSF 372.
   c. ASME A112.19.3/CSA B45.4.
4. Receptor(s):

   a. Type: With back.
   b. Shape: Rectangular.
   c. Back Panel: Stainless steel wall plate behind drinking fountain.
   d. Bubblers: One for each receptor, with adjustable stream regulator, located on deck.
   e. Drain: Grid type with NPS 1-1/4 tailpiece.

5. Maximum Water Flow: 0.15 gpm.
6. Control: Push button Sensor.
7. Supply: NPS 3/8 with shutoff valve.
8. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 chrome-plated brass P-trap and waste.
9. Filter: One or more water filters with capacity sized for unit peak flow rate.

   a. Standards:

      1) NSF 42.
      2) NSF 53.

10. Electrical Characteristics:

a. Standard: 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. Volts: 120 V ac.
c. Phase: Single.
d. Hertz: 60 Hz.

11. Support: Provide manufacturer's mounting plate.
12. Drinking Fountain Mounting Height: High/low - standard/accessible in accordance with ICC A117.1.

2.3 FIXTURE CARRIERS

A. Fixture Carriers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. WATTS; A Watts Water Technologies Company.
c. Zurn Industries, LLC.

2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fixtures level and plumb in accordance with roughing-in drawings. For fixtures indicated for juveniles, install at height required by authorities having jurisdiction.

B. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

C. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."

E. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Install ball shutoff valve on water supply to each fixture. Install ball or gate valves with valved bypass on water connections to remote water coolers. Comply with valve requirements specified in Section 220523 "General-Duty Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplates to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplates to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

C. Adjust electronic-sensor settings.

3.6 CLEANING

A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, in accordance with manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224700

Table of Contents Generated by MasterWorks: 11/14/2024

Division	Section Title	Pages
	SPECIFICATIONS GROUP	
	Facility Services Subgroup	
DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)		
230500	COMMON WORK RESULTS FOR HVAC	21
230529	HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT	16
230546	COATINGS FOR HVAC	8
230548	VIBRATION AND SEISMIC CONTROLS FOR HVAC	22
230548.13	VIBRATION CONTROLS FOR HVAC	25
230553	IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT	10
230593	TESTING, ADJUSTING, AND BALANCING FOR HVAC	18
230713	DUCT INSULATION	34
230716	HVAC EQUIPMENT INSULATION	37
230800	COMMISSIONING OF HVAC	8
233113	METAL DUCTS	21
233300	AIR DUCT ACCESSORIES	8
233400	HVAC FANS	36
233413	AXIAL HVAC FANS	14
233416	CENTRIFUGAL HVAC FANS	27
233423	HVAC POWER VENTILATORS	17
233439	HIGH-VOLUME, LOW-SPEED FANS	12
233713.13	AIR DIFFUSERS	3
233713.23	REGISTERS AND GRILLES	3
238236	FINNED-TUBE RADIATION HEATERS	11
238239.19	WALL AND CEILING UNIT HEATERS	4

END OF TABLE OF CONTENTS

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Motors.
2. Sleeves with waterstop.
3. Sleeve-seal systems.
4. Grout.
5. Escutcheons.
6. Thermometers, bimetallic actuated.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of HVAC equipment Sections.

   a. Include construction details, material descriptions, and dimensions of individual components, and finishes.
   b. Include operating characteristics and furnished accessories.

B. Delegated Design Submittals: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

C. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for sealants.>

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter.

B. Welding certificates.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of [**expansion joint,**] [**meter,**] [**and**] [**gauge**] to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

1.6 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.

PART 2 - PRODUCTS

2.1 MOTORS

A. Motor Requirements, General:

1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
3. Comply with NEMA MG 1 unless otherwise indicated.
4. Comply with IEEE 841 for severe-duty motors.

B. Motor Characteristics:

1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 ft. above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Polyphase Motors:

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium Efficient, as defined in NEMA MG 1.
3. Service Factor: 1.15.

4. Multispeed Motors: Variable torque.

    a. For motors with 2:1 speed ratio, consequent pole, single winding.
    b. For motors with other than 2:1 speed ratio, separate winding for each speed.

5. Multispeed Motors, Two Winding: Separate winding for each speed.
6. Rotor: Random-wound, squirrel cage.
7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
8. Temperature Rise: Match insulation rating.
9. Insulation: [**Class F**] <**Insert class**>.
10. Code Letter Designation:

    a. Motors 15 Hp and Larger: NEMA starting Code F or Code G.
    b. Motors Smaller Than 15 Hp: Manufacturer's standard starting characteristic.

11. Enclosure Material: Cast iron for motor frame sizes [**324T**] <**Insert number**> and larger; rolled steel for motor frame sizes smaller than [**324T**] <**Insert number**>.

D. Additional Requirements for Polyphase Motors:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
2. Motors Used with Variable-Frequency Controllers:[**Ratings, characteristics, and features coordinated with and approved by controller manufacturer.**]

    a. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time-rise pulses produced by pulse-width-modulated inverters.
    b. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
    c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
    d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

3. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

E. Single-Phase Motors:

1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:

    a. Permanent-split capacitor.
    b. Split phase.
    c. Capacitor start, inductor run.
    d. Capacitor start, capacitor run.

2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 hp and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of

motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

F. Electronically Commutated Motors:

1. Microprocessor-Based Electronic Control Module: Converts [**120 V**] [**or**] [**240 V**] single-phase AC power to three-phase DC power to operate the brushless DC motor.
2. Three-phase power motor module with permanent magnet rotor.
3. [**Circuit board**] [**or**] [**digital speed controller/LED display**].
4. Building Automation System Interface: Via [**AC voltage signal**] [**DC voltage signal**] [**or**] [**Digital Serial Interface (DSI)**].

2.2 SLEEVES AND SLEEVE SEALS

A. Sleeves with Waterstop:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: Manufactured [**PVC/HDPE**] [**steel**] [**stainless steel**] [**galvanized-steel**], sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.

B. Sleeve-Seal Systems:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

   a. Hydrostatic seal: 20 psig.
   b. Sealing Elements: [**EPDM-rubber**] [**High-temperature-silicone**] [**Nitrile (Buna-N)**] interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
   c. Pressure Plates: [**Carbon steel**] [**Composite plastic**] [**Stainless steel**] [**Stainless steel, Type 316**].
   d. Connecting Bolts and Nuts: [**Carbon steel, with zinc coating. ASTM B633**] [**Stainless steel**] [**Stainless steel, Type 316,**] of length required to secure pressure plates to sealing elements.

C. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: 5000 psi, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

2.3 ESCUTCHEONS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Escutcheon Types:

1. One-Piece, Steel Type: With [**polished, chrome-plated**] [**polished brass**] finish and setscrew fastener.
2. One-Piece, Stainless Steel Type: With polished stainless steel finish.
3. One-Piece, Cast-Brass Type: With [**polished, chrome-plated**] [**polished brass**] finish and setscrew fastener.
4. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped [**steel**] [**brass**] with polished, chrome-plated finish and spring-clip fasteners.
5. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
6. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; [**concealed**] [**and**] [**exposed-rivet**] hinge; and spring-clip fasteners.

C. Floor Plates:

1. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Attach guides to pipe, and secure guides to building structure.

C. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

D. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9.
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-58, Type 24; U bolts bolted to anchor.

E. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
3. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

3.2 INSTALLATION OF SLEEVES - GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide [**1-inch**] [**2-inch**] <**Insert dimension**> annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas [**2 inches**] <**Insert dimension**> above finished floor level.

3. Using [**grout**] [**or**] [**silicone sealant**], seal space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.3 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width of concrete slab or wall.

C. Secure nailing flanges to wooden concrete forms.

D. Using grout, seal space around outside of sleeves.

3.4 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.5 INSTALLATION OF ESCUTCHEONS

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

3.6 INSTALLATION OF METERS AND GAUGES

A. Install thermowells with socket extending [**a minimum of 2 inches into fluid**] [**one-third of pipe diameter**] [**to center of pipe**] and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing, and support tubing to prevent kinks. Use minimum tubing length.

G. Install pipe-mounted thermal-energy temperature sensors in thermowells and extend wiring to indicator.

H. Install duct-thermometer-mounting brackets in walls of ducts. Attach to duct with screws.

I. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.

J. Install remote-mounted pressure gauges on panel.

K. Install valve and snubber in piping for each pressure gauge for fluids (except steam).

L. Install valve and syphon fitting in piping for each pressure gauge for steam.

M. Install test plugs in piping tees.

N. Install flow indicators in piping systems in accessible positions for easy viewing.

O. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

P. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler.
3. Two inlets and two outlets of each chiller.
4. Inlet and outlet of each hydronic coil in air-handling units.
5. Two inlets and two outlets of each hydronic heat exchanger.
6. Inlet and outlet of each thermal-storage tank.
7. Outside-, return-, supply-, and mixed-air ducts.

8. <**Insert location**>.

Q. Install pressure gauges in the following locations:

1. Discharge of each pressure-reducing valve.
2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
3. Suction and discharge of each pump.
4. <**Insert location**>.

3.7 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

D. Connect thermal-energy meter transmitters to meters.

3.8 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gauges to proper angle for best visibility.

3.9 FIELD QUALITY CONTROL

A. Sleeves and Sleeve Seals:

1. Perform the following tests and inspections:

a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

2. Prepare test and inspection reports.

B. Escutcheons:

1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.10 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above and below Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [**1-inch**] <**Insert dimension**> annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

a. Sleeves with waterstops.

1) Select sleeve size to allow for [**1-inch**] <**Insert dimension**> annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:

a. [**Sleeves with waterstops**] [**or**] [**stack-sleeve fittings**].

4. Interior Walls and Partitions:

a. Sleeves without waterstops.

3.11 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping and Relocated Existing Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Chrome-Plated Piping: One piece, [**steel**] [**cast brass**][**or split-plate steel**] with polished, chrome-plated finish.
3. Insulated Piping:

a. One piece, steel with [**polished, chrome-plated**] [**polished brass**] finish.
b. One piece, stainless steel with polished stainless steel finish.
c. One piece, cast brass with [**polished, chrome-plated**] [**polished brass**] finish.
d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**] [**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

4. Bare Piping at Wall and Floor Penetrations in Finished Spaces:

a. One piece, steel with [**polished, chrome-plated**] [**polished brass**] finish.
b. One piece, stainless steel with polished stainless steel finish.
c. One piece, cast brass with [**polished, chrome-plated**] [**polished brass**] finish.
d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**] [**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

5. Bare Piping at Ceiling Penetrations in Finished Spaces:

a. One piece, steel with [**polished, chrome-plated**] [**polished brass**] finish.
b. One piece, stainless steel with polished stainless steel finish.
c. One piece, cast brass with [**polished, chrome-plated**] [**polished brass**] finish.
d. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**] [**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

6. Bare Piping in Unfinished Service Spaces:

a. One piece, steel with polished, chrome-plated finish.
b. One piece, cast brass with [**polished, chrome-plated**] [**rough-brass**] finish.
c. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**] [**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

7. Bare Piping in Equipment Rooms:

a. One piece, steel with polished, chrome-plated finish.
b. One piece, cast brass with [**polished, chrome-plated**] [**rough-brass**] finish.
c. One piece, stamped steel [**or split plate, stamped steel with concealed hinge**] [**or split plate, stamped steel with exposed-rivet hinge**] with polished, chrome-plated finish.

B. Escutcheons for Existing Piping to Remain:

1. Chrome-Plated Piping: Split plate, stamped steel with [**concealed**] [**or**] [**exposed-rivet**] hinge with polished, chrome-plated finish.
2. Insulated Piping: Split plate, stamped steel with [**concealed**] [**or**] [**exposed-rivet**] hinge with polished, chrome-plated finish.
3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split plate, stamped steel with [**concealed**] [**or**] [**exposed-rivet**] hinge with polished, chrome-plated finish.
4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split plate, stamped steel with [**concealed**] [**or**] [**exposed-rivet**] hinge with polished, chrome-plated finish.
5. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel with [**concealed**] [**or**] [**exposed-rivet**] hinge with polished, chrome-plated finish.
6. Bare Piping in Equipment Rooms: Split plate, stamped steel with [**concealed**] [**or**] [**exposed-rivet**] hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: Split floor plate.
2. Existing Piping to Remain: Split floor plate.

3.12 THERMOMETER APPLICATION

A. Thermometers at inlet and outlet of each hydronic zone are to be the following:

1. [**Liquid-filled**] [**Sealed**], bimetallic-actuated type.
2. [**Direct**] [**Remote**]-mounted, [**metal**] [**plastic**]-case, vapor-actuated type.
3. [**Compact**] [**Industrial**]-style, liquid-in-glass type.
4. [**Direct**] [**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**] [**EPDM**] self-sealing rubber inserts.

B. Thermometers at inlet and outlet of each hydronic boiler are to be the following:

1. [**Liquid-filled**] [**Sealed**], bimetallic-actuated type.
2. [**Direct**] [**Remote**]-mounted, [**metal**] [**plastic**]-case, vapor-actuated type.
3. [**Compact**] [**Industrial**]-style, liquid-in-glass type.

4. [**Direct**] [**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**] [**EPDM**] self-sealing rubber inserts.

C. Thermometers at inlets and outlets of each chiller are to be the following:

1. [**Liquid-filled**] [**Sealed**], bimetallic-actuated type.
2. [**Direct**] [**Remote**]-mounted, [**metal**] [**plastic**]-case, vapor-actuated type.
3. [**Compact**] [**Industrial**]-style, liquid-in-glass type.
4. [**Direct**] [**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**] [**EPDM**] self-sealing rubber inserts.

D. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems are to be the following:

1. [**Liquid-filled**] [**Sealed**], bimetallic-actuated type.
2. [**Direct**] [**Remote**]-mounted, [**metal**] [**plastic**]-case, vapor-actuated type.
3. [**Compact**] [**Industrial**]-style, liquid-in-glass type.
4. [**Direct**] [**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**] [**EPDM**] self-sealing rubber inserts.

E. Thermometers at inlets and outlets of each hydronic heat exchanger are to be the following:

1. [**Liquid-filled**] [**Sealed**], bimetallic-actuated type.
2. [**Direct**] [**Remote**]-mounted, [**metal**] [**plastic**]-case, vapor-actuated type.
3. [**Compact**] [**Industrial**]-style, liquid-in-glass type.
4. [**Direct**] [**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**] [**EPDM**] self-sealing rubber inserts.

F. Thermometers at inlet and outlet of each hydronic heat-recovery unit are to be the following:

1. [**Liquid-filled**] [**Sealed**], bimetallic-actuated type.
2. [**Direct**] [**Remote**]-mounted, [**metal**] [**plastic**]-case, vapor-actuated type.
3. [**Compact**] [**Industrial**]-style, liquid-in-glass type.
4. [**Direct**] [**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**] [**EPDM**] self-sealing rubber inserts.

G. Thermometers at inlet and outlet of each thermal-storage tank are to be the following:

1. [**Liquid-filled**] [**Sealed**], bimetallic-actuated type.
2. [**Direct**] [**Remote**]-mounted, [**metal**] [**plastic**]-case, vapor-actuated type.
3. [**Compact**] [**Industrial**]-style, liquid-in-glass type.
4. [**Direct**] [**Remote**]-mounted, light-activated type.
5. Test plug with [**chlorosulfonated polyethylene synthetic**] [**EPDM**] self-sealing rubber inserts.

H. Thermometers at outside-, return-, supply-, and mixed-air ducts are to be the following:

1. [**Liquid-filled**] [**Sealed**], bimetallic-actuated type.
2. [**Direct**] [**Remote**]-mounted, [**metal**] [**plastic**]-case, vapor-actuated type.

3. [**Compact**] [**Industrial**]-style, liquid-in-glass type.
4. [**Direct**] [**Remote**]-mounted, light-activated type.

I. Thermometer stems are to be of length to match thermowell insertion length.

3.13 THERMOMETER SCALE-RANGE APPLICATION

A. Scale Range for Chilled-Water Piping:

1. [**Minus 40 to plus 160 deg F**]
[**Minus 40 to plus 160 deg F and minus 40 to plus 100 deg C**].
2. [**0 to 100 deg F**] [**0 to 100 deg F and minus 20 to plus 50 deg C**].
3. [**0 to 150 deg F**] [**0 to 150 deg F and minus 20 to plus 70 deg C**].
4. [**0 to 250 deg F**] [**0 to 250 deg F and 0 to 150 deg C**].

B. Scale Range for Condenser-Water Piping:

1. [**0 to 100 deg F**] [**0 to 100 deg F and minus 20 to plus 50 deg C**].
2. [**0 to 150 deg F**] [**0 to 150 deg F and minus 20 to plus 70 deg C**].
3. [**0 to 250 deg F**] [**0 to 250 deg F and 0 to 150 deg C**].
4. [**20 to 240 deg F**] [**20 to 240 deg F and 0 to 150 deg C**].
5. [**30 to 240 deg F**] [**30 to 240 deg F and 0 to plus 115 deg C**].

C. Scale Range for Heating, Hot-Water Piping:

1. [**0 to 250 deg F**] [**0 to 250 deg F and 0 to 150 deg C**].
2. [**20 to 240 deg F**] [**20 to 240 deg F and 0 to 150 deg C**] .
3. [**30 to 240 deg F**] [**30 to 240 deg F and 0 to plus 115 deg C**].
4. [**50 to 400 deg F**] [**50 to 400 deg F and 0 to 200 deg C**].
5. [**50 to 550 deg F**] [**50 to 550 deg F and 10 to 300 deg C**].

D. Scale Range for Steam and Steam-Condensate Piping:

1. [**0 to 250 deg F**] [**0 to 250 deg F and 0 to 150 deg C**].
2. [**0 to 250 deg F**] [**0 to 250 deg F and 0 to 150 deg C**].
3. [**30 to 240 deg F**] [**30 to 240 deg F and 0 to plus 115 deg C**].
4. [**50 to 400 deg F**] [**50 to 400 deg F and 0 to 200 deg C**].

E. Scale Range for Air Ducts:

1. [**Minus 40 to plus 110 deg F**]
[**Minus 40 to plus 110 deg F and minus 40 to plus 45 deg C**].
2. [**Minus 40 to plus 160 deg F**]
[**Minus 40 to plus 160 deg F and minus 40 to plus 100 deg C**].
3. [**0 to 100 deg F**] [**0 to 100 deg F and minus 20 to plus 50 deg C**].
4. [**0 to 150 deg F**] [**0 to 150 deg F and minus 20 to plus 70 deg C**].
5. [**0 to 250 deg F**] [**0 to 250 deg F and 0 to 150 deg C**].
6. [**20 to 240 deg F**] [**20 to 240 deg F and 0 to 150 deg C**].
7. [**30 to 240 deg F**] [**30 to 240 deg F and 0 to plus 115 deg C**].
8. [**50 to 400 deg F**] [**50 to 400 deg F and 0 to 200 deg C**].

3.14 PRESSURE-GAUGE APPLICATION

A. Pressure gauges at discharge of each pressure-reducing valve are to be the following:

1. [**Liquid filled**] [**Sealed**] [**Open front, pressure relief**] [**Solid front, pressure relief**] <**Insert type**>, [**direct**] [**remote**] mounted, metal case.
2. [**Sealed**] <**Insert type**>, [**direct**] [**remote**] mounted, plastic case.
3. Test plug with [**chlorosulfonated polyethylene synthetic**] [**EPDM**] self-sealing rubber inserts.

B. Pressure gauges at inlet and outlet of each chiller chilled-water and condenser-water connection are to be the following:

1. [**Liquid filled**] [**Sealed**] [**Open front, pressure relief**] [**Solid front, pressure relief**] <**Insert type**>, [**direct**] [**remote**] mounted, metal case.
2. [**Sealed**] <**Insert type**>, [**direct**] [**remote**] mounted, plastic case.
3. Test plug with [**chlorosulfonated polyethylene synthetic**] [**EPDM**] self-sealing rubber inserts.

C. Pressure gauges at suction and discharge of each pump are to be the following:

1. [**Liquid-filled**] [**Sealed**] [**Open front, pressure relief**] [**Solid front, pressure relief**] <**Insert type**>, [**direct**] [**remote**] mounted, metal case.
2. [**Sealed**] <**Insert type**>, [**direct**] [**remote**] mounted, plastic case.
3. Test plug with [**chlorosulfonated polyethylene synthetic**] [**EPDM**] self-sealing rubber inserts.

3.15 PRESSURE-GAUGE SCALE-RANGE APPLICATION

A. Scale Range for Chilled-Water Piping:

1. [**30 in. Hg to 15 psi**] [**30 in. Hg to 15 psi and minus 100 to 0 kPa**].
2. [**0 to 30 psi**] [**0 to 30 psi and 0 to 240 kPa**].
3. [**0 to 100 psi**] [**0 to 100 psi and 0 to 600 kPa**].
4. [**0 to 160 psi**] [**0 to 160 psi and 0 to 1100 kPa**].
5. [**0 to 200 psi**] [**0 to 200 psi and 0 to 1400 kPa**].
6. [**0 to 300 psi**] [**0 to 300 psi and 0 to 2500 kPa**].
7. [**0 to 600 psi**] [**0 to 600 psi and 0 to 4000 kPa**].

B. Scale Range for Condenser-Water Piping:

1. [**30 in. Hg to 15 psi**] [**30 in. Hg to 15 psi and minus 100 to 0 kPa**].
2. [**0 to 30 psi**] [**0 to 30 psi and 0 to 240 kPa**].
3. [**0 to 100 psi**] [**0 to 100 psi and 0 to 600 kPa**].
4. [**0 to 160 psi**] [**0 to 160 psi and 0 to 1100 kPa**].
5. [**0 to 200 psi**] [**0 to 200 psi and 0 to 1400 kPa**].
6. [**0 to 300 psi**] [**0 to 300 psi and 0 to 2500 kPa**].
7. [**0 to 600 psi**] [**0 to 600 psi and 0 to 4000 kPa**].

C. Scale Range for Heating, Hot-Water Piping:

1. [**30 in. Hg to 15 psi**] [**30 in. Hg to 15 psi and minus 100 to 0 kPa**].
2. [**0 to 30 psi**] [**0 to 30 psi and 0 to 240 kPa**].

3. [**0 to 100 psi**] [**0 to 100 psi and 0 to 600 kPa**].
4. [**0 to 160 psi**] [**0 to 160 psi and 0 to 1100 kPa**].
5. [**0 to 200 psi**] [**0 to 200 psi and 0 to 1400 kPa**].
6. [**0 to 300 psi**] [**0 to 300 psi and 0 to 2500 kPa**].
7. [**0 to 600 psi**] [**0 to 600 psi and 0 to 4000 kPa**].

D. Scale Range for Steam Piping:

1. [**30 in. Hg to 15 psi**] [**30 in. Hg to 15 psi and minus 100 to 0 kPa**].
2. [**0 to 30 psi**] [**0 to 30 psi and 0 to 240 kPa**].
3. [**0 to 100 psi**] [**0 to 100 psi and 0 to 600 kPa**].
4. [**0 to 160 psi**] [**0 to 160 psi and 0 to 1100 kPa**].
5. [**0 to 200 psi**] [**0 to 200 psi and 0 to 1400 kPa**].
6. [**0 to 300 psi**] [**0 to 300 psi and 0 to 2500 kPa**].
7. [**0 to 600 psi**] [**0 to 600 psi and 0 to 4000 kPa**].

3.16 FLOWMETER APPLICATION

A. Flowmeters for Chilled-Water Piping: [**Orifice**] [**Pitot-tube**] [**Turbine**] [**Venturi**] [**Vortex-shedding**] type.

B. Flowmeters for Condenser-Water Piping: [**Orifice**] [**Pitot-tube**] [**Turbine**] [**Venturi**] [**Vortex-shedding**] type.

C. Flowmeters for Heating, Hot-Water Piping: [**Orifice**] [**Pitot-tube**] [**Turbine**] [**Venturi**] [**Vortex-shedding**] type.

D. Flowmeters for Steam and Steam-Condensate Piping: [**Orifice**] [**Turbine**] [**Venturi**] [**Vortex-shedding**] type.

3.17 THERMAL-ENERGY METER APPLICATION

A. Thermal-Energy Meters for Chilled-Water Piping: [**Turbine**] [**Ultrasonic**] type.

B. Thermal-Energy Meters for Condenser-Water Piping: [**Turbine**] [**Ultrasonic**] type.

C. Thermal-Energy Meters for Heating, Hot-Water Piping: [**Turbine**] [**Ultrasonic**] type.

D. Thermal-Energy Meters for Steam and Steam-Condensate Piping: [**Turbine**] [**Ultrasonic**] type.

END OF SECTION 230500

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports - metal.
2. Pipe hangers - metal, trapeze type.
3. Pipe hangers - FRP.
4. Strut support systems - metal, rod type.
5. Strut support systems - FRP.
6. Strut support systems - rooftop mounted.
7. Thermal-hanger shield inserts.
8. Fastener systems.
9. Equipment supports.
10. Equipment stands - outdoor type.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 230500 "Common Work Results for HVAC" for pipe guides and anchors.
3. Section 230548 "Vibration and Seismic Controls for HVAC" Section 230548.13 "Vibration Controls for HVAC" for vibration isolation devices.
4. Section 233113 "Metal Ducts" for duct hangers and supports.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for recycled content.>

C. Shop Drawings:[**Signed and sealed by a qualified professional engineer.**] Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Metal strut support systems.
3. Rooftop-mounted strut support systems.
4. FRP strut support systems.
5. Pipe stands.
6. Equipment supports.

D. Delegated Design Submittals: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication/assembly and design calculations for trapeze hangers.
2. Detail fabrication/assembly and design calculations for each type of strut support system, by the manufacturer's technical representative.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for HVAC piping and equipment are to withstand the effects of gravity loads and stresses within limits and under conditions indicated in accordance with [**ASCE/SEI 7**] <**Insert requirement**>.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment[**and obtain approval from authorities having jurisdiction**].

2.2 PIPE HANGERS AND SUPPORTS - METAL

A. Pipe Hangers and Supports - Carbon Steel:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
3. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
4. Nonmetallic Coatings: Plastic coated, or epoxy powder coated.
5. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

6. Hanger Rods: Continuous-thread rod, nuts, and washers made of [**carbon steel**] [**stainless steel**] <**Insert material**>.

B. Pipe Hangers and Supports - Stainless Steel:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
3. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**stainless steel**] <**Insert material**>.

C. Pipe/Tube Hangers and Supports - Copper:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**copper-plated steel**] [**stainless steel**] <**Insert material**>.

2.3 PIPE HANGERS - METAL, TRAPEZE TYPE

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 PIPE HANGERS - FRP

A. Pipe Hangers - FRP, Clevis Type:

1. Description: Similar to MSS SP-58, Type 1, factory-fabricated steel pipe hanger except hanger is made of fiberglass-reinforced plastic resin.
2. Hanger Rods: Continuous-thread [**stainless steel**] <**Insert material**> rod, washer, and nuts made of [**FRP**] [**polyurethane**] [**or**] [**stainless steel**] <**Insert material**>.
3. Flammability: ASTM D635, ASTM E84, and UL 94.

B. Pipe Hangers - FRP, Strap Type:

1. Description: Similar to MSS SP-58, Type 9 or Type 10 steel pipe hanger except hanger is made of fiberglass-reinforced plastic resin.

   a. Flammability: ASTM D635, ASTM E84, and UL 94.

2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of [**stainless steel**] <**Insert material**>.

2.5 STRUT SUPPORT SYSTEMS - METAL, ROD TYPE

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Factory-fabricated pipe-support assembly made of steel channels, vertical metal support rods, accessories, fittings, and other components for supporting multiple parallel pipes.

C. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.

D. Struts: Continuous slotted [**carbon-steel**] [**stainless steel, Type 304**] [**stainless steel, Type 316**] [**extruded-aluminum**] <**Insert material**> [**channel with inturned lips**] [**or**] [**angle**] <**Insert strut type**>.

E. Strut Width: Selected for applicable load criteria.

F. Strut Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

G. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**galvanized steel**] [**stainless steel**] <**Insert material**>.

H. Metallic Coating: [**Plain**] [**Pregalvanized G90**] [**Electroplated zinc**] [**Hot-dip galvanized**] [**Gold (yellow zinc dichromate) galvanized**].

I. Paint Coating: [**Green epoxy, acrylic, or urethane**] <**Insert paint type**>.

J. Plastic Coating: [**PVC**] <**Insert plastic type**>.

K. Combination Coating: <**Insert combination coating**>.

2.6 STRUT SUPPORT SYSTEMS - FRP

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Structural-grade, factory-formed, glass-fiber-resin channels and angles for supporting multiple parallel pipes.

1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Struts: Continuous slotted fiberglass-reinforced plastic channel with inturned lips.
3. Strut Width: Selected for applicable load criteria.
4. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
5. Fitting and Accessory Materials: Same as those for channels and angles[**, except metal items may be stainless steel**].
6. Rated Strength: Selected to suit applicable load criteria.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.7 STRUT SUPPORT SYSTEMS - ROOFTOP MOUNTED

A. General Requirements: Shop-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Pipe Stand - Compact:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
3. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
4. <Double click to insert sustainable design text for recycled content.>
5. Hardware: Galvanized steel or polycarbonate.
6. Accessories: Protection pads.

C. Pipe Stand - Single Base, Single Pipe, Low Profile:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
3. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
4. <Double click to insert sustainable design text for recycled content.>
5. Vertical Members: Two, [**galvanized-steel**] [**stainless steel**], continuous-thread 1/2-inch rods.
6. Horizontal Member: Adjustable-height, [**galvanized-steel**] [**stainless steel**] pipe support channels.
7. Pipe Supports: [**Roller**] [**Strut clamps**] [**Clevis hanger**] [**Swivel hanger**].
8. Hardware: [**Galvanized**] [**Stainless**] steel.
9. Accessories: Protection pads.
10. Height: [**12 inches above roof**] <**Insert lesser dimension above roof**>.

D. Pipe Stand - Single Base, Single Pipe, High Profile:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
3. Base: Single vulcanized rubber or molded polypropylene.
4. <Double click to insert sustainable design text for recycled content.>
5. Vertical Members: Two, [**galvanized-steel**] [**stainless steel**], continuous-thread 1/2-inch rods.
6. Horizontal Member: One, adjustable-height, [**galvanized-steel**] [**or**] [**stainless steel**] pipe support slotted channel or plate.
7. Pipe Supports: [**Roller**] [**Clevis hanger**] [**Swivel hanger**].
8. Hardware: [**Galvanized**] [**Stainless**] steel.
9. Accessories: Protection pads[**, 1/2-inch continuous-thread galvanized-steel rod**] [**, 1/2-inch continuous-thread stainless steel rod**].
10. Height: [**36 inches above roof**] <**Insert lesser dimension above roof**>.

E. Pipe Stand - Multiple Pipe, High Profile:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
3. Bases: Two or more; [**vulcanized rubber**] [**molded polypropylene**] <**Insert material**>.
4. <Double click to insert sustainable design text for recycled content.>
5. Vertical Members: Two or more, [**galvanized-steel**] [**stainless steel**] channels.
6. Horizontal Members: One or more, adjustable-height, [**galvanized-steel**] [**stainless steel**] pipe support.
7. Pipe Supports: [**Roller**] [**Strut clamps**] [**Clevis hanger**] [**Swivel hanger**].
8. Hardware: [**Galvanized**] [**Stainless**] steel.
9. Accessories: Protection pads[**, 1/2-inch continuous-thread rod**].
10. Height: [**36 inches above roof**] <**Insert lesser dimension above roof**>.

F. Pipe Stand - Curb-Mounted Type: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.8 THERMAL-HANGER SHIELD INSERTS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Insulation-Insert Material for Cold Piping: [**ASTM C552, Type II cellular glass with 100 psi**] [**or**] [**ASTM C591, Type VI, Grade 1 polyisocyanurate with 125 psi**] <**Insert insulation type and compressive strength**> minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: [**Water-repellent-treated, ASTM C533, Type I calcium silicate with 100 psi**] [**ASTM C552, Type II cellular glass with 100 psi**] [**or**] [**ASTM C591, Type VI, Grade 1 polyisocyanurate with 125 psi**] <**Insert insulation type and compressive strength**> minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield are to cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield are to cover bottom 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.9 FASTENER SYSTEMS

A. Fastener System - Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities required for supported loads and building materials where used.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Fastener System - Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities required for supported loads and building materials where used.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Indoor Applications: [**Zinc-plated**] [**or**] [**stainless**] steel.
3. Outdoor Applications: Stainless steel.

2.10 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.11 EQUIPMENT STANDS, OUTDOOR TYPE

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Individual foot supports with elevated adjustable channel cross bars and clamps/fasteners/bolts for ground- or roof-supported outdoor equipment components, without roof membrane penetration, in a prefabricated system that can be modularly-assembled on site.

C. Foot Material: Rubber or polypropylene.

D. Rails Material: Hot dip galvanized carbon steel.

E. Wind/Sliding Load Resistance: Up to [**100 mph**] <**Insert value**> minimum.

2.12 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

F. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000 psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry static loads within specified loading limits. Minimum static design load used for strength determination is to include weight of supported components plus [**200 lb**] <**Insert value**>.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

B. Install lateral bracing with pipe hangers and supports to prevent swaying.

C. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, [**NPS 2-1/2**] <**Insert pipe size**> and larger[**and at changes in direction of piping**]. Coordinate location of concrete inserts before concrete is placed.

D. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

E. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

F. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Thermal-hanger shield inserts may be used as an option. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields are to span an arc of 180 degrees.

    a. Thermal-hanger shield inserts may be used as an option. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches long and 0.048 inch thick.
    b. NPS 4 (DN 100): 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

G. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

H. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2. Field fabricate in accordance with ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel in accordance with AWS D1.1/D1.1M.

I. FRP Pipe-Hanger Installation: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.

J. Strut System Installation: [**Metal**] [**FRP**]. Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.

K. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

L. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick after concrete is placed and cured. Use installers that are licensed by powder-actuated tool manufacturer.
2. Install mechanical-expansion anchors after concrete is placed and completely cured.
3. Install fasteners in accordance with manufacturer's written instructions.
4. Install lag screw wood fasteners in accordance with manufacturer's written instructions.

M. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

N. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

O. Equipment Support Installation:

1. Fabricate from welded-structural-steel shapes.
2. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
3. Grouting: Place grout under supports for floor-mounted equipment, and make bearing surface smooth.
4. Provide lateral bracing, to prevent swaying.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for [**trapeze pipe hangers**] [**and**] [**equipment supports**].

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to [**1-1/2 inches**] <**Insert dimension**>.

3.5 PAINTING

A. Touchup:

1. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

   a. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

2. Comply with requirements in [**Section 099113 "Exterior Painting"**] [**Section 099123 "Interior Painting"**] [**and**] [**Section 099600 "High-Performance Coatings"**] <**Insert painting Section(s)**> for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
3. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel [**pipe hangers and supports**] [**metal trapeze pipe hangers**] [**and**] [**metal framing systems**] and attachments for general service applications.

F. Use [**stainless steel pipe hangers**] [**FRP pipe hangers**] [**and**] [**FRP strut systems**] and [**stainless steel**] [**or**] [**corrosion-resistant**] attachments for hostile environment applications.

G. Use copper-plated pipe hangers and [**copper**] [**or**] [**stainless steel**] attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is unnecessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Use [**powder-actuated fasteners**] [**or**] [**mechanical-expansion anchors**] instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230546 - COATINGS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. 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 application of coating systems on internal HVAC components and external equipment surfaces, including the following systems:

1. Bake-cured corrosion-resistant coating systems.
2. Air-dried corrosion-resistant coating systems.

1.3 DEFINITIONS

A. Salt Water Acetic Acid Test (SWAAT): A salt fog-spray test of corrosion resistance performed in accordance with ASTM G85, Annex 3.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include Safety Data Sheets, preparation requirements, and application instructions.

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for paints and coatings.>

1.5 INFORMATIONAL SUBMITTALS

A. Source Quality-Control Reports:

1. Certification of coating material testing.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Coatings: [**1**] <**Insert number**> [**container**] [**spray can**] of each material and color applied [**, including base coat and top coat products**].

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in clean, dry, well-ventilated areas with ambient temperatures continuously maintained between 50 and 75 deg F.

1. Keep containers out of direct sunlight; avoid excessive heat and keep from freezing.
2. Maintain containers in clean condition, free of foreign materials and residue.
3. Remove rags and waste from storage areas daily.

1.8 CONDITIONS FOR COATING APPLICATION

A. Comply with manufacturer's recommendations regarding required temperature and humidity ranges during coating application.

PART 2 - PRODUCTS

2.1 CORROSION-RESISTANT COATING SYSTEMS, GENERAL

A. Material Compatibility:

1. Provide materials for application within each coating system that are compatible with one another and with metal substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coating material in coating system, submit compatibility certification from manufacturer of each coating product that products are compatible with substrate base material and with substrate-coating products applied as earlier coats.
3. Products shall be of same manufacturer for each coat in a coating system.

B. Colors: [**Manufacturer's standard**] <**Insert requirements**>.

C. <Double click to insert sustainable design text for paints.>

2.2 BAKE-CURED CORROSION-RESISTANT COATING SYSTEMS

A. Base Coat Performance Requirements:

1. Corrosion Resistance: ASTM B117: [**1500**] [**2000**] [**3500**] [**6000**] <**Insert number**> hours.
2. Cross-Hatch Adhesion: ASTM D3359: [**5B**] <**Insert value**>.
3. SWAAT: ASTM G85: [**1000**] [**Insert number**] hours.
4. Cyclic Weathering: ISO 12944-9, [**4200**] <**Insert number**> hours.
5. Mandrel Flexibility: ASTM D522/D522M: [**1/4 inch**] [**1/2 inch**] <**Insert value**> without cracking or delamination of film after full cure.
6. Adhesion - Elcometer: ASTM D4541: [**1100 psi**] <**Insert value**>.
7. Impact: ASTM D2794.

   a. Direct Hit: [**70 lb.-in.**] [**80 lb.-in.**] [**90 lb.-in.**] [**100 lb.-in.**] <**Insert value**>.
   b. Reverse Hit: [**20 lb.-in.**] [**30 lb.-in.**] [**40 lb.-in.**] [**50 lb.-in.**] <**Insert value**>.

8. pH Range, 14-Day Liquid Spot Test: [**2.4 to 12.6**] [**or**] [**3 to 12**] [**Insert value**].
9. Dry Heat Resistance: ASTM D2485: [**320 deg F**] [**392 deg F**] <**Insert value**> maximum.

10. Dry Film Thickness: [**0.5 to 1.2 mils**] [**0.6 to 1.5 mils**] <**Insert thickness range**>.
11. Heat-Transfer Reduction: [**1 percent maximum**] <**Insert value**>.
12. Hardness: ASTM D3363 Pencil Test: [**2B-HB**] [**5H-6H**] <**Insert value**>.

B. Bake-Cured Coating Acceptable for Equipment Serving Food-Preparation Areas: In accordance with NSF 51.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

C. Bake-Cured Top Coat Performance Requirements: Provide product with UV shielding properties, color stability, and maintenance of manufacturer's standard sheen, after exposure to outdoor conditions.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

D. Bake-Cured, Immersion-Applied Phenolic Epoxy System.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

E. Baked-Cured, Immersion-Applied Epoxy Coating System.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.3 AIR-DRIED CORROSION-RESISTANT COATING SYSTEMS

A. Performance Requirements:

1. Corrosion Resistance: ASTM B117: [**1500**] [**2000**] [**3500**] <**Insert number**> hours.
2. Cross-Hatch Adhesion: ASTM D3359: [**5B**] <**Insert value**>.
3. Cyclic Weathering: ISO 12944-9, Offshore Standard: [**4200**] <**Insert number**> hours.
4. Mandrel Flexibility: ASTM D522/D522M: [**1/2 inch**] [**1/8 inch**] <**Insert value**> without cracking or delamination of film after full cure.
5. Impact: ASTM D2794.

   a. Direct Hit: [**100 in-lb**] <**Insert value**>.

6. Dry Heat Resistance: ASTM D2485: [**356 deg F**] <**Insert value**> maximum.
7. Dry Film Thickness: [**2 to 3 mils**] <**Insert thickness range**>.
8. Heat-Transfer Reduction: [**1 percent**] <**Insert value**> maximum.
9. Hardness: ASTM D3363 Pencil Test: [**2B-HB**] [**2H**] [**HBF**] <**Insert value**>.

B. Air-Dried, Spray-Applied Principle Coating System.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

C. Air-Dried Phenolic System.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

D. Air-Dried, Spray-Applied Coating System.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

E. Air-Dried, Spray-Applied, Polyurethane Mixed with Aluminum Flakes System.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

F. Base Coat Performance Requirements:

1. Corrosion Resistance: ASTM B117: [**1500**] [**2000**] [**3000**] [**4000**] [**5000**] [**6000**] [**10,000**] <**Insert number**> hours.
2. SWAAT: ASTM G85: [**1000**] [**Insert number**] hours.
3. Cyclic Weathering: ISO 12944-9: [**4200**] <**Insert number**> hours.
4. Cross-Hatch Adhesion: ASTM D3359: [**5B**] <**Insert value**>.
5. Mandrel Flexibility: ASTM D522/D522M: [**1/8 inch**] [**1/4 inch**] [**1/2 inch**] <**Insert value**> without cracking or delamination of film after full cure.
6. Adhesion - Elcometer: ASTM D4541: [**1,100 psi**] <**Insert value**>
7. Impact: ASTM D2794.

   a. Direct Hit: [**100 lb.-in.**] [**160 lb.-in.**] <**Insert value**>.

8. Dry Heat Resistance: ASTM D2485: [**250 deg F**] <**Insert value**> maximum.
9. Dry Film Thickness: [**0.5 to 1.2 mils**] [**0.6 to 1.5 mils**] <**Insert thickness range**>.
10. Heat-Transfer Reduction: [**1 percent**] <**Insert value**> maximum.
11. Hardness: ASTM D3363 Pencil Test: [**2B-HB**] [**HB-F**] <**Insert value**>.

G. Air-Dried Coating Acceptable for Equipment Serving Food-Preparation Areas": In accordance with 21 CFR 175.300.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

H. Air-Dried Top Coat Performance Requirements: Provide product with UV shielding properties, color stability, and maintenance of manufacturer's standard sheen, after exposure to outdoor conditions.

I. Spray-Can Application Systems:

1. Type: Air dry, phenolic.
2. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.4 SOURCE QUALITY CONTROL

A. Certification of Coating Material Testing: Submit manufacturer's test report of corrosion-resistance performance testing, as performed by a nationally recognized testing laboratory.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with coating manufacturer's requirements and other conditions affecting performance of the Work.

B. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

C. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and coating systems indicated.

1. Thinning: Thin coating material with manufacturer's recommended thinning products when recommended or permitted by coating system manufacturer.

B. Comply with coating system manufacturer's recommendations to clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

3.3 APPLICATION

A. Verify with coating manufacturer whether coatings required must be applied and cured in factory-certified application shop.

B. Apply coating systems with equipment designed to deposit coating of specified uniform thickness over HVAC components, in complex, three-dimensional geometries.

1. Apply coatings with manufacturer-recommended tools and techniques suited for specified coating system and each coated HVAC component.
2. Do not apply coatings over labels or equipment name, identification, performance rating, or nomenclature plates.

C. Perform inspection and coating system manufacturer's recommended tests to verify coating integrity and thickness. Where coating was damaged by testing, repair damage in accordance with coating system manufacturer's written recommendations.

END OF SECTION 230546

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient support.
9. Resilient pipe guides.
10. Air-spring isolators.
11. Restrained-air-spring isolators.
12. Elastomeric hangers.
13. Spring hangers.
14. Snubbers.
15. Restraints - rigid type.
16. Restraints - cable type.
17. Restraint accessories.
18. Post-installed concrete anchors.
19. Concrete inserts.
20. Vibration isolation equipment bases.
21. Seismically restrained isolation roof-curb rails.

B. Related Requirements:

1. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components.
2. Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" specifies devices for fire-suppression equipment and systems.
3. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" specifies devices for plumbing equipment and systems.

1.2 DEFINITIONS

A. Designated Seismic System: An architectural, mechanical, electrical, plumbing, or fire protection system and its components for which the component importance factor is greater than 1.0 when determined in accordance with Section 018123 "Facility Seismic and Wind Criteria."

B. IBC: International Building Code.

C. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

1.3 DELEGATED DESIGN SERVICES

A. Delegated Design Professional: Engage qualified professional structural engineer to design seismic and wind restraints.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

2. Include load rating for each seismic-[**and wind-**]restraint device.
3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-[**and wind-**]restraint component.
4. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by [**ICC-ES product listing**] [**UL product listing**] [**FM Approvals**] [**an evaluation service member of ICC-ES**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**].
5. Annotate to indicate application of each product submitted and compliance with requirements.
6. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
3. Show coordination of seismic[**and wind**] restraints for components with other systems and equipment in the vicinity, including other supports and other seismic restraints.

C. Delegated Design Submittals:

1. All delegated design and submittals for [**seismic**] [**and**] [**wind**] restraints must be signed and sealed by a qualified professional structural engineer responsible for their preparation. Structural engineer is to possess qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering, including design of seismic and wind restraints, equipment hangers and supports, and concrete attachments.
2. For each seismic-restraint device, including [**seismic-restrained mounting,**] [**pipe-riser resilient support,**] [**snubber,**] [**seismic restraint,**] [**seismic-restraint accessory,**] [**concrete anchor and insert,**] [**and**] [**restrained isolation roof-curb rail**] that is required by this Section or is indicated on Drawings, submit the following:

a. Seismic Restraint, Vibration Isolator, and Vibration Isolation Base Selection: Select and submit seismic restraints [**and**] vibration isolators [**, and vibration isolation bases**] complying with performance requirements, design criteria, and analysis data.
b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building

structure, spring deflection changes, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.

c. Post-Installed Concrete Anchors and Concrete Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by an NRTL for reinforcement use.

d. Seismic Design Calculations: Submit all input data and loading calculations.

3. For each wind-restraint device, including [**restraint - rigid,**] [**restraint - cable,**] [**restraint accessory,**] [**concrete anchor,**] [**and**] [**concrete insert**] that is required by this Section or is indicated on Drawings, submit the following:

   a. Wind Restraints: Select and submit wind restraints complying with performance requirements, design criteria, and analysis data.
   b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated wind-resistant loads. Include certification that device is approved by an NRTL for reinforcement use.
   c. Wind-Restraint Design Calculations: Submit all input data and loading calculations.

4. Seismic- and Wind**-**Restraint Detail Drawing:

   a. Design Analysis: To support selection and arrangement of seismic[**and wind**] restraints. Include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
   c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.

5. Product Listing, Preapproval, and Evaluation Documentation: By [**an evaluation service member of ICC-ES**] [**UL**] [**FM Approvals**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**], showing maximum ratings of restraint items and basis for approval (tests or calculations).
6. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
7. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation [**and wind-**] and seismic-restraint devices for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For [**professional engineer**] [**and**] [**testing agency**].

C. Welding certificates.

D. Air-Spring Isolator Performance Certification: Include natural frequency, load, and damping test data[**performed by an independent agency**].

E. Field quality-control reports.

1.6 REGULATORY AGENCY APPROVALS

A. Delegated design submittals and Shop Drawings requiring approval by authorities having jurisdiction must be signed by qualified structural professional engineer responsible for their preparation. [**Obtain approval by authorities having jurisdiction prior to submitting for action by Architect.**] [**Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.**]

1.7 QUALIFICATIONS

A. Professional Structural Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering, including design of seismic and wind restraints, equipment hangers and supports, and concrete foundations.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [**air-spring isolators**] [**and**] [**restrained-air-spring isolators**] to include in operation and maintenance manuals.

1.9 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage qualified professional structural engineer to prepare seismic- and wind-restraint calculations in accordance with criteria specified in Section 018123 "Facility Seismic and Wind Criteria."

B. Seismic- and Wind-Restraint-Device Load Ratings: Devices are to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices are to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: [**ICC-ES product listing**] [**UL product listing**] [**FM Approvals**] [**an evaluation service member of ICC-ES**] [**an agency acceptable to authorities having jurisdiction**].

C. Consequential Damage: Provide additional seismic[**and wind**] restraints for suspended components or anchorage of floor-, roof-, or wall-mounted components so that failure of a non-essential or essential component will not cause failure of any other essential building component.

D. Fire/Smoke Resistance: Seismic- and wind-restraint devices that are not constructed of ferrous metals are to have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by qualified testing laboratory in accordance with ASTM E84 or UL 723 and be labeled as such.

E. Component Supports:

1. Load ratings, features, and applications of reinforcement components are to be based on testing standards of qualified testing laboratory.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain elastomeric isolation pads from single manufacturer.
3. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
4. Size: Factory or field cut to match requirements of supported equipment.
5. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
6. Surface Pattern: Smooth, ribbed, or waffle pattern.
7. Infused nonwoven cotton or synthetic fibers.
8. Load-bearing metal plates adhered to pads.
9. Sandwich-Core Material: [**Resilient**] [**and**] [**elastomeric**] <**Insert compound**>.

   a. Surface Pattern: Smooth, ribbed, or waffle pattern.
   b. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain double-deflection, elastomeric isolation mounts from single manufacturer.
3. Mounting Plates:

   a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded[**with threaded studs or bolts**].
   b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

4. Elastomeric Material: Molded, oil- and water- resistant neoprene rubber, silicone rubber, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain restrained elastomeric isolation mounts from single manufacturer.
3. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

   a. Housing: Cast-ductile iron or welded steel.
   b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain freestanding, laterally stable, open-spring isolators from single manufacturer.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates limit floor load to 500 psig.
8. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.6 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain freestanding, laterally stable, open-spring isolators in two-part telescoping housing from single manufacturer.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.

b. Top housing with [**attachment and leveling bolt**] [**threaded mounting holes and internal leveling device**] [**elastomeric pad**].

2.7 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain restrained-spring isolators from single manufacturer.
3. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

   a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
   b. Top plate with [**threaded mounting holes**] [**elastomeric pad**].
   c. Internal leveling bolt that acts as blocking during installation.

4. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
5. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
6. Minimum Additional Travel: 50 percent of the required deflection at rated load.
7. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
8. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain freestanding, open-spring isolators with vertical-limit stop restraints from single manufacturer.
3. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with [**adjustable**] [**non-adjustable**] snubbers to limit vertical movement.

   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
   b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 PIPE-RISER RESILIENT SUPPORT

A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-Inch- (13-mm-) Thick Neoprene <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain resilient pipe-riser supports from single manufacturer.
3. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch-thick neoprene.
4. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
5. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.10 RESILIENT PIPE GUIDES

A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-Inch- (13-mm-) Thick Neoprene <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain resilient pipe guides from single manufacturer.
3. Description: Resilient pipe guide with telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene.
4. Factory-Set Height Guide with Shear Pin: Shear pin to be removable and reinsertable to allow for selection of pipe movement. Guides to be capable of motion to meet location requirements.

2.11 AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain air-spring isolators from single manufacturer.
3. Arrangement: [**Single**] [**or**] [**multiple**].
4. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
5. Maximum Natural Frequency: 3 Hz.
6. Operating Pressure Range: 25 to 100 psig.
7. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
8. Automatic leveling valve.

2.12 RESTRAINED-AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain restrained-air-spring isolators from single manufacturer.
3. Arrangement: [**Single**] [**or**] [**multiple**].

4. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

    a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
    b. Top plate with [**threaded mounting holes**] [**elastomeric pad**].
    c. Internal leveling bolt that acts as blocking during installation.

5. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
6. Minimum Additional Travel: 50 percent of the required deflection at rated load.
7. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
8. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
9. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
10. Maximum Natural Frequency: [**3 Hz**] <**Insert frequency**>.
11. Operating Pressure Range: 25 to 100 psig.
12. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
13. Automatic leveling valve.

2.13 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain elastomeric hangers from a single manufacturer.
3. Description: Elastomeric hanger mounted in a steel frame with upper and lower steel hanger rods.
4. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
5. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.14 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain spring hangers from single manufacturer.
3. Description: Combination coil-spring and elastomeric-insert hanger.
4. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
5. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
6. Minimum Additional Travel: 50 percent of the required deflection at rated load.
7. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
8. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

9. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
10. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
11. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.15 SNUBBERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain snubbers from single manufacturer.

C. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with [**ACI 318-08 Appendix D for 2009 IBC**] [**ACI 318-11 Appendix D for 2012 IBC**] [**ACI 318-14, Ch. 17 for 2015 or 2018 IBC**].
2. Preset Concrete Inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
3. Anchors in Masonry: Design in accordance with TMS 402.
4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
5. Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch thick.

2.16 RESTRAINTS - RIGID TYPE

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain rigid-type restraints from single manufacturer.

C. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.17 RESTRAINTS - CABLE TYPE

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain cable-type restraints from single manufacturer.

C. Seismic- and Wind-Restraint Cables: [**ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel**] [**ASTM A492 stainless steel**] cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

D. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.18 RESTRAINT ACCESSORIES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain restraint accessories from single manufacturer.

C. Hanger-Rod Stiffener: [**Steel tube or steel slotted-support-system sleeve with internally bolted connections**] [**Reinforcing steel angle clamped**] to hanger rod. Non-metallic stiffeners are unacceptable.

D. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to [**rigid channel bracings**] [**and**] [**restraint cables**].

E. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

F. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

G. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.19 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain mechanical anchor bolts from single manufacturer.
3. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain adhesive anchor bolts from single manufacturer.
3. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in wind-restraint applications. Post-installed concrete anchors must comply with all requirements of [**ASCE/SEI 7-05, Ch. 13**] [**ASCE/SEI 7-10, Ch. 13**] [**ASCE/SEI 7-16, Ch. 13**].

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp that is not vibration isolated.

1. Undercut expansion anchors are permitted.

2.20 CONCRETE INSERTS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain concrete inserts from single manufacturer.

C. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.

D. Comply with ANSI/MSS SP-58.

2.21 VIBRATION ISOLATION EQUIPMENT BASES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain vibration isolation equipment bases from single manufacturer.

C. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails to have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

D. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases to have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

E. Concrete Inertia Base: [**Factory-fabricated**] [**or**] [**field-fabricated**], welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases to have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.22 SEISMICALLY RESTRAINED ISOLATION ROOF-CURB RAILS

A. Seismically Restrained Isolation Roof-Curb Rails:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Source Limitations: Obtain restrained isolation roof-curb rails from single manufacturer.
3. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic[**and wind**] forces.
4. Upper Frame: To provide continuous support for equipment and to be captive to resiliently resist seismic[**and wind**] forces.
5. Lower Support Assembly: To be formed sheet metal section containing adjustable and removable steel springs that support the upper frame. Lower support assembly to have a means for attaching to building structure and a wood nailer for attaching roof materials, and to be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly. Mount adjustable, restrained-spring isolators on elastomeric vibration isolation pads and provide access ports, for level adjustment, with removable waterproof covers at all isolator locations. Locate isolators so they are accessible for adjustment at any time during the life of the installation without interfering with integrity of roof.
6. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.
7. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- [**and wind-**]restraint devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by [**an evaluation service member of ICC-ES**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**].

B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Assemblies: Where not specifically indicated otherwise, select sizes of components so strength is adequate to carry static[**, wind load,**] and seismic loads within specified loading limits.

3.3 INSTALLATION OF VIBRATION CONTROLS AND SEISMIC RESTRAINTS FOR HVAC PIPING AND EQUIPMENT

A. Provide seismic-[**and wind-**]restraint devices and vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Devices Schedules, where indicated on Drawings, or where Specifications indicate they are to be installed on specific equipment and systems.

B. Provide seismic-restraint [**and wind-restraint**]devices for systems and equipment where indicated in Equipment Schedules or Seismic-Restraint Devices Schedules, where indicated on Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

D. Installation of vibration isolators[**, wind restraints,**] must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

E. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

F. Equipment Restraints:

1. Install snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint[**, and wind-restraint**] devices using methods approved by [**an evaluation service member of ICC-ES**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

G. Piping Restraints:

1. Comply with requirements in MSS SP-127.

2. Space lateral supports a maximum of [**40 feet**] <**Insert dimension**> o.c., and longitudinal supports a maximum of [**80 feet**] <**Insert dimension**> o.c.
3. Brace a change of direction longer than 12 feet.

H. Ductwork Restraints:

1. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with [**SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."**] [**SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems - OSHPD Edition."**] [**ASCE/SEI 7.**][**See Section 233113 "Metal Ducts" for Seismic Hazard Level (SHL).**][**See Section 233113 "Metal Ducts" for "Connection Level" performance requirement for OSHPD jurisdictions.**] <**Insert requirement.**>
2. Space lateral supports a maximum of [**40 feet**] <**Insert dimension**> o.c., and longitudinal supports a maximum of [**80 feet**] <**Insert dimension**> o.c.
3. Brace a change of direction longer than 12 feet.
4. Select seismic-restraint devices with capacities adequate to carry static and seismic loads.
5. Install cable restraints on ducts that are suspended with vibration isolators.

I. Install seismic-[**and wind**]restraint cables so they do not bend across edges of adjacent equipment or building structure.

J. Install seismic-[**and wind-**]restraint devices using methods approved by [**an evaluation service member of ICC-ES**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

K. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

L. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

M. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

N. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Mechanical Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors to be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 INSTALLATION OF AIR-SPRING ISOLATORS

A. Independent Isolator Installation:

1. Install tank valve into each air isolator.
2. Inflate each isolator to [**height**] [**and**] [**pressure**] specified on Drawings.

B. Pressure-Regulated Isolator Installation:

1. Coordinate the constant pressure-regulated air supply to air springs with requirements for piping and connections specified in Section 221513 "General-Service Compressed-Air Piping."
2. Connect all pressure regulators to a single dry, filtered [**facility**] [**constant**] air supply.
3. Inflate isolators to [**height**] [**and**] [**or**] [**pressure**] specified on Drawings.

3.5 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties" for piping flexible connections.

3.6 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate dimensions of steel equipment rails and bases, concrete inertia bases, and restrained isolation roof-curb rails with requirements of isolated equipment specified in this and other Sections. Where dimensions of these bases are indicated on Drawings, dimensions may require adjustment to accommodate actual isolated equipment.

3.7 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:

1. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].
2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
5. Test no fewer than [**four**] <**Insert number**> of each type and size of installed anchors and fasteners selected by Architect.
6. Test to 90 percent of rated proof load of device.
7. Measure isolator restraint clearance.
8. Measure isolator deflection.
9. Verify snubber minimum clearances.
10. Test and adjust restrained-air-spring isolator controls and safeties.

D. Remove and replace malfunctioning units and retest as specified above.

E. Units will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 230548

SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC

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. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient support.
9. Resilient pipe guides.
10. Air-spring isolators.
11. Restrained-air-spring isolators.
12. Elastomeric hangers.
13. Spring hangers.
14. Snubbers.
15. Restraints - rigid type.
16. Restraints - cable type.
17. Restraint accessories.
18. Post-installed concrete anchors.
19. Concrete inserts.
20. Vibration isolation equipment bases.
21. Restrained isolation roof-curb rails.

B. Related Requirements:

1. Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.
2. Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

2. Include load rating for each wind-force-restraint fitting and assembly.
3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device [**and wind-force-restraint**]component.
4. Annotate to indicate application of each product submitted and compliance with requirements.
5. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal:

1. For each wind-load protection device that is required by this Section or is indicated on Drawings, submit the following:

a. Vibration Isolator and Wind-Load-Restraint Selection: Select vibration isolators, wind-load restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
c. Concrete Anchors and Inserts: Include calculations showing anticipated wind loads.
d. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.
e. Qualified Professional Engineer: All designated-design submittals for wind-restraint calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.

2. Wind-Restraint Detail Drawing:

a. Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.
b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during wind events. Indicate association with vibration isolation devices.
c. Coordinate vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.

3. All delegated-design submittals for wind-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.
4. Product Listing, Preapproval, and Evaluation Documentation: By [**an evaluation service member of ICC-ES**] [**UL**] [**FM Approvals**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**], showing maximum ratings of restraint items and basis for approval (tests or calculations).
5. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
6. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints.

B. Qualification Data: For testing agency.

C. Welding certificates.

D. Air-Spring Mounting System Performance Certification: Include natural frequency, load, and damping test data[**performed by an independent agency**].

E. Field quality-control reports.

F. Wind-Force Performance Certification: Provide special certification for HVAC components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-force performance certification.

1. Provide equipment manufacturer's written certification for each designated HVAC device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
2. Provide manufacturer's written certification for each designated louver, damper, or similar device, stating that it will remain in place and protect opening from penetration of windborne debris and comply with all requirements of authorities having jurisdiction.
3. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.
4. The following HVAC systems and components require special certification for high wind performance. Written special certification of resistance to the effects of high wind force and impact damage must be provided by manufacturer:

   a. <**Insert list**>.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For [**air-spring mounts**] [**and**] [**restrained-air-spring mounts**] to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7 and be acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Wind-Load-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: [**ICC-ES product listing**] [**UL product listing**] [**FM Approvals**] [**an evaluation service member of ICC-ES**] [**an agency acceptable to authorities having jurisdiction**].

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design system.
   1. Wind-Load Performance: Equipment shall withstand the effects of high wind events determined in accordance with [**ASCE/SEI 7-05**] [**ASCE/SEI 7-10**] [**ASCE/SEI 7-16**] <**Insert requirement**>.

B. Wind-Load Design Calculations:

   1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in [**ASCE/SEI 7-05**] [**ASCE/SEI 7-10**] [**ASCE/SEI 7-16**] <**Insert ASCE/SEI 7 edition or other wind-force calculation method required by authorities having jurisdiction**>. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.
      a. Factors indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
      b. Coordinate design wind-load calculations with vibration isolation requirements. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
   2. Design wind pressure "p" for external sidewall-mounted equipment such as louvers is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:
      a. PART 1: Low-Rise Buildings.
      b. PART 2: Low-Rise Buildings (Simplified).
      c. PART 3: Buildings with "h" less than 60 feet.
      d. PART 4: Buildings with "h" greater than 60 feet and less than 160 feet.
      e. PART 5: Open Buildings.

3. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
   a. Risk Category: [**I**] [**II**] [**III**] [**IV**] [**V**].
   b. h = Mean Roof Height: <**Insert value**>.
   c. V = Basic Wind Speed: <**Insert value**>.
   d. K_d = Wind Directionality Factor: <**Insert factor**>.
   e. Exposure Category: [**B**] [**C**] [**D**].
   f. K_{zt} = Topographic Factor: <**Insert factor**>.
   g. K_e = Ground Elevation Factor: <**Insert factor**>.
   h. K_z = Velocity Pressure Exposure Coefficient (Evaluated at Height z): <**Insert coefficient**>.
   i. K_h = Velocity Pressure Exposure Coefficient (Evaluated at Height h): <**Insert coefficient**>.
   j. q_z = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
   k. q_h = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
   l. G = Gust-Effect Factor: [**0.85**] <**Insert factor**>.
   m. Enclosure Classification: <**Insert classification**>.
   n. GC_{pi} = Internal Pressure Coefficient: <**Insert coefficient**>.
4. Design wind pressure "p" for external sidewall-mounted equipment such as louvers are to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-10, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:

   a. PART 1: Low-Rise Buildings.
   b. PART 2: Low-Rise Buildings (Simplified).
   c. PART 3: Buildings with "h" greater than 60 feet.
   d. PART 4: Buildings with "h" less than 160 feet.
   e. PART 5: Open Buildings.

5. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-10, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
   a. Risk Category: [**I**] [**II**] [**III**] [**IV**] [**V**].
   b. h = Mean roof height: <**Insert value**>.
   c. V = Basic Wind Speed: <**Insert value**>.
   d. K_d = Wind Directionality Factor: <**Insert factor**>.
   e. Exposure Category: [**B**] [**C**] [**D**].
   f. K_{zt} = Topographic Factor: <**Insert factor**>.
   g. K_z = Velocity Pressure Exposure Coefficient (Evaluated at Height z): <**Insert coefficient**>.
   h. K_h = Velocity Pressure Exposure Coefficient (Evaluated at Height h): <**Insert coefficient**>.
   i. q_z = Velocity Pressure at Height z: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
   j. q_h = Velocity Pressure at Height h: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
   k. G = Gust-Effect Factor: [**0.85**] <**Insert factor**>.
   l. Enclosure Classification: <**Insert classification**>.
   m. GC_{pi} = Internal Pressure Coefficient: <**Insert coefficient**>.

1. Design wind force "F" for rooftop equipment and external sidewall-mounted equipment such as louvers is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-05, Ch. 6.
   a. I = Importance Factor: <**Insert factor**>.
   b. h = Mean Roof Height: <**Insert value**>.
   c. V = Basic Wind Speed: <**Insert value**>.
   d. K_d = Wind Directionality Factor: <**Insert factor**>.
   e. Exposure Category: [**B**] [**C**] [**D**].
   f. K_{zt} = Topographic Factor: <**Insert factor**>.
   g. K_z = Velocity Pressure Exposure Coefficient (Evaluated at Height z): <**Insert coefficient**>.
   h. K_h = Velocity Pressure Exposure Coefficient (Evaluated at Height h): <**Insert coefficient**>.
   i. q_z = Velocity Pressure at Height z: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.
   j. q_h = Velocity Pressure at Roof Height h: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.
   k. G = Gust-Effect Factor: [**0.85**] <**Insert factor**>.
   l. GC_{pi} = Internal Pressure Coefficient: <**Insert coefficient**>.
   m. GC_p = External Pressure Coefficient: <**Insert coefficient**>.
   n. C_f = Force Coefficient: Value determined by delegated wind-load design Contractor from ASCE/SEI 7-05, Figures 6-21 through 6-23 or other source approved by authorities having jurisdiction.
   o. A_f = Projected Area Normal to the Wind: Except where "C_f" is specified for the actual surface area. Value determined by delegated wind-load design Contractor from equipment submittal or manufacturer.

C. Consequential Damage: Provide additional restraints for suspended HVAC components or anchorage of floor-, roof-, or wall-mounted HVAC components as indicated in [**ASCE/SEI 7-05**] [**ASCE/SEI 7-10**] [**ASCE/SEI 7-16**] so that failure of a non-essential or essential HVAC component will not cause the failure of any other essential architectural, mechanical, or electrical building component.

D. Fire/Smoke Resistance: All components that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

E. Component Supports:

1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Minimum deflection as indicated on Drawings.

5. Pad Material: Oil- and water-resistant rubber.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: [**Resilient**] [**and**] [**elastomeric**] <**Insert compound**>.
   a. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Elastomeric Isolation Mounts: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Mounting Plates:

   a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded[**with threaded studs or bolts**].
   b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

3. Minimum deflection as indicated on Drawings.
4. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Description: All-directional isolator with restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

   a. Housing: Cast-ductile iron or welded steel.
   b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

3. Minimum deflection as indicated on Drawings.

2.5 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psi.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
8. Minimum deflection as indicated on Drawings.

2.6 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Minimum deflection as indicated on Drawings.
7. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

    a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psi.
    b. Top housing with [**attachment and leveling bolt**] [**threaded mounting holes and internal leveling device**] [**elastomeric pad**].

2.7 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

    a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psi.
    b. Top plate with [**threaded mounting holes**] [**elastomeric pad**].
    c. Internal leveling bolt that acts as blocking during installation.

3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Minimum deflection as indicated on Drawings.

2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with [**adjustable**] [**non-adjustable**] snubbers to limit vertical movement.

   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psi.
   b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Minimum deflection as indicated on Drawings.

2.9 PIPE-RISER RESILIENT SUPPORT

A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch-Thick Neoprene: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
3. Maximum Load Per Support: 500 psi on isolation material providing equal isolation in all directions.
4. Minimum deflection as indicated on Drawings.

2.10 RESILIENT PIPE GUIDES

A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-inch-Thick Neoprene: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.11 AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
3. Maximum Natural Frequency: 3 Hz.
4. Operating Pressure Range: 25 to 100 psi.
5. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
6. Minimum deflection as indicated on Drawings.
7. Automatic leveling valve.

2.12 RESTRAINED-AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

   a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psi.
   b. Top plate with [**threaded mounting holes**] [**elastomeric pad**].
   c. Internal leveling bolt that acts as blocking during installation.

3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
4. Minimum deflection as indicated on Drawings.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
9. Maximum Natural Frequency: 3 Hz.
10. Operating Pressure Range: 25 to 100 psi.
11. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
12. Automatic leveling valve.

2.13 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.

4. Minimum deflection as indicated on Drawings.

2.14 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression: <**Insert drawing designation**>.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Minimum deflection as indicated on Drawings.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
9. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
10. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.15 SNUBBERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be prequalified in accordance with ACI 355.2 testing and designated in accordance with [**ACI 318-08 Appendix D for 2009 IBC**] [**ACI 318-11 Appendix D for 2012 IBC**] [**ACI 318-14 Ch. 17 for 2015 or 2018 IBC**].

2. Preset Concrete Inserts: Prequalified in accordance with ICC-ES AC446 testing.
3. Anchors in Masonry: Design in accordance with TMS 402.
4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
5. Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch thick.

2.16 RESTRAINTS - RIGID TYPE

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure

at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.17 RESTRAINTS - CABLE TYPE

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Restraint Cables: [**ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel**] [**ASTM A492 stainless steel**] cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.

C. Restraint cable assembly and cable fittings must comply with [**ASCE/SEI 19-10**] [**ASCE/SEI 19-16**]. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.18 RESTRAINT ACCESSORIES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Hanger-Rod Stiffener: [**Steel tube or steel slotted-support-system sleeve with internally bolted connections**] [**Reinforcing steel angle clamped**] to hanger rod.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to [**rigid channel bracings**] [**and**] [**restraint cables**].

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.19 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in wind-load applications. Post-installed concrete anchors must comply with all requirements of [**ASCE/SEI 7-05, Ch. 13**] [**ASCE/SEI 7-10, Ch. 13**] [**ASCE/SEI 7-16, Ch. 13**].

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp that is not vibration isolated.

1. Undercut expansion anchors are permitted.

2.20 CONCRETE INSERTS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Provide preset concrete inserts that are prequalified in accordance with ICC-ES AC466 testing.

C. Comply with ANSI/MSS SP-58.

2.21 VIBRATION ISOLATION EQUIPMENT BASES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

D. Concrete Inertia Base: [**Factory-fabricated**] [**or**] [**field-fabricated**], welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

   a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.22 RESTRAINED ISOLATION ROOF-CURB RAILS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment.

C. Upper Frame: Shall provide continuous and captive support for equipment.

D. Lower Support Assembly: Shall be formed sheet metal section containing adjustable and removable steel springs that support upper frame. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials and shall be insulated with a minimum of 2 inches of rigid glass-fiber insulation on inside of assembly.

1. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with integrity of roof.
2. Minimum deflection as indicated on Drawings.

E. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation [**and wind-load control**]devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by [**an evaluation service member of ICC-ES**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**].

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to wind-load forces.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static and wind force loads within specified loading limits.

3.3 INSTALLATION OF VIBRATION [**AND WIND-LOAD**]CONTROL DEVICES

A. Provide vibration [**and wind-load**]control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules on Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

C. Installation of vibration isolators[**and wind-load restraints**] must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

D. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

E. Equipment Restraints:

1. Install snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

3. Install wind-load-restraint devices using methods approved by [**an evaluation service member of ICC-ES**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

F. Piping Restraints:

1. Comply with requirements in MSS SP-127.
1. Space lateral supports a maximum of [**40 feet**] <**Insert dimension**> o.c., and longitudinal supports a maximum of [**80 feet**] <**Insert dimension**> o.c.
2. Brace a change of direction longer than 12 feet.

G. Install wind-load-restraint cables so they do not bend across edges of adjacent equipment or building structure.

H. Install wind-load-restraint devices using methods approved by [**an evaluation service member of ICC-ES**] [**OSHPD**] [**an agency acceptable to authorities having jurisdiction**] that provides required submittals for component.

I. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

J. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

K. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

L. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 INSTALLATION OF AIR-SPRING ISOLATORS

A. Independent Isolator Installation:

1. Install automatic leveling valve into each air isolator.
2. Inflate each isolator to [**height**] [**and**] [**pressure**] specified on Drawings.

B. Pressure-Regulated Isolator Installation:

1. Coordinate the constant pressure-regulated air supply to air springs with requirements for piping and connections specified in Section 221513 "General-Service Compressed-Air Piping."
2. Connect all pressure regulators to a single dry, filtered [**facility**] [**constant**] air supply.
3. Inflate isolators to [**height**] [**and**] [**or**] [**pressure**] specified on Drawings.

3.5 ACCOMMODATION OF DIFFERENTIAL MOTION

A. Provide flexible connections in piping systems where they cross structural joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties" for piping flexible connections.

3.6 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate dimensions of equipment bases with requirements of isolated equipment specified in this and other Sections. Where dimensions of base are indicated on Drawings, they may require adjustment to accommodate isolated equipment.

3.7 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

D. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least [**four**] <**Insert number**> of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. Test and adjust restrained-air-spring isolator controls and safeties.

E. Remove and replace malfunctioning units and retest as specified above.

F. Prepare test and inspection reports.

END OF SECTION 230548.13

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Warning tape.
4. Pipe labels.
5. Duct labels.
6. Stencils.
7. Valve tags.
8. Warning tags.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve-numbering scheme.

E. Valve Schedules: Provide for each piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Material and Thickness: [**Brass, 0.032-inch**] [**stainless steel, 0.025-inch**] [**aluminum, 0.032-inch**] [**anodized aluminum, 0.032-inch**] minimum thickness, with predrilled or stamped holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for

greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, [**1/16 inch**] [**1/8 inch**] <**Insert dimension**> thick, with predrilled holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, [**1/16 inch**] [**1/8 inch**] <**Insert dimension**> thick, with predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless steel rivets or self-taping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA70E[**and other applicable codes and standards**].

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 WARNING TAPE

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Material: Vinyl.

C. Minimum Thickness: 0.005 inch.

D. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.

E. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.

F. Maximum Temperature: 160 deg F.

G. Minimum Width: [**2 inches**] [**4 inches**].

2.4 PIPE LABELS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to [**partially cover**] [**cover full**] circumference of pipe and to attach to pipe without fasteners or adhesive.

E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on[**main**] distribution piping. Arrows may be either integral with label or applied separately.
3. Lettering Size: [**Size letters in accordance with ASME A13.1 for piping**] [**At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances**].

2.5 DUCT LABELS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, [**1/16 inch**] [**1/8 inch**] <**Insert dimension**> thick, and having predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings. Also include the following:

1. Duct size.
2. Flow-Direction Arrows: Include flow-direction arrows on[**main**] distribution ducts. Arrows may be either integral with label or may be applied separately.
3. Lettering Size: [**Size letters in accordance with ASME A13.1 for piping**] [**At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances**].

2.6 STENCILS

A. Stencils for Piping:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Lettering Size: [**Size letters in accordance with ASME A13.1 for piping**] [**At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances**].
3. Stencil Material: Aluminum, brass, or fiberboard.
4. Stencil Paint: Exterior, gloss, [**alkyd enamel**] [**acrylic enamel**] <**Insert paint type**> in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
5. Identification Paint: Exterior, [**alkyd enamel**] [**acrylic enamel**] <**Insert paint type**>. Paint may be in pressurized spray-can form.
6. Letter and Background Color: As indicated for specific application under Part 3.

B. Stencils for Ducts:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Lettering Size: Minimum letter height of 1-1/4 inches for viewing distances of up to 15 ft. and proportionately larger lettering for greater viewing distances.
3. Stencil Material: [**Aluminum**] [**Brass**] [**Fiberboard**] [**Fiberboard or metal**] <**Insert material**>.
4. Stencil Paint: Exterior, gloss, [**alkyd enamel**] [**acrylic enamel**] <**Insert paint type**>. Paint may be in pressurized spray-can form.
5. Identification Paint: Exterior, [**alkyd enamel**] [**acrylic enamel**] <**Insert paint type**>. Paint may be in pressurized spray-can form.
6. Letter and Background Color: Color as indicated for specific application under Part 3.

C. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Lettering Size: Minimum letter height of 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.
3. Stencil Material: [**Aluminum**] [**Brass**] [**Fiberboard**] [**Fiberboard or metal**] <**Insert material**>.
4. Stencil Paint: Exterior, gloss, [**alkyd enamel**] [**acrylic enamel**] <**Insert paint type**>. Paint may be in pressurized spray-can form.
5. Identification Paint: Exterior, [**alkyd enamel**] [**acrylic enamel**] <**Insert paint type**>. Paint may be in pressurized spray-can form.
6. Letter and Background Color: As indicated for specific application under Part 3.

2.7 VALVE TAGS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: [**Brass, 0.04-inch**] [**stainless steel, 0.024-inch**] [**aluminum, 0.031-inch**] [**or**] [**anodized aluminum, 0.031-inch**] minimum thickness, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass [**wire**] [**link chain**] [**or**] [**beaded chain**] [**or**] [**S-hook**].

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Include valve-tag schedule in operation and maintenance data.

2.8 WARNING TAGS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Preprinted[**or partially preprinted**] accident-prevention tags of plasticized card stock[**with matte finish suitable for writing**].

1. Size: [**3 by 5-1/4 inches minimum**] [**Approximately 4 by 7 inches**] <**Insert size**>.
2. Fasteners: [**Brass grommet and wire**] [**Reinforced grommet and wire or string**].
3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Letter and Background Color: As indicated for specific application under Part 3.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of mechanical equipment.

B. Sign and Label Colors:

1. [**White letters on an ANSI Z535.1 safety-blue background**] <**Insert colors**>.

C. Locate equipment labels where accessible and visible.

D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E[**, and other applicable codes and standards**].

3.4 INSTALLATION OF WARNING TAPE

A. Warning Tape Color and Pattern: [**Yellow background with black diagonal stripes**] <**Insert color, marking pattern, text**>.

B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than 6 ft. of clearance.

C. Locate tape so as to be readily visible from the point of normal approach.

3.5 INSTALLATION OF PIPE LABELS

A. Piping Color Coding: Painting of piping is specified in [**Section 099123 "Interior Painting."**] [**Section 099600 "High-Performance Coatings."**]

B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

C. Stenciled Pipe Label Option: Stenciled labels showing service and flow direction may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1,[**with painted, color-coded bands or rectangles**] on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

D. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within 3 ft. of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within 3 ft. of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of [**25 ft.**] <**Insert dimension**> along each run. Reduce intervals to [**10 ft.**] <**Insert dimension**> in areas of congested piping, ductwork, and equipment.

E. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

F. Flow-Direction Arrows: Use arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

G. Pipe-Label Color Schedule:

1. Chilled-Water Piping: [**White letters on an ANSI Z535.1 safety-green background**] <**Insert colors**>.
2. Condenser-Water Piping: [**White letters on an ANSI Z535.1 safety-green background**] <**Insert colors**>.
3. Heating Water Piping: [**White letters on an ANSI Z535.1 safety-green background**] <**Insert colors**>.
4. Refrigerant Piping: [**White letters on an ANSI Z535.1 safety-blue background**] <**Insert colors**>.
5. Low-Pressure Steam Piping: [**Black letters on an ANSI Z535.1 safety-yellow background**] [**White letters on an ANSI Z535.1 safety-green background**] <**Insert colors**>.
6. High-Pressure Steam Piping: [**Black letters on an ANSI Z535.1 safety-yellow background**] [**White letters on an ANSI Z535.1 safety-green background**] <**Insert colors**>.
7. Steam Condensate Piping: [**Black letters on an ANSI Z535.1 safety-yellow background**] [**White letters on an ANSI Z535.1 safety-green background**] <**Insert colors**>.
8. Toxic and Corrosive Fluids: [**Black letters on an ANSI Z535.1 safety-orange background**] <**Insert colors**>.
9. Flammable Fluids: [**Black letters on an ANSI Z535.1 safety-yellow background**] <**Insert colors**>.
10. Combustible Fluids: [**White letters on an ANSI Z535.1 safety-brown background**] <**Insert colors**>.
11. Potable and Other Water: [**White letters on an ANSI Z535.1 safety-green background**] <**Insert colors**>.

12. Compressed Air: [**White letters on an ANSI Z535.1 safety-blue background**] <**Insert colors**>.
13. <**Insert additional systems and colors as required**>.

3.6 INSTALLATION OF DUCT LABELS

A. Install [**plastic-laminated**] [**self-adhesive**] duct labels showing service and flow direction with permanent adhesive on air ducts.

1. Provide labels in the following color codes:

a. For air supply ducts: [**White letters on blue background**] <**Insert color**>.
b. For air return ducts: [**White letters on blue background**] <**Insert color**>**.**
c. For exhaust-, outside-, relief-, return-, and mixed-air ducts: [**White letters on blue background**] <**Insert color**>.
d. [**Insert additional systems and colors as needed**].

B. Stenciled Duct-Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.

1. For all air ducts: [**Black letters on white background**] <**Insert color**>.

C. Locate label near each point where ducts enter into and exit from concealed spaces and at maximum intervals of [**20 ft.**] where exposed or are concealed by removable ceiling system.

D. Stenciled Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

1. [**Black letters on White background**] <**Insert color**>.

3.7 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below.

1. Valve-Tag Size and Shape:

a. Chilled Water: [**1-1/2 inches**] [**2 inches**], [**round**] [**square**] <**Insert shape**>.
b. Condenser Water: [**1-1/2 inches**] [**2 inches**], [**round**] [**square**] <**Insert shape**>.
c. Refrigerant: [**1-1/2 inches**] [**2 inches**], [**round**] [**square**] <**Insert shape**>.
d. Hot Water: [**1-1/2 inches**] [**2 inches**], [**round**] [**square**] <**Insert shape**>.
e. Gas: [**1-1/2 inches**] [**2 inches**], [**round**] [**square**] <**Insert shape**>.
f. Low-Pressure Steam: [**1-1/2 inches**] [**2 inches**], [**round**] [**square**] <**Insert shape**>.
g. High-Pressure Steam: [**1-1/2 inches**] [**2 inches**], [**round**] [**square**] <**Insert shape**>.
h. Steam Condensate: [**1-1/2 inches**] [**2 inches**], [**round**] [**square**] <**Insert shape**>.

2. Valve-Tag Colors:

   a. For each piping system, use the same lettering and background coloring system on valve tags as used for the Pipe Label Schedule text and background.

3.8 INSTALLATION OF WARNING TAGS

A. Warning Tag Color: [**Black letters on an ANSI Z535.1 safety-yellow background**] <**Insert color**>.

B. Attach warning tags, with proper message, to equipment and other items where [**indicated on Drawings**] [**scheduled**].

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

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. Testing, Adjusting, and Balancing of Air Systems:

    a. Constant-volume air systems.

2. Testing, Adjusting, and Balancing of Hydronic Piping Systems:

    a. Constant-flow hydronic systems.
    b. Variable-flow hydronic systems.
    c. Primary-secondary hydronic systems.

3. Testing, adjusting, and balancing of equipment.
4. Sound tests.
5. Vibration tests.
6. Duct leakage tests verification.
7. Pipe leakage tests verification.
8. HVAC-control system verification.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.4 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at [**Project site**] <**Insert location**> after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details.

Provide a minimum of [**14**] <**Insert number**> days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

   a. The Contract Documents examination report.
   b. The TAB plan.
   c. Needs for coordination and cooperation of trades and subcontractors.
   d. Proposed procedures for documentation and communication flow.

1.5 ACTION SUBMITTALS

A. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for air balancing or HVAC flushing.>

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within [**30**] [**60**] [**90**] <**Insert number**> days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within [**30**] [**60**] [**90**] <**Insert number**> days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.

C. Strategies and Procedures Plan: Within [**30**] [**60**] [**90**] <**Insert number**> days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.

D. System Readiness Checklists: Within [**30**] [**60**] [**90**] <**Insert number**> days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Instrument calibration reports, to include the following:

   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

1.7 QUALITY ASSURANCE

A. TAB Specialists Qualifications, Certified by AABC:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC.

B. TAB Specialists Qualifications, Certified by [**NEBB**] [**or**] [**TABB**]:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by [**NEBB**] [**or**] [**TABB**].
2. TAB Technician: Employee of the TAB specialist and certified by [**NEBB**] [**or**] [**TABB**].

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

1. <Double click to insert sustainable design text for ASHRAE 62.1, Section 7.2.2 "Air Balancing.">

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

E. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.8 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

A. Subject to compliance with requirements, [**engage one of the following**] [**available TAB specialists that may be engaged include, but are not limited to, the following**]:

1. <**Insert TAB specialist's name**>.

3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify

that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.

F. Examine equipment performance data, including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainer baskets are installed and clean.

L. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.

Q. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
b. Duct systems are complete with terminals installed.
c. Volume, smoke, and fire dampers are open and functional.
d. Clean filters are installed.
e. Fans are operating, free of vibration, and rotating in correct direction.
f. Variable-frequency controllers' startup is complete and safeties are verified.
g. Automatic temperature-control systems are operational.
h. Ceilings are installed.
i. Windows and doors are installed.
j. Suitable access to balancing devices and equipment is provided.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in [**AABC's "National Standards for Total System Balance"**] [**ASHRAE 111**] [**NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems"**] and in this Section.

B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.
4. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in [**inch-pound (IP)**] [**and**] [**metric (SI)**] units.

3.5 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:

1. Motors.
2. Pumps.
3. Fans and ventilators.
4. Radiant heaters.
5. Unit heaters.
6. Heating and ventilating units.
7. Unit ventilators.
8. Radiators.
9. Convectors.
10. Finned-tube radiation heaters.

3.6 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' Record drawings 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 outdoor-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.

3.7 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 total airflow.

a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.

b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

2. Measure fan static pressures as follows:

a. Measure static pressure directly at the fan outlet or through the flexible connection.
b. Measure static pressure directly at the fan inlet or through the flexible connection.
c. Measure static pressure across each component that makes up the air-handling system.
d. Report artificial loading of filters at the time static pressures are measured.

3. Review Contractor-prepared shop drawings and Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from [**Architect**] [**Owner**] [**Construction Manager**] [**Commissioning Authority**] for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. 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 occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.8 PROCEDURES FOR MOTORS

A. Motors [**1/2**] <**Insert value**> HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.9 SOUND TESTS

A. After systems are balanced and Substantial Completion, measure and record sound levels at [**five**] [**10**] [**15**] <**Insert number**> locations as designated by the Architect.

B. Instrumentation:

1. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.
2. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels, and measuring the equivalent continuous sound pressure level (L_{eq}).
3. The sound-testing meter must be capable of using one-third octave band filters to measure mid-frequencies from 31.5 Hz to 8000 Hz.
4. The accuracy of the sound-testing meter shall be plus or minus one decibel.

C. Test Procedures:

1. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
2. Equipment should be operating at design values.
3. Calibrate the sound-testing meter prior to taking measurements.
4. Use a microphone suitable for the type of noise levels measured that is compatible with meter. Provide a windshield for outside or in-duct measurements.
5. Record a set of background measurements in dBA and sound pressure levels in the eight unweighted octave bands [**63 Hz to 8000 Hz (NC)**] [**31.5 Hz to 4000 Hz (RC)**] with the equipment off.
6. Take sound readings in dBA and sound pressure levels in the eight unweighted octave bands [**63 Hz to 8000 Hz (NC)**] [**31.5 Hz to 4000 Hz (RC)**] with the equipment operating.
7. Take readings no closer than 36 inches from a wall or from the operating equipment and approximately 60 inches from the floor, with the meter held or mounted on a tripod.
8. For outdoor measurements, move sound-testing meter slowly and scan area that has the most exposure to noise source being tested. Use A-weighted scale for this type of reading.

D. Reporting:

1. Report shall record the following:

    a. Location.
    b. System tested.
    c. dBA reading.
    d. Sound pressure level in each octave band with equipment on and off.

2. Plot sound pressure levels on [**Noise Criteria (NC)**] [**or**] [**Room Criteria (RC)**] worksheet with equipment on and off.

3.10 VIBRATION TESTS

A. After systems are balanced and Substantially Completion, measure and record vibration levels on equipment having motor horsepower equal to or greater than [**10**] [**15**] [**25**] <**Insert number**>.

B. Instrumentation:

1. Use portable, battery-operated, and microprocessor-controlled vibration meter with or without a built-in printer.
2. The meter shall automatically identify engineering units, filter bandwidth, amplitude, and frequency scale values.
3. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.
4. Verify calibration date is current for vibration meter before taking readings.

C. Test Procedures:

1. To ensure accurate readings, verify that accelerometer has a clean, flat surface and is mounted properly.
2. With the unit running, set up vibration meter in a safe, secure location. Connect transducer to meter with proper cables. Hold magnetic tip of transducer on top of the bearing, and measure unit in mils of deflection. Record measurement, then move transducer to the side of the bearing and record in mils of deflection. Record an axial reading in mils of deflection by holding nonmagnetic, pointed transducer tip on end of shaft.
3. Change vibration meter to velocity (inches per second) measurements. Repeat and record above measurements.
4. Record CPM or rpm.
5. Read each bearing on motor, fan, and pump as required. Track and record vibration levels from rotating component through casing to base.

D. Reporting:

1. Report shall record location and the system tested.
2. Include horizontal-vertical-axial measurements for tests.
3. Verify that vibration limits follow Specifications, or, if not specified, follow the General Machinery Vibration Severity Chart or Vibration Acceleration General Severity Chart from AABC's "National Standards for Total System Balance." Acceptable levels of vibration are normally "smooth" to "good."
4. Include in General Machinery Vibration Severity Chart, with conditions plotted.

3.11 DUCT LEAKAGE TESTS

A. Witness the duct leakage testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.12 PIPE LEAKAGE TESTS

A. Witness the pipe pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.13 HVAC CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify HVAC control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.14 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: [**Plus or minus 10 percent**] [**Plus 10 percent or minus 5 percent**] <**Insert value**>. If design value is less than 100 cfm, within 10 cfm.
2. Air Outlets and Inlets: [**Plus or minus 10 percent**] [**Plus 10 percent or minus 5 percent**] <**Insert value**>. If design value is less than 100 cfm, within 10 cfm.
3. Heating-Water Flow Rate: [**Plus or minus 5 percent**] [**Plus or minus 10 percent**] [**Plus 10 percent or minus 5 percent**] <**Insert value**>. If design value is less than 10 gpm, within 10 percent.
4. Chilled-Water Flow Rate: [**Plus or minus 5 percent**] [**Plus or minus 10 percent**] [**Plus 10 percent or minus 5 percent**] <**Insert value**>. If design value is less than 10 gpm, within 10 percent.

5. Condenser-Water Flow Rate: [**Plus or minus 5 percent**] [**Plus or minus 10 percent**] [**Plus 10 percent or minus 5 percent**] <**Insert value**>.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.15 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.

B. Status Reports: Prepare [**weekly**] [**biweekly**] [**monthly**] <**Insert time interval**> progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.16 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. 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; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
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 supervisor 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's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans performance forms, including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Heating coil, dry-bulb conditions.
    e. Face and bypass damper settings at coils.
    f. Fan drive settings, including settings and percentage of maximum pitch diameter.
    g. [**Variable-frequency controller**] [**Inlet vane**] settings for variable-air-volume systems.
    h. Settings for pressure controller(s).
    i. Other system operating conditions that affect performance.

16. Test conditions for pump performance forms, including the following:

    a. Variable-frequency controller settings for variable-flow hydronic systems.
    b. Settings for pressure controller(s).
    c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units, include the following:

1. Unit Data:

    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches, and bore.
    i. Center-to-center dimensions of sheave and amount of adjustments in inches.
    j. Number, make, and size of belts.
    k. Number, type, and size of filters.

2. Motor Data:

   a. Motor make, and frame type and size.
   b. Horsepower and speed.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Center-to-center dimensions of sheave and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan speed.
   d. Inlet and discharge static pressure in inches wg.
   e. For each filter bank, filter static-pressure differential in inches wg.
   f. Preheat-coil static-pressure differential in inches wg.
   g. Cooling-coil static-pressure differential in inches wg.
   h. Heating-coil static-pressure differential in inches wg.
   i. List for each internal component with pressure-drop, static-pressure differential in inches wg.
   j. Outdoor airflow in cfm.
   k. Return airflow in cfm.
   l. Outdoor-air damper position.
   m. Return-air damper position.
   n. [**Vortex damper position**].

F. Apparatus-Coil Test Reports:

1. Coil Data:

   a. System identification.
   b. Location.
   c. Coil type.
   d. Number of rows.
   e. Fin spacing in fins per inch o.c.
   f. Make and model number.
   g. Face area in sq. ft..
   h. Tube size in NPS.
   i. Tube and fin materials.
   j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

   a. Airflow rate in cfm.
   b. Average face velocity in fpm.
   c. Air pressure drop in inches wg.
   d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
   e. Return-air, wet- and dry-bulb temperatures in deg F.
   f. Entering-air, wet- and dry-bulb temperatures in deg F.
   g. Leaving-air, wet- and dry-bulb temperatures in deg F.
   h. Water flow rate in gpm.
   i. Water pressure differential in feet of head or psig.
   j. Entering-water temperature in deg F.
   k. Leaving-water temperature in deg F.

l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and speed.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btu/h.
i. High-fire fuel input in Btu/h.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h.

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btu/h.
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.

h. Airflow rate in cfm.
i. Face area in sq. ft..
j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.
b. Airflow rate in cfm.
c. Air velocity in fpm.
d. Entering-air temperature in deg F.
e. Leaving-air temperature in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and speed.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan speed.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System fan and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.

e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

K. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.17 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of [**Architect**] [**Owner**] [**Construction Manager**] [**Commissioning Authority**].

B. [**Architect**] [**Owner**] [**Construction Manager**] [**Commissioning Authority**] shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either [**10**] <**Insert number**> percent of the total measurements recorded or the extent of measurements that can be accomplished in [**a normal 8-hour business day**] <**Insert value**>.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than [**10**] [**20**] <**Insert number**> percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
2. If the second final inspection also fails, Owner may pursue others Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.18 ADDITIONAL TESTS

A. Within [**90**] <**Insert number**> days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
4. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
5. Outdoor, concealed supply and return.
6. Outdoor, exposed supply and return.

B. Related Requirements:

1. Section 230716 "HVAC Equipment Insulation."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for recycled content.>
2. <Double click to insert sustainable design text for adhesives.>
3. <Double click to insert sustainable design text for coatings.>
4. <Double click to insert sustainable design text for sealants.>

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Sheet Form Insulation Materials: 12 inches square.
2. Sheet Jacket Materials: 12 inches square.
3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program[**, certified by the Department of Labor, Bureau of Apprenticeship and Training**].

B. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Ductwork Mockups:

a. One 10-foot section each of rectangular and round straight duct.
b. One each of a 90-degree mitered round and rectangular elbow, and one each of a 90-degree radius round and rectangular elbow.
c. One rectangular branch takeoff and one round branch takeoff from a rectangular duct. One round tee fitting.
d. One rectangular and round transition fitting.
e. Four support hangers for round and rectangular ductwork.
f. Each type of damper and specialty.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers are to be marked with the manufacturer's name, appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. [**All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.**]
2. [**All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.**]
3. [**All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.**]

2.2 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials are to be applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534, Type II for sheet materials.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

G. Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 450 deg F in accordance with ASTM C411. Comply with ASTM C553, Type II, and ASTM C1290, [**Type I, unfaced**] [**Type II with factory-applied vinyl jacket**] [**Type III with factory-applied FSK jacket**] [**Type III with factory-applied FSP jacket**]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

H. High-Temperature, Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to 1000 deg F. Comply with ASTM C553, Type V.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

I. Mineral Wool Blanket: Basalt volcanic rock-derived fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to 1200 deg F in accordance with ASTM C447. Comply with ASTM C553.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

J. Glass-Fiber Board Insulation: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 250 deg F for jacketed and between 35 deg F and 450 deg F for unfaced in accordance with ASTM C411. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation [**unfaced**] [**with factory-applied ASJ**] [**with factory-applied FSK jacket**]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

K. High-Temperature, Glass-Fiber Board: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 1000 deg F in accordance with ASTM C411. Comply with ASTM C612, Type III, unfaced.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

L. Mineral Wool Board: Basalt volcanic rock-derived fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 1100 deg F in accordance with ASTM C411. Comply with ASTM C612, Type III, unfaced.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

M. Glass-Fiber, Pipe and Tank: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 850 deg F, in accordance with ASTM C411. Comply with ASTM C1393.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Semirigid board material with factory-applied [**ASJ**] [**FSK**] jacket.
3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

N. Mineral Wool, Pipe and Tank: Mineral wool fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 1000 deg F, in accordance with ASTM C411. Comply with ASTM C1393.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Semirigid board material with factory-applied [**ASJ**] [**FSK**] jacket.
3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

O. Polyolefin: Polyethylene thermal plastic insulation. Comply with ASTM C1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.3 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C656, Type II, Grade 6. Tested and certified to provide a [**1**] [**2**]-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a [**1**] [**2**]-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.4 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for VOC content of plastic foam adhesive.>
3. <Double click to insert sustainable design text for low emitting adhesives.>

C. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for fiberglass pipe adhesive.>
3. <Double click to insert sustainable design text for low emitting adhesives.>

D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for adhesive.>
3. <Double click to insert sustainable design text for low emitting adhesives.>

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for adhesive.>
3. <Double click to insert sustainable design text for low emitting adhesives.>

2.5 MASTICS AND COATINGS

A. Materials are compatible with insulation materials, jackets, and substrates.

1. <Double click to insert sustainable design text for mastic coatings.>

B. Vapor-Retarder Mastic, Water Based, Interior Use: Suitable for indoor use on below ambient services.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Comply with MIL-PRF-19565C, Type II, for permeance requirements[**, with supplier listing on DOD QPD - Qualified Products Database**].
5. Color: [**White**] <**Insert color**>.

C. Vapor-Retarder Mastic, Solvent Based, Interior Use: Suitable for indoor use on below ambient services.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
3. Service Temperature Range: 0 to 180 deg F.
4. Color: [**White**] <**Insert color**>.

D. Vapor-Retarder Mastic, Solvent Based, Exterior Use: Suitable for outdoor use on below ambient services.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Color: [**White**] <**Insert color**>.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Color: [**White**] <**Insert color**>.

2.6 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and are compatible with insulation materials, jackets, and substrates.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for VOC content of adhesive.>
3. <Double click to insert sustainable design text for low emitting adhesives.>
4. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
5. Service Temperature Range: 0 to plus 180 deg F.
6. Color: White.

2.7 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Materials are compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. <Double click to insert sustainable design text for sealant.>
7. <Double click to insert sustainable design text for sealants.>

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Materials are compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. <Double click to insert sustainable design text for sealant.>
7. <Double click to insert sustainable design text for sealants.>

2.8 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested in accordance with ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

6. ASJ+: All-service jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
7. PSK Jacket: Aluminum foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: [**White**] [**Color-code jackets based on system. Color as selected by Architect**].

D. Metal Jacket:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

   a. [**Sheet and roll stock ready for shop or field sizing**] [**Factory cut and rolled to size**].
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: [**1-mil-thick, heat-bonded polyethylene and kraft paper**] [**3-mil-thick, heat-bonded polyethylene and kraft paper**] [**3-mil-thick polysurlyn**].
   d. Moisture Barrier for Outdoor Applications: [**3-mil-thick, heat-bonded polyethylene and kraft paper**] [**3-mil-thick polysurlyn**].

3. Stainless Steel Jacket: ASTM A240/A240M.

   a. [**Sheet and roll stock ready for shop or field sizing**] [**Factory cut and rolled to size**].
   b. Material, finish, and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: [**1-mil-thick, heat-bonded polyethylene and kraft paper**] [**3-mil-thick, heat-bonded polyethylene and kraft paper**] [**3-mil-thick polysurlyn**].
   d. Moisture Barrier for Outdoor Applications: [**3-mil-thick, heat-bonded polyethylene and kraft paper**] [**3-mil-thick polysurlyn**].

E. Self-Adhesive Outdoor Jacket (Asphaltic): 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with [**white**] [**stucco-embossed**] aluminum-foil facing.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

F. Self-Adhesive Indoor/Outdoor Jacket (Non-Asphaltic): Vapor barrier and waterproofing jacket for installation over insulation located aboveground outdoors or indoors. Specialized jacket has five layers of laminated aluminum and polyester film with low-temperature acrylic pressure-sensitive adhesive. Outer aluminum surface is coated with UV-resistant coating for protection from environmental contaminants.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Permeance: 0.00 perm as tested in accordance with ASTM F1249.
3. Flamespread/Smoke Developed: 25/50 as tested in accordance with ASTM E84.
4. Aluminum Finish: [**Embossed**] [**Smooth**].

2.10 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Mesh: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering ducts.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Woven Polyester Mesh: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for ducts.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.11 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Cloth: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.12 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Width: [**3 inches**] <**Insert value**>.
3. Thickness: [**11.5 mils**] <**Insert value**>.
4. Adhesion: [**90 ounces force/inch**] <**Insert value**> in width.
5. Elongation: [**2**] <**Insert value**> percent.
6. Tensile Strength: [**40 lbf/inch**] <**Insert value**> in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Width: [**3 inches**] <**Insert value**>.
3. Thickness: [**6.5 mils**] <**Insert value**>.
4. Adhesion: [**90 ounces force/inch**] <**Insert value**> in width.
5. Elongation: [**2**] <**Insert number**> percent.

6. Tensile Strength: [**40 lbf/inch**] <**Insert value**> in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Width: [**2 inches**] <**Insert value**>.
3. Thickness: [**6 mils**] <**Insert value**>.
4. Adhesion: [**64 ounces force/inch**] <**Insert value**> in width.
5. Elongation: [**500**] <**Insert number**> percent.
6. Tensile Strength: [**18 lbf/inch**] <**Insert value**> in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Width: [**2 inches**] <**Insert value**>.
3. Thickness: [**3.7 mils**] <**Insert value**>.
4. Adhesion: [**100 ounces force/inch**] <**Insert value**> in width.
5. Elongation: [**5**] <**Insert number**> percent.
6. Tensile Strength: [**34 lbf/inch**] <**Insert value**> in width.

2.13 SECUREMENTS

A. Bands:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Stainless Steel: ASTM A240/A240M, [**Type 304**] [**or**] [**Type 316**]; 0.015 inch thick, [**1/2 inch**] [**3/4 inch**] wide with [**wing seal**] [**or**] [**closed seal**].
3. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, [**1/2 inch**] [**3/4 inch**] wide with [**wing seal**] [**or**] [**closed seal**].
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, [**0.106-inch-**] [**0.135-inch-**] diameter shank, length to suit depth of insulation indicated.

   a. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, [**0.106-inch-**] [**0.135-inch-**] diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

   a. <Double click here to find, evaluate, and insert list of manufacturers and products.>

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in

position indicated when self-locking washer is in place. Comply with the following requirements:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: [**Copper- or zinc-coated, low-carbon steel**] [**Aluminum**] [**Stainless steel**], fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: [**Copper- or zinc-coated, low-carbon steel**] [**Aluminum**] [**Stainless steel**], fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, [**galvanized-steel**] [**aluminum**] [**stainless steel**] sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

D. Wire: [**0.080-inch nickel-copper alloy**] [**0.062-inch soft-annealed, stainless steel**] [**0.062-inch soft-annealed, galvanized steel**].

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.14 CORNER ANGLES

A. PVC Corner Angles: [**30 mils**] <**Insert dimension**> thick, minimum 1 by 1 inch, PVC in accordance with ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: [**0.040 inch**] <**Insert dimension**> thick, minimum 1 by 1 inch, aluminum in accordance with ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

C. Stainless Steel Corner Angles: [**0.024 inch**] <**Insert dimension**> thick, minimum 1 by 1 inch, stainless steel in accordance with ASTM A240/A240M, [**Type 304**] [**or**] [**Type 316**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents[**, unless otherwise approved by the engineer-of-record**].

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at [**2 inches**] [**4 inches**] o.c.

   a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC AND POLYOLEFIN INSULATION

A. Comply with manufacturer's written installation instructions and ASTM C1710.

B. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Square and Rectangular Ducts and Plenums:

1. Provide 1/4 inch more per side for a tight, compression fit.

2. Cut sheet insulation with the following dimensions:

   a. Width of duct plus 1/4 inch, one piece.
   b. Height of duct plus 1/4 inch, plus thickness of insulation, two pieces.
   c. Width of duct plus 1/4 inch, plus two times the thickness of insulation, one piece.

3. Insulate the bottom of the duct with the sheet from (a) above, then the sides with the two sheets from (b) above, and finally the top of the duct with the sheet from (c) above.
4. Insulation without self-adhering backing:

   a. Apply 100 percent coverage of manufacturer adhesive on the metal surface, then the insulation, except for the last 1/4 inch where sheets will butt together.
   b. Roll sheet down into position.
   c. Press two sheets together under compression and apply adhesive at the butt joint to seal the two sheets together.

5. Insulation with self-adhering backing:

   a. Peel back release paper in 6- to 8-inch increments and line up sheet.
   b. Press firmly to activate adhesive.
   c. Align material and continue to line up correctly, pressing firmly while slowly removing release paper.
   d. Allow 1/4-inch overlap for compression at butt joints.
   e. Apply adhesive at the butt joint to seal the two sheets together.

6. Insulate duct brackets following manufacturer's written installation instructions.

D. Circular Ducts:

1. Determine the circumference of the duct, using a strip of insulation the same thickness as to be used.
2. Cut the sheet to the required size.
3. Apply 100 percent coverage of manufacturer adhesive on the metal surface then the insulation.
4. Apply manufacturer adhesive to the cut surfaces along 100 percent of the longitudinal seam. Press together the seam at the ends and then the middle. Close the entire seam starting from the middle.

3.6 INSTALLATION OF GLASS-FIBER AND MINERAL-WOOL INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

B. Comply with manufacturer's written installation instructions.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for [**100**] [**50**] <**Insert number**> percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.
e. Impale insulation over pins and attach speed washers.
f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

C. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for [**100**] [**50**] <**Insert number**> percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.
e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.8 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Comply with manufacturer's written installation instructions.

B. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

C. Insulate duct access panels and doors to achieve same fire rating as duct.

D. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

3.9 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: [**Two**] <**Insert number**> finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless steel jackets.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to

[**one**] <**Insert number**> location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
4. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
5. Outdoor, concealed supply and return.
6. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.12 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval, supply-air duct insulation is[**one of**] the following:

1. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
2. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
3. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
4. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

B. Concealed, round and flat-oval, return-air duct insulation is[**one of**] the following:

1. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
2. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
3. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
4. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

C. Concealed, round and flat-oval, outdoor-air duct insulation is[**one of**] the following:

1. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.

2. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
3. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
4. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

D. Concealed, round and flat-oval, exhaust-air duct insulation is[**one of**] the following:

1. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
2. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
3. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
4. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

E. Concealed, rectangular, supply-air duct insulation is[**one of**] the following:

1. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
2. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
3. Glass-Fiber Board: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Board: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

F. Concealed, rectangular, return-air duct insulation is[**one of**] the following:

1. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
2. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
3. Glass-Fiber Board: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Board: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

G. Concealed, rectangular, outdoor-air duct insulation is[**one of**] the following:

1. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
2. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
3. Glass-Fiber Board: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Board: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

H. Concealed, rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior is[**one of**] the following:

1. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
2. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
3. Glass-Fiber Board: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Board: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

I. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated [**blanket**] [**or**] [**board**]; thickness as required to achieve 2-hour fire rating.

J. Concealed, supply-air plenum insulation is[**one of**] the following:

1. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
2. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
3. Glass-Fiber Board: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Board: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

K. Concealed, return-air plenum insulation is[**one of**] the following:

1. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
2. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
3. Glass-Fiber Board: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Board: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

L. Concealed, outdoor-air plenum insulation is[**one of**] the following:

1. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
2. Glass-Fiber Board: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
3. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
4. Mineral Wool Board: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

M. Concealed, exhaust-air plenum insulation is[**one of**] the following:

1. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
2. Glass-Fiber Board: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
3. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
4. Mineral Wool Board: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

N. Exposed, round and flat-oval, supply-air duct insulation is[**one of**] the following:

1. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
2. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
3. Glass-Fiber Pipe and Tank: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick.
4. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Pipe and Tank: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick.
6. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

O. Exposed, round and flat-oval, return-air duct insulation is[**one of**] the following:

1. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
2. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
3. Glass-Fiber Pipe and Tank: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick.
4. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Pipe and Tank: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick.
6. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

P. Exposed, round and flat-oval, outdoor-air duct insulation is[**one of**] the following:

1. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
2. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
3. Glass-Fiber Pipe and Tank: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick.
4. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Pipe and Tank: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick.
6. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

Q. Exposed, round and flat-oval, exhaust-air duct insulation is[**one of**] the following:

1. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
2. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
3. Glass-Fiber Pipe and Tank: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick.
4. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Pipe and Tank: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick.

6. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

R. Exposed, rectangular, supply-air duct insulation is[**one of**] the following:

1. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
2. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
3. Glass-Fiber Board: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Board: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4-lb/cu. ft.**] [**6-lb/cu. ft.**] <**Insert density**> nominal density.
6. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

S. Exposed, rectangular, return-air duct insulation is[**one of**] the following:

1. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
2. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
3. Glass-Fiber Board: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Board: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

T. Exposed, rectangular, outdoor-air duct insulation is[**one of**] the following:

1. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
2. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
3. Glass-Fiber Board: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Board: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

U. Exposed, rectangular, exhaust-air duct insulation is[**one of**] the following:

1. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
2. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
3. Glass-Fiber Board: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Board: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

V. Exposed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated [**blanket**] [**or**] [**board**]; thickness as required to achieve 2-hour fire rating.

W. Exposed, supply-air plenum insulation is[**one of**] the following:

1. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
2. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
3. Glass-Fiber Board: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Board: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

X. Exposed, return-air plenum insulation is[**one of**] the following:

1. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
2. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
3. Glass-Fiber Board: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Board: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

Y. Exposed, outdoor-air plenum insulation is[**one of**] the following:

1. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
2. Glass-Fiber Board: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
3. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
4. Mineral Wool Board: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

Z. Exposed, exhaust-air plenum insulation is[**one of**] the following:

1. Glass-Fiber Blanket: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
2. Glass-Fiber Board: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
3. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
4. Mineral Wool Board: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

3.13 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Concealed, round and flat-oval, supply-air duct insulation is[**one of**] the following:

1. Glass-Fiber Blanket: [**2 inches**] [**3 inches**] <**Insert dimension**> and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
2. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

C. Concealed, round and flat-oval, return-air duct insulation is[**one of**] the following:

1. Glass-Fiber Blanket: [**2 inches**] [**3 inches**] <**Insert dimension**> and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
2. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

D. Concealed, round and flat-oval, outdoor-air duct insulation is[**one of**] the following:

1. Glass-Fiber Blanket: [**2 inches**] [**3 inches**] <**Insert dimension**> and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
2. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

E. Concealed, rectangular, supply-air duct insulation is[**one of**] the following:

1. Glass-Fiber Blanket: [**2 inches**] [**3 inches**] <**Insert dimension**> and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
2. Glass-Fiber Board: [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
3. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
4. Mineral Wool Board: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

F. Concealed, rectangular, return-air duct insulation is[**one of**] the following:

1. Glass-Fiber Blanket: [**2 inches**] [**3 inches**] <**Insert dimension**> and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
2. Glass-Fiber Board: [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
3. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
4. Mineral Wool Board: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

G. Concealed, supply-air plenum insulation is[**one of**] the following:

1. Glass-Fiber Blanket: [**2 inches**] [**3 inches**] <**Insert dimension**> and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
2. Glass-Fiber Board: [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.

3. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
4. Mineral Wool Board: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

H. Concealed, return-air plenum insulation is[**one of**] the following:

1. Glass-Fiber Blanket: [**2 inches**] [**3 inches**] <**Insert dimension**> and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
2. Glass-Fiber Board: [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
3. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
4. Mineral Wool Board: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

I. Exposed, round and flat-oval, supply-air duct insulation is[**one of**] the following:

1. Glass-Fiber Blanket: [**2 inches**] [**3 inches**] <**Insert dimension**> and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
2. Glass-Fiber Pipe and Tank: [**1-1/2 inches**] [**2 inches**] [**3 inches**] <**Insert dimension**> thick.
3. Mineral Wool Blanket: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
4. Mineral Wool Pipe and Tank: [**1-1/2 inches**] [**2 inches**] <**Insert dimension**> thick.

J. Exposed, round and flat-oval, return-air duct insulation is[**one of**] the following:

1. Glass-Fiber Blanket: [**2 inches**] [**3 inches**] <**Insert dimension**> and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
2. Glass-Fiber Board: [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
3. Mineral Wool Blanket: [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
4. Mineral Wool Board: [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

K. Exposed, rectangular, supply-air duct insulation is[**one of**] the following:

1. Glass-Fiber Blanket: [**2 inches**] [**3 inches**] <**Insert dimension**> and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
2. Glass-Fiber Board: [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
3. Mineral Wool Blanket: [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
4. Mineral Wool Board: [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

L. Exposed, rectangular, return-air duct insulation is[**one of**] the following:

1. Glass-Fiber Blanket: [**2 inches**] [**3 inches**] <**Insert dimension**> and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
2. Glass-Fiber Board: [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.

3. Mineral Wool Blanket: [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
4. Mineral Wool Board: [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

M. Exposed, supply-air plenum insulation is[**one of**] the following:

1. Glass-Fiber Blanket: [**2 inches**] [**3 inches**] <**Insert dimension**> and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
2. Glass-Fiber Board: [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
3. Mineral Wool Blanket: [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
4. Mineral Wool Board: [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

N. Exposed, return-air plenum insulation is[**one of**] the following:

1. Glass-Fiber Blanket: [**2 inches**] [**3 inches**] <**Insert dimension**> and [**0.75 lb/cu. ft.**] [**1.5 lb/cu. ft.**] [**3 lb/cu. ft.**] nominal density.
2. Glass-Fiber Board: [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
3. Mineral Wool Blanket: [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
4. Mineral Wool Board: [**2 inches**] [**3 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:

1. None.
2. [**PVC**] [**PVC, Color-Coded by System**]: [**20 mils**] [**30 mils**] thick.
3. Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] [**0.040 inch**] thick.
4. Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] thick.
5. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch**] [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] thick.
6. <**Insert jacket type**>.

D. Ducts and Plenums, Exposed:

1. None.
2. [**PVC**] [**PVC, Color-Coded by System**]: [**20 mils**] [**30 mils**] thick.
3. Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] [**0.040 inch**] thick.

4. Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] thick.
5. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch**] [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] thick.
6. <**Insert jacket type**>.

3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:

1. None.
2. [**PVC**] [**PVC, Color-Coded by System**]: [**20 mils**] [**30 mils**] thick.
3. Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] [**0.040 inch**] thick.
4. Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] thick.
5. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch**] [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] thick.
6. <**Insert jacket type**>.

D. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] [**0.040 inch**] thick.
2. Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] thick.
3. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch**] [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] thick.
4. <**Insert jacket type**>.

E. Ducts and Plenums, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. [**Painted**]Aluminum, [**Smooth**] [**Stucco Embossed**] with [**1-1/4-Inch-Deep Corrugations**] [**2-1/2-Inch-Deep Corrugations**] [**4-by-1-Inch Box Ribs**]: [**0.032 inch**] [**0.040 inch**] thick.
2. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth**] [**Stucco Embossed**], with [**1-1/4-Inch-Deep Corrugations**] [**2-1/2-Inch-Deep Corrugations**] [**4-by-1-Inch Box Ribs**]: [**0.020 inch**] [**0.024 inch**] thick.
3. <**Insert jacket type**>.

END OF SECTION 230713

SECTION 230716 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating HVAC equipment that is not factory insulated.

B. Related Sections:

1. Section 230713 "Duct Insulation."
2. Section 230719 "HVAC Piping Insulation."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for recycled content.>
2. <Double click to insert sustainable design text for sealants.>

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail removable insulation at equipment connections.
2. Detail application of field-applied jackets.
3. Detail application at linkages of control devices.
4. Detail field application for each equipment type.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Sheet Form Insulation Materials: 12 inches square.
2. Sheet Jacket Materials: 12 inches square.
3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program[**, certified by the Department of Labor, Bureau of Apprenticeship and Training**].

B. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Equipment Mockups:

a. One chilled-water pump and one heating-hot-water pump.
b. One tank or vessel.
c. <**Insert mockup**>.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect [**seven**] <**Insert number**> days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system **materials are to be delivered to the Project site in unopened containers**. The packaging is to include, the name of the manufacturer, fabricator, type, description, and size[**, as well as ASTM standard designation, and maximum use temperature**].

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. [**All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.**]
2. [**All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.**]
3. [**All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.**]

2.2 INSULATION MATERIALS

A. Comply with requirements in "Breeching Insulation Schedule," "Indoor Equipment Insulation Schedule," and "Outdoor, Aboveground Equipment Insulation Schedule" articles for where insulating materials are applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Calcium Silicate: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I or Type II.

1. Prefabricated Fitting Covers: Comply with ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>

G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Block Insulation: Type I.
3. Special-Shaped Insulation: Type III.
4. Board Insulation: Type IV.
5. Fabricated shapes in accordance with ASTM C450 and ASTM C585.

6. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Flexible Elastomeric: Closed-cell or expanded-rubber materials; suitable for maximum use temperature between minus 70 deg F and 220 deg F. Comply with ASTM C534/C534M, Type II for sheet materials.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

I. Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 450 deg F in accordance with ASTM C411. Comply with ASTM C553, Type II, and ASTM C1290, [**Type I, unfaced**] [**Type II, with factory-applied vinyl jacket**] [**Type III, with factory-applied FSK jacket**]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

J. High-Temperature, Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to 1000 deg F. Comply with ASTM C553, Type V.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

K. Mineral Wool Blanket: Basalt volcanic rock-derived fibers bonded with a thermosetting resin, unfaced; suitable for maximum use temperature up to 1200 deg F in accordance with ASTM C447. Comply with ASTM C553.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

L. Glass-Fiber Board: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 250 deg F for jacketed and between 35 deg F and 450 deg F for unfaced in accordance with ASTM C411. Comply with ASTM C612, Type IA or Type IB. Provide insulation [**unfaced**] [**with factory-applied ASJ**] [**with factory-applied FSK jacket**]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

M. High-Temperature, Glass-Fiber Board: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 1000 deg F in accordance with ASTM C411. Comply with ASTM C612, Type III, unfaced.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

N. Mineral Wool Board: Basalt volcanic rock-derived fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 1100 deg F in accordance with ASTM C411. Comply with ASTM C612, Type III, unfaced.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

O. Glass-Fiber, Pipe and Tank: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 850 deg F, in accordance with ASTM C411. Comply with ASTM C1393.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Semirigid board material with factory-applied [**ASJ**] [**FSK**] jacket.

3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

P. Mineral Wool, Pipe and Tank: Mineral wool fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 1000 deg F, in accordance with ASTM C411. Comply with ASTM C1393.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Semirigid board material with factory-applied [**ASJ**] [**FSK**] jacket.
3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

Q. Polyisocyanurate: Prefabricated, rigid cellular polyisocyanurate material intended for use as thermal insulation. Comply with ASTM C591.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Type I or Type IV, except thermal conductivity (k-value) does not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.
3. Flame-spread index is 25 or less and smoke-developed index is 50 or less for thicknesses of up to 1.5 inches as tested in accordance with ASTM E84.
4. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.

a. Equipment Applications: [**None**] [**field-applied PVDC jacket**] [**field-applied PVDC-SSL jacket**].

R. Polyolefin: Polyethylene thermal plastic insulation. Comply with ASTM C1427, Type II, Grade 1 for sheet materials.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

S. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C578, Type IV or VIII.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Fabricate shapes in accordance with ASTM C450 and ASTM C585.

2.3 INSULATING CEMENTS

A. Glass-Fiber and Mineral Wool Insulating Cement: Comply with ASTM C195.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

C. Glass-Fiber and Mineral Wool, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.4 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for calcium silicate adhesive VOC content.>
3. <Double click to insert sustainable design text for low emitting adhesives.>

C. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for cellular glass adhesive VOC Content.>
3. <Double click to insert sustainable design text for low emitting adhesives.>

D. Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for phenolic and polyisocyanurate adhesive VOC content.>
3. <Double click to insert sustainable design text for low emitting adhesives.>

E. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for VOC content of plastic foam adhesive.>
3. <Double click to insert sustainable design text for low emitting adhesives.>
4. Flame-spread index is 25 or less and smoke-developed index is 50 or less as tested in accordance with ASTM E84.
5. Wet Flash Point: Below 0 deg F
6. Service Temperature Range: 40 to 200 deg F.
7. Color: [**Black**] <**Insert color**>.

F. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for mineral fiber adhesive VOC content>
3. <Double click to insert sustainable design text for low emitting adhesives.>

G. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for polystyrene adhesive VOC content.>
3. <Double click to insert sustainable design text for low emitting adhesives.>

H. ASJ Adhesive and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for adhesive for ASJ, FSK, and PVDC jackets VOC content.>
3. <Double click to insert sustainable design text for low emitting adhesives.>

I. PVC Jacket Adhesive: Compatible with PVC jacket.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for adhesive for PVC jacket>
3. <Double click to insert sustainable design text for low emitting adhesives.>

2.5 MASTICS AND COATINGS

A. Materials are compatible with insulation materials, jackets, and substrates.

1. <Double click to insert sustainable design text for insulation mastics VOC content.>
2. <Double click to insert sustainable design text for low-emitting mastics VOC content.>

B. Vapor-Retarder Mastic, Water Based: Suitable for indoor and outdoor use on below-ambient services.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: [**0 to plus 180 deg F**] [**Minus 20 to plus 180 deg F**].
4. Comply with MIL-PRF-19565C, Type II, for permeance requirements[**, with supplier listing on DOD QPD - Qualified Products Database**].
5. Color: [**White**] <**Insert color**>.

C. Vapor-Retarder Mastic, Solvent Based, Indoor Use: Suitable for indoor use on below-ambient services.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: 0 to 180 deg F.
4. Color: [**White**] <**Insert color**>.

D. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Color: [**White**] <**Insert color**>.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
3. Service Temperature Range: [**0 to plus 180 deg F**] [**Minus 20 to plus 180 deg F**].
4. Color: [**White**] <**Insert color**>.

2.6 LAGGING ADHESIVES

A. Adhesives comply with MIL-A-3316C, Class I, Grade A and are compatible with insulation materials, jackets, and substrates.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. <Double click to insert sustainable design text for lagging adhesives.>
3. <Double click to insert sustainable design text for low emitting adhesives.>
4. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment insulation.
5. Service Temperature Range: [**20 to plus 180 deg F**] [**0 to plus 180 deg F**].
6. Color: White.

2.7 SEALANTS

A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: [**Minus 58 to plus 176 deg F**] [**Minus 100 to plus 300 deg F**].
4. Color: White or gray.
5. <Double click to insert sustainable design text for sealant.>
6. <Double click to insert sustainable design text for sealants.>

C. FSK and Metal Jacket Flashing Sealants:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.
5. <Double click to insert sustainable design text for aealants for FSK and metal jacket flashing VOC content.>
6. <Double click to insert sustainable design text for sealants.>

D. ASJ Flashing Sealants and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. <Double click to insert sustainable design text for ASJ, vinyl, PVDC, and PVC flashing products VOC content.>
6. <Double click to insert sustainable design text for sealants.>

2.8 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
4. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested in accordance with ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C1136, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: [**White**] [**Color-code jackets based on system. Color as selected by Architect**].
4. Factory-fabricated tank heads and tank side panels.

D. Metal Jacket:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

   a. [**Sheet and roll stock ready for shop or field sizing**] [**Factory cut and rolled to size**].
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: [**1-mil-thick, heat-bonded polyethylene and kraft paper**] [**3-mil-thick, heat-bonded polyethylene and kraft paper**] [**3-mil-thick polysurlyn**].
   d. Moisture Barrier for Outdoor Applications: [**3-mil-thick, heat-bonded polyethylene and kraft paper**] [**3-mil-thick polysurlyn**].
   e. Factory-Fabricated Fitting Covers:

      1) Same material, finish, and thickness as jacket.
      2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Stainless Steel Jacket: ASTM A240/A240M.

a. [**Sheet and roll stock ready for shop or field sizing**] [**Factory cut and rolled to size**].
b. Material, finish, and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: [**1-mil-thick, heat-bonded polyethylene and kraft paper**] [**3-mil-thick, heat-bonded polyethylene and kraft paper**] [**3-mil-thick polysurlyn**].
d. Moisture Barrier for Outdoor Applications: [**3-mil-thick, heat-bonded polyethylene and kraft paper**] [**3-mil-thick polysurlyn**].
e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Self-Adhesive Outdoor Jacket (Asphaltic): 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with [**white**] [**stucco-embossed**] aluminum-foil facing.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

F. Self-Adhesive Indoor/Outdoor Jacket (Non-Asphaltic): Vapor barrier and waterproofing jacket for installation over insulation located aboveground outdoors or indoors. Specialized jacket has five layers of laminated aluminum and polyester film with low-temperature acrylic pressure-sensitive adhesive. Outer aluminum surface is coated with UV-resistant coating for protection from environmental contaminants.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Permeance: 0.00 perm as tested in accordance with ASTM F1249.
3. Flamespread/Smoke Developed: 25/50 as tested in accordance with ASTM E84.
4. Aluminum Finish: [**Embossed**] [**Smooth**].

G. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested in accordance with ASTM E96/E96M and with a flame-spread index of 10 and a smoke-developed index of 20 when tested in accordance with ASTM E84.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

H. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested in accordance with ASTM E96/E96M and with a flame-spread index of 25 and a smoke-developed index of 50 when tested in accordance with ASTM E84.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

I. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.10 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Mesh: Approximately 4 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering equipment.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Woven Polyester Mesh: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for equipment.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.11 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Cloth: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.12 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Width: [**3 inches**] <**Insert value**>.
3. Thickness: [**11.5 mils**] <**Insert value**>.
4. Adhesion: [**90 ounces force/inch**] <**Insert value**> in width.
5. Elongation: [**2**] <**Insert number**> percent.
6. Tensile Strength: [**40 lbf/inch**] <**Insert value**> in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Width: [**3 inches**] <**Insert value**>.
3. Thickness: [**6.5 mils**] <**Insert value**>.
4. Adhesion: [**90 ounces force/inch**] <**Insert value**> in width.
5. Elongation: [**2**] <**Insert number**> percent.
6. Tensile Strength: [**40 lbf/inch**] <**Insert value**> in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Width: [**2 inches**] <**Insert value**>.
3. Thickness: [**6 mils**] <**Insert value**>.

4. Adhesion: [**64 ounces force/inch**] <**Insert value**> in width.
5. Elongation: [**500**] <**Insert number**> percent.
6. Tensile Strength: [**18 lbf/inch**] <**Insert value**> in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Width: [**2 inches**] <**Insert value**>.
3. Thickness: [**3.7 mils**] <**Insert value**>.
4. Adhesion: [**100 ounces force/inch**] <**Insert value**> in width.
5. Elongation: [**5**] <**Insert number**> percent.
6. Tensile Strength: [**34 lbf/inch**] <**Insert value**> in width.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Width: [**3 inches**] <**Insert value**>.
3. Film Thickness: [**6 mils**] <**Insert value**>.
4. Adhesive Thickness: [**1.5 mils**] <**Insert value**>.
5. Elongation at Break: [**145**] <**Insert number**> percent.
6. Tensile Strength: [**55 psi**] <**Insert value**> in width.

F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Width: [**3 inches**] <**Insert value**>.
3. Film Thickness: [**6 mils**] <**Insert value**>.
4. Adhesive Thickness: [**1.5 mils**] <**Insert value**>.
5. Elongation at Break: [**145**] <**Insert number**> percent.
6. Tensile Strength: [**55 psi**] <**Insert value**> in width.

2.13 SECUREMENTS

A. Bands:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Stainless Steel: ASTM A240/A240M, [**Type 304**] [**or**] [**Type 316**]; 0.015 inch thick, [**1/2 inch**] [**3/4 inch**] wide with [**wing seal**] [**or**] [**closed seal**].
3. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, [**1/2 inch**] [**3/4 inch**] wide with [**wing seal**] [**or**] [**closed seal**].
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding; [**0.106-inch-**] [**0.135-inch-**] diameter shank, length to suit depth of insulation indicated.

   a. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding; [**0.106-inch-**] [**0.135-inch-**] diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

    a. <Double click here to find, evaluate, and insert list of manufacturers and products.>

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

    a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
    b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    c. Spindle: [**Copper- or zinc-coated, low-carbon steel**] [**Aluminum**] [**Stainless steel**], fully annealed, 0.106-inch-diameter shank; length to suit depth of insulation indicated.
    d. Adhesive: Recommended by hanger manufacturer. Use product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

    a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
    b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
    c. Spindle: Nylon, 0.106-inch-diameter shank; length to suit depth of insulation indicated, up to 2-1/2 inches.
    d. Adhesive: Recommended by hanger manufacturer. Use product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

    a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
    b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    c. Spindle: [**Copper- or zinc-coated, low-carbon steel**] [**Aluminum**] [**Stainless steel**], fully annealed; 0.106-inch-diameter shank; length to suit depth of insulation indicated.
    d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, [**galvanized-steel**] [**aluminum**] [**stainless steel**] sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

    a. <Double click here to find, evaluate, and insert list of manufacturers and products.>

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

D. Wire: [**0.080-inch nickel-copper alloy**] [**0.062-inch soft-annealed, stainless steel**] [**0.062-inch soft-annealed, galvanized steel**].

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.14 CORNER ANGLES

A. PVC Corner Angles: [**30-mils-**] <**Insert dimension**> thick, minimum 1- by 1-inch PVC in accordance with ASTM D1784, Class 16354-C, white or color-coded to match adjacent surface.

B. Aluminum Corner Angles: [**0.040-inch-**] <**Insert dimension**> thick, minimum 1- by 1-inch aluminum in accordance with ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

C. Stainless Steel Corner Angles: [**0.024-inch-**] <**Insert dimension**> thick, minimum 1- by 1-inch stainless steel in accordance with ASTM A240/A240M, [**Type 304**] [**or**] [**Type 316**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range of between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, and jackets, of thicknesses required for each item of equipment, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with the Contract Documents[**, unless otherwise approved by the engineer-of-record**].

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at [**2 inches**] [**4 inches**] o.c.
4. For below-ambient services, apply vapor-barrier mastic over staples.
5. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

O. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. [**Mineral Wool**] [**Glass-Fiber**], Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive, anchor pins, and speed washers.

1. Apply adhesives in accordance with manufacturer's recommended coverage rates per unit area, for [**100**] [**50**] <**Insert number**> percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints and 16 inches o.c. in both directions.
    d. Do not compress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins, and attach speed washers.

g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable and replaceable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply [**100**] <**Insert value**> percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a field-adjustable latching mechanism.
2. Fabricate boxes from [**galvanized steel**] [**aluminum**] [**or**] [**stainless steel**], at least [**0.040 inch**] [**0.050 inch**] [**0.060 inch**] thick.
3. For below-ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.5 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Boiler Breechings:

1. Secure single-layer insulation with stainless steel bands at 12-inch intervals, and tighten bands without deforming insulation material.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless steel bands at 12-inch intervals.

3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Install in accordance with manufacturer's written installation instructions and ASTM C1710.

B. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:

1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. 33-1/2-inch-circumference limit allows for 2-inch-overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.

2. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.8 FINISHES

A. Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: [**Two**] <**Insert number**> finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless steel jackets.

3.9 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections.

B. Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

E. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to [**one**] <**Insert number**> location(s) for each type of equipment defined in "Indoor Equipment Insulation Schedule" and "Outdoor, Aboveground Equipment Insulation Schedule" articles. For large equipment, remove only a portion adequate to determine compliance.

F. All insulation applications will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.10 EQUIPMENT INSULATION SCHEDULE, GENERAL

A. Insulation conductivity and thickness per pipe size comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.

B. Acceptable insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials is Contractor's option.

3.11 BREECHING INSULATION SCHEDULE

A. Round, exposed breeching and connector insulation is [**one of**] the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Glass-Fiber Blanket: 3 inches thick and 3 lb/cu. ft. nominal density.
3. Mineral Wool Blanket: 3 inches thick and 4 lb/cu. ft. nominal density.

B. Round, concealed breeching and connector insulation is[**one of**] the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Glass-Fiber Blanket: 3 inches thick and 3 lb/cu. ft. nominal density.
3. Mineral Wool Blanket: 3 inches thick and 4 lb/cu. ft. nominal density.

C. Rectangular, exposed breeching and connector insulation is [**one of**] the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Glass-Fiber Blanket: 3 inches thick and 3 lb/cu. ft. nominal density.
3. High-Temperature Glass-Fiber Board: 3 inches thick and [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Mineral Wool Blanket: 3 inches thick and 4 lb/cu. ft. nominal density.
5. Mineral Wool Board: 3 inches thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.

D. Rectangular, concealed breeching and connector insulation is [**one of**] the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Glass-Fiber Blanket: 3 inches thick and 3 lb/cu. ft. nominal density.
3. High-Temperature Glass-Fiber Board: 3 inches thick and [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Mineral Wool Blanket: 3 inches thick and [**4 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Board: 3 inches thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.

3.12 INDOOR EQUIPMENT INSULATION SCHEDULE

A. Insulate indoor and outdoor equipment that is not factory insulated.

B. Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, [**condenser bundles,**] [**heat-recovery bundles,**] suction piping, compressor inlets, tube sheets, water boxes, and nozzles with[**one of**] the following:

1. Cellular Glass: [**2 inches**] <**Insert dimension**> thick.
2. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
3. Glass-Fiber Board: [**1 inch**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Glass-Fiber Pipe and Tank: [**1 inch**] <**Insert dimension**> thick.
5. Mineral Wool Board: [**1 inch**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Mineral Wool Pipe and Tank: [**1.5 inches**] <**Insert dimension**> thick.

7. Polyisocyanurate: [**1 inch**] <**Insert dimension**> thick.
8. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

C. Heat-exchanger (water-to-water for cooling service) insulation is[**one of**] the following:

1. Cellular Glass: [**2 inches**] <**Insert dimension**> thick.
2. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
3. Glass-Fiber Blanket: [**1 inch**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Glass-Fiber Board: [**1 inch**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
5. Glass-Fiber Pipe and Tank: [**1 inch**] <**Insert dimension**> thick.
6. Mineral Fiber Blanket: [**1 inch**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
7. Mineral Wool Board: [**1 inch**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
8. Mineral Wool Pipe and Tank: [**1.5 inches**] <**Insert dimension**> thick.
9. Polyisocyanurate: [**1 inch**] <**Insert dimension**> thick.
10. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

D. Heat-exchanger (water-to-water for heating service) insulation is[**one of**] the following:

1. Calcium Silicate: [**3 inches**] <**Insert dimension**> thick.
2. Cellular Glass: [**3 inches**] <**Insert dimension**> thick.
3. Glass-Fiber Blanket: [**2 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Glass-Fiber Board: [**2 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
5. Glass-Fiber Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.
6. Mineral Wool Blanket: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
7. Mineral Wool Board: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
8. Mineral Wool Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.

E. Steam-to-steam generator insulation is[**one of**] the following:

1. Calcium Silicate: [**3 inches**] <**Insert dimension**> thick.
2. Cellular Glass: [**3 inches**] <**Insert dimension**> thick.
3. Glass-Fiber Board: [**2 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Glass-Fiber Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.
5. Mineral Wool Board: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] [**8 lb/cu. ft.**] <**Insert density**> nominal density.
6. Mineral Wool Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.

F. Steam-to-hot-water converter insulation is[**one of**] the following:

1. Calcium Silicate: [**3 inches**] <**Insert dimension**> thick.
2. Cellular Glass: [**3 inches**] <**Insert dimension**> thick.
3. Glass-Fiber Blanket: [**2 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Glass-Fiber Board: [**2 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
5. Glass-Fiber Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.

6. Mineral Wool Blanket: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] [**8 lb/cu. ft.**] <**Insert density**> nominal density.
7. Mineral Wool Board: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] [**8 lb/cu. ft.**] <**Insert density**> nominal density.
8. Mineral Wool Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.

G. Hot-water-to-steam converter insulation is[**one of**] the following:

1. Calcium Silicate: [**3 inches**] <**Insert dimension**> thick.
2. Cellular Glass: [**3 inches**] <**Insert dimension**> thick.
3. Glass-Fiber Board: [**2 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Glass-Fiber Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.
5. Mineral Wool Board: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] [**8 lb/cu. ft.**] <**Insert density**> nominal density.
6. Mineral Wool Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.

H. Chilled-water pump insulation is[**one of**] the following:

1. Cellular Glass: [**3 inches**] <**Insert dimension**> thick.
2. Glass-Fiber Board: [**2 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
3. Mineral Wool Board: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

I. Condenser-water pump insulation is[**one of**] the following:

1. Cellular Glass: [**2 inches**] <**Insert dimension**> thick.
2. Glass-Fiber Board: [**1 inch**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
3. Mineral Wool Board: [**1 inch**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

J. Dual-service heating and cooling pump insulation is[**one of**] the following:

1. Cellular Glass: [**3 inches**] <**Insert dimension**> thick.
2. Glass-Fiber Board: [**2 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
3. Mineral Wool Board: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
4. Polyisocyanurate: [**1 inch**] <**Insert dimension**> thick.

K. Heating-hot-water pump insulation is[**one of**] the following:

1. Calcium Silicate: [**3 inches**] <**Insert dimension**> thick.
2. Cellular Glass: [**3 inches**] <**Insert dimension**> thick.
3. Glass-Fiber Board: [**2 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Mineral Wool Board: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

L. Heat-recovery pump insulation is[**one of**] the following:

1. Cellular Glass: [**2 inches**] <**Insert dimension**> thick.

2. Glass-Fiber Board: [**2 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
3. Mineral Wool Board: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.

M. Steam condensate pump and boiler feedwater pump insulation is[**one of**] the following:

1. Calcium Silicate: [**3 inches**] <**Insert dimension**> thick.
2. Cellular Glass: [**3 inches**] <**Insert dimension**> thick.
3. Glass-Fiber Board: [**2 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Glass-Fiber Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.
5. Mineral Wool Board: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] [**8 lb/cu. ft.**] <**Insert density**> nominal density.
6. Mineral Wool Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.

N. Chilled-water expansion/compression tank insulation is[**one of**] the following:

1. Cellular Glass: [**3 inches**] <**Insert dimension**> thick.
2. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
3. Glass-Fiber Board: [**2 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Glass-Fiber Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.
5. Mineral Wool Board: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Mineral Wool Pipe and Tank: [**1.5 inches**] <**Insert dimension**> thick.
7. Polyisocyanurate: [**1 inch**] <**Insert dimension**> thick.
8. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

O. Condenser-water expansion/compression tank insulation is[**one of**] the following:

1. Cellular Glass: [**2 inches**] <**Insert dimension**> thick.
2. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
3. Glass-Fiber Board: [**1 inch**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Glass-Fiber Pipe and Tank: [**1 inch**] <**Insert dimension**> thick.
5. Mineral Wool Board: [**1 inch**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Mineral Wool Pipe and Tank: [**1.5 inches**] <**Insert dimension**> thick.
7. Polyisocyanurate: [**1 inch**] <**Insert dimension**> thick.
8. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

P. Dual-service heating and cooling expansion/compression tank insulation is[**one of**] the following:

1. Cellular Glass: [**2 inches**] <**Insert dimension**> thick.
2. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
3. Glass-Fiber Board: [**2 inch**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Glass-Fiber Pipe and Tank: [**2 inch**] <**Insert dimension**> thick.
5. Mineral Wool Board: [**2 inch**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Mineral Wool Pipe and Tank: [**2 inch**] <**Insert dimension**> thick.
7. Polyisocyanurate: [**1 inch**] <**Insert dimension**> thick.
8. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

Q. Heating-hot-water expansion/compression tank insulation is[**one of**] the following:

1. Calcium Silicate: [**2 inches**] <**Insert dimension**> thick.
2. Cellular Glass: [**2 inches**] <**Insert dimension**> thick.
3. Glass-Fiber Board: [**2 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Glass-Fiber Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.
5. Mineral Wool Board: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Mineral Wool Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.

R. Heat-recovery expansion/compression tank insulation is[**one of**] the following:

1. Cellular Glass: [**2 inches**] <**Insert dimension**> thick.
2. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
3. Glass-Fiber Board: [**1 inch**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Glass-Fiber Pipe and Tank: [**1 inch**] <**Insert dimension**> thick.
5. Mineral Wool Board: [**1 inch**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Mineral Wool Pipe and Tank: [**1.5 inches**] <**Insert dimension**> thick.
7. Polyisocyanurate: [**1 inch**] <**Insert dimension**> thick.
8. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

S. Chilled-water air-separator insulation is[**one of**] the following:

1. Cellular Glass: [**2 inches**] <**Insert dimension**> thick.
2. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
3. Glass-Fiber Board: [**2 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Glass-Fiber Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.
5. Mineral Wool Board: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Mineral Wool Pipe and Tank: [**1.5 inches**] <**Insert dimension**> thick.
7. Polyisocyanurate: [**1 inch**] <**Insert dimension**> thick.
8. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

T. Condenser-water air-separator insulation is[**one of**] the following:

1. Cellular Glass: [**2 inches**] <**Insert dimension**> thick.
2. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
3. Glass-Fiber Board: [**1 inch**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Glass-Fiber Pipe and Tank: [**1 inch**] <**Insert dimension**> thick.
5. Mineral Wool Board: [**1 inch**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Mineral Wool Pipe and Tank: [**1.5 inches**] <**Insert dimension**> thick.
7. Polyisocyanurate: [**1 inch**] <**Insert dimension**> thick.
8. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

U. Dual-service heating and cooling air-separator insulation is[**one of**] the following:

1. Cellular Glass: [**2 inches**] <**Insert dimension**> thick.
2. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.

3. Mineral-Fiber Board: [**2 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Mineral-Fiber Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.
5. Mineral Wool Board: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Mineral Wool Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.
7. Polyisocyanurate: [**1 inch**] <**Insert dimension**> thick.
8. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

V. Heating-hot-water air-separator insulation is[**one of**] the following:

1. Calcium Silicate: [**3 inches**] <**Insert dimension**> thick.
2. Cellular Glass: [**3 inches**] <**Insert dimension**> thick.
3. Glass-Fiber Board: [**2 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Glass-Fiber Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.
5. Mineral Wool Board: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Mineral Wool Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.

W. Heat-recovery air-separator insulation is[**one of**] the following:

1. Cellular Glass: [**2 inches**] <**Insert dimension**> thick.
2. Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.
3. Glass-Fiber Board: [**1 inch**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Glass-Fiber Pipe and Tank: [**1 inch**] <**Insert dimension**> thick.
5. Mineral Wool Board: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Mineral Wool Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.
7. Polyisocyanurate: [**1 inch**] <**Insert dimension**> thick.
8. Polyolefin: [**1 inch**] <**Insert dimension**> thick.

X. Thermal storage tank (brine, water, ice) insulation is[**one of**] the following:

1. Cellular Glass: [**4 inches**] <**Insert dimension**> thick.
2. Glass-Fiber Board: [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
3. Glass-Fiber Pipe and Tank: [**3 inches**] <**Insert dimension**> thick.
4. Mineral Wool Board: [**3 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] [**8 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Pipe and Tank: [**3 inches**] <**Insert dimension**> thick.
6. Polyisocyanurate (Outdoor Application Only): [**3 inches**] <**Insert dimension**> thick.
7. Polystyrene (Outdoor Application Only): [**3 inches**] <**Insert dimension**> thick.

Y. Deaerator insulation is[**one of**] the following:

1. Calcium Silicate: [**3 inches**] <**Insert dimension**> thick.
2. Cellular Glass: [**3 inches**] <**Insert dimension**> thick.
3. Glass-Fiber Board: [**3 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Glass-Fiber Pipe and Tank: [**3 inches**] <**Insert dimension**> thick.
5. Mineral Wool Board: [**3 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] [**8 lb/cu. ft.**] <**Insert density**> nominal density.
6. Mineral Wool Pipe and Tank: [**3 inches**] <**Insert dimension**> thick.

Z. Steam condensate tank and receiver insulation is[**one of**] the following:

1. Calcium Silicate: [**3 inches**] <**Insert dimension**> thick.
2. Cellular Glass: [**3 inches**] <**Insert dimension**> thick.
3. Glass-Fiber Board: [**2 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Glass-Fiber Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.
5. Mineral Wool Board: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
6. Mineral Wool Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.

AA. Steam flash-tank, flash-separator, moisture-separator, and blow-off-tank insulation is[**one of**] the following:

1. Calcium Silicate: [**3 inches**] <**Insert dimension**> thick.
2. Cellular Glass: [**3 inches**] <**Insert dimension**> thick.
3. Glass-Fiber Board: [**2 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
4. Glass-Fiber Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.
5. Mineral Wool Board: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] [**8 lb/cu. ft.**] <**Insert density**> nominal density.
6. Mineral Wool Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.

BB. Piping system filter-housing insulation is[**one of**] the following:

1. Cellular Glass: [**3 inches**] <**Insert dimension**> thick.
2. Glass-Fiber Board: [**2 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
3. Glass-Fiber Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.
4. Mineral Wool Board: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.

3.13 OUTDOOR, ABOVEGROUND EQUIPMENT INSULATION SCHEDULE

A. Retain "one of" option in paragraph below to allow Contractor to select materials from those retained. Heated, fuel-oil storage tank insulation is[**one of**] the following:

1. Cellular Glass: [**3 inches**] <**Insert dimension**> thick.
2. Glass-Fiber Board: [**2 inches**] <**Insert dimension**> thick and [**2 lb/cu. ft.**] [**3 lb/cu. ft.**] [**6 lb/cu. ft.**] nominal density.
3. Glass-Fiber Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.
4. Mineral Wool Board: [**2 inches**] <**Insert dimension**> thick and [**4 lb/cu. ft.**] [**6 lb/cu. ft.**] <**Insert density**> nominal density.
5. Mineral Wool Pipe and Tank: [**2 inches**] <**Insert dimension**> thick.
6. Polyisocyanurate: [**1-1/2 inches**] <**Insert dimension**> thick.

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. None.
2. [**PVC**] [**PVC, Color-Coded by System**]: [**20 mils**] [**30 mils**] thick.
3. Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] [**0.040 inch**] thick.
4. Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] thick.
5. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth No. 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch**] [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] thick.
6. <**Insert jacket type**>.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces of up to 72 Inches:

1. None.
2. [**PVC**] [**PVC, Color-Coded by System**]: [**20 mils**] [**30 mils**] thick.
3. Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] [**0.040 inch**] thick.
4. Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] thick.
5. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth No. 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch**] [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] thick.
6. <**Insert jacket type**>.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. None.
2. [**Painted**]Aluminum, [**Smooth**] [**Stucco Embossed**] with [**1-1/4-Inch-Deep Corrugations**] [**2-1/2-Inch-Deep Corrugations**] [**4-by-1-Inch Box Ribs**]: [**0.032 inch**] [**0.040 inch**] thick.
3. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth**] [**Stucco Embossed**], with [**1-1/4-Inch-Deep Corrugations**] [**2-1/2-Inch-Deep Corrugations**] [**4-by-1-Inch Box Ribs**]: [**0.020 inch**] [**0.024 inch**] thick.
4. <**Insert jacket type**>.

3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. None.
2. [**PVC**] [**PVC, Color-Coded by System**]: [**20 mils**] [**30 mils**] thick.
3. Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] [**0.040 inch**] thick.
4. Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] thick.

5. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth No. 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch**] [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] thick.
6. <**Insert jacket type**>.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces of up to 72 Inches:

1. [**Painted**]Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**] [**with Z-Shaped Locking Seam**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] [**0.040 inch**] thick.
2. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth No. 2B Finish**] [**Corrugated**] [**Stucco Embossed**] [**with Z-Shaped Locking Seam**]: [**0.010 inch**] [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] thick.
3. <**Insert jacket type**>.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. [**Painted**]Aluminum, [**Smooth**] [**Stucco Embossed**] with [**1-1/4-Inch-Deep Corrugations**] [**2-1/2-Inch-Deep Corrugations**] [**4-by-1-Inch Box Ribs**]: [**0.032 inch**] [**0.040 inch**] thick.
2. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth**] [**Stucco Embossed**], with [**1-1/4-Inch-Deep Corrugations**] [**2-1/2-Inch-Deep Corrugations**] [**4-by-1-Inch Box Ribs**]: [**0.020 inch**] [**0.024 inch**] thick.
3. <**Insert jacket type**>.

END OF SECTION 230716

SECTION 230800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes Cx process requirements for the following HVAC systems, assemblies, and equipment:

1. Heating and cooling terminal and unitary equipment.
2. HVAC controls.
3. TAB verification.

B. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
2. For construction checklists, comply with requirements in various Division 23 Sections specifying HVAC systems, system components, equipment, and products.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."

C. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."

D. IgCC: International Green Construction Code.

E. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they mean "as-built" systems, assemblies, subsystems, equipment, and components.

F. TAB: Testing, adjusting, and balancing.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**BAS**] [**and**] [**HVAC**] testing technician.

B. Construction Checklists:

1. Draft Cx plan, including draft construction checklists to be prepared by CxA under Section 019113 "General Commissioning Requirements." Div. 23 Subcontractor is to review Construction Checklist in accordance with requirements in Section 019113 "General Commissioning Requirements" and ASHRAE 202 and to resolve any issues with the CxA.
2. Cx plan, including material, installation, and performance construction checklists for systems, assemblies, subsystems, equipment, and components relating to [**BAS**] [**and**] [**HVAC**] to be part of the Cx process and in accordance with requirements in Section 019113 "General Commissioning Requirements and ASHRAE 202."

C. Test Equipment and Instruments: For all test equipment and instruments to be used in conducting Cx tests by Div. 23 Subcontractor, provide the following:

1. Equipment/instrument identification number.
2. Planned Cx application or use.
3. Manufacturer, make, model, and serial number.
4. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
5. Equipment manufacturers' proprietary instrumentation and tools. For each instrument or tool, identify the following:

    a. Instrument or tool identification number.
    b. Equipment schedule designation of equipment for which the instrument or tool is required.
    c. Manufacturer, make, model, and serial number.
    d. Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

1.5 QUALITY ASSURANCE

A. BAS Testing Technician Qualifications: Technicians performing BAS Construction Checklist verification tests, Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations are to have the following minimum qualifications:

1. Journey level or equivalent skill level with knowledge of BAS, HVAC, electrical concepts, and building operations.
2. Minimum [**three years'**] <**Insert time**> experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. International Society of Automation (ISA)-Certified Control Systems Technician (CCST) Level I.

B. HVAC Testing Technician Qualifications: Technicians to perform HVAC Construction Checklist verification tests, Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level; vocational school four-year-program graduate or an Associate's degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC equipment, assemblies, and systems.
2. Minimum [**three years'**] <**Insert time**> experience that is to include installing, servicing, and operating systems manufactured by approved manufacturer.

C. Testing Equipment and Instrumentation Quality and Calibration:

1. Capable of testing and measuring performance within the specified acceptance criteria.
2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
3. Be maintained in good repair and operating condition throughout duration of use on Project.
4. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

D. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:

   a. Be calibrated by manufacturer with current calibration tags permanently affixed.
   b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.

2. HVAC proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 Cx PROCESS:

A. Perform Cx process in accordance with Section 019113 "General Commissioning Requirements" for [**BAS**] [**and**] [**HVAC**] and in accordance with the following:

1. [**IgCC, which requires compliance with ASHRAE 202**].
2. [**ASHRAE 202**].
3. [**Commissioning standards acceptable to the authority having jurisdiction**].
4. <**Insert standard**>.

3.2 CONSTRUCTION CHECKLISTS

A. Preliminary detailed construction checklists are to be prepared under Section 019113 "General Commissioning Requirements" for each [**BAS**] [**and**] [**HVAC**] system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in [**IgCC and**] ASHRAE 202. Contractor performs the following:

1. Review [**BAS**] [**and**] [**HVAC**] preliminary construction checklists and provide written comments on checklist items where appropriate.
2. Return preliminary Construction Checklist with review comments within [**10**] <**Insert number**> days of receipt.

3. When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."
4. Use only construction checklists marked "Approved for Use, (date)" When performing tests. Mark construction checklists in the appropriate place as indicated Project events are completed, and provide pertinent details and other information.

B. Prepare preliminary detailed construction checklists for each [**BAS**] [**and**] [**HVAC**] system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in [**IgCC and ASHRAE 202**] [**ASHRAE 202**].

1. Submit preliminary construction checklists to CxA and Designer for review.
2. When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."
3. Use only construction checklists, marked "Approved for Use, (date)" when performing tests. Mark construction checklists in the appropriate place, as indicated Project events are completed and provide pertinent details and other information.

C. Systems required to be commissioned under IgCC:

1. Heating, ventilating, air-conditioning, and refrigeration systems (mechanical and/or passive) and associated controls.
2. Air-curtain systems.
3. Water-pumping and -mixing systems over 5 hp and purification systems.
4. Renewable energy systems and energy storage systems.
5. Energy and building management and demand-control systems.

D. Additional systems required to be commissioned:

1. Air duct systems, including the following:

   a. Duct systems.
   b. Air-duct accessories, including volume dampers, fire and smoke dampers, turning vanes, sound attenuators, and flexible connectors.
   c. Duct-mounted access doors and panels.
   d. Hangers and supports.

2. Heating and cooling terminal and unitary equipment, including the following:

   a. Unit ventilators.
   b. Unit heaters.
   c. Fan-coil units.
   d. Finned-tube radiation.
   e. Electric heating.
   f. Unitary heating and cooling equipment.

3. Vibration isolation systems.
4. Controls and instrumentation, including the following:

   a. Energy monitoring and recording system.
   b. Controllers and sensors.
   c. Automatic control valves, dampers, and actuators.
   d. Control interface with fans, pumps, dampers, and other equipment and systems.
   e. Demand-control systems.
   f. <**Insert systems**>.

5. TAB Verification:

    a. Airflow.
    b. Space pressurization.

6. Documentation:

    a. Mechanical systems manuals.
    b. Documentation of required commissioning.

7. Mechanical insulation, including the following:

    a. Duct and plenum insulation.
    b. HVAC piping insulation.

8. <**Insert additional systems**>.

3.3 Cx TESTING PREPARATION

A. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.

B. Certify that HVAC instrumentation and control systems have been completed and calibrated, point-to-point checkout has been successfully completed, and systems are operating in accordance with their design sequence of operation, Contract Documents, and approved submittals. Certify that all sensors are operating within specified accuracy and all systems are set to and maintaining set points as required by the design documents.

C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

3.4 Cx TEST CONDITIONS

A. Perform tests using design conditions, whenever possible.

    1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA, and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
    2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
    3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

B. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to Architect. After deficiencies are resolved, reschedule tests.

C. If seasonal testing is specified, complete appropriate initial performance tests and documentation, and schedule seasonal tests.

3.5 Cx TESTS COMMON TO HVAC SYSTEMS

A. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.

B. Test systems, assemblies, subsystems, equipment, and components for operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response in accordance with acceptance criteria.

C. Coordinate schedule with, and perform Cx activities at the direction of, CxA.

D. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance test requirements specified in Division 23 Sections specifying HVAC systems and equipment.

E. Provide technicians, instrumentation, tools, and equipment to perform and document the following:

1. Cx Construction Checklist verification tests.
2. Cx Construction Checklist verification test demonstrations.

3.6 CONSTRUCTION CHECKLIST EXAMPLES

A. Vibration Isolation in HVAC Systems:

1. Prerequisites: Acceptance of results of construction checklists for vibration[**and seismic**] control devices specified in [**Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment"**] [**Section 230548.13 "Vibration Controls for HVAC Piping and Equipment"**].
2. Components to Be Tested:

   a. Vibration isolation control devices in HVAC systems.
   b. Support systems.

3. Test Purpose: Evaluate effectiveness of vibration isolation control devices.
4. Test Conditions, Constant Speed Equipment: Measure vibration of the facility structure at [**three**] <**Insert number**> locations designated by Owner's witness while the isolated equipment operates.
5. Test Conditions, Variable Speed Equipment: Measure vibration of the facility structure at [**three**] <**Insert number**> locations designated by Owner's witness at the following operating conditions:

   a. Maximum speed.
   b. Minimum speed.

c. Critical speed.

6. Acceptance Criteria: Structure-borne vibration not to exceed specified performance.

3.7 TAB VERIFICATION

A. Prerequisites: Completion of "Examination" Article requirements and correction of deficiencies, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

B. Completion of "Preparation" Article requirements for preparation of a TAB plan that includes strategies and step-by-step procedures, and system-readiness checks and reports, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

C. Scope: HVAC air systems and hydronic piping systems.

D. Purpose: Differential flow relationships intended to maintain air and water pressurization differentials between the various areas of Project.

E. Conditions of the Test:

1. Cx Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
2. Systems operating in full heating mode[**with minimum outside-air volume**].
3. Systems operating in full cooling mode[**with minimum outside-air volume**].
4. For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.

F. Acceptance Criteria:

1. Under all conditions, rechecked measurements comply with "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
2. Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than the tolerances allowed.
3. Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Double-wall rectangular ducts and fittings.
3. Single-wall round ducts and fittings.
4. Double-wall round ducts and fittings.
5. Sheet metal materials.
6. Duct liner.
7. Sealants and gaskets.
8. Hangers and supports.

B. Related Requirements:

1. Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraint devices and installation.
2. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
3. Section 233119 "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
4. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 DEFINITIONS

A. OSHPD: Office of Statewide Health Planning and Development (State of California).

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for HVAC units.>
2. <Double click to insert sustainable design text for adhesives.>
3. <Double click to insert sustainable design text for sealants.>
4. <Double click to insert sustainable design text for laboratory test reports for antimicrobial coatings.>

C. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top [**and bottom**]of ducts.
5. Dimensions of [**main**] [**all**] duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment[**, seismic restraints,**] and vibration isolation.
13. <**Insert lists of areas or systems requiring Shop Drawings**>.

D. Delegated Design Submittals:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations[**, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation**] for selecting hangers and supports[**and seismic restraints**].

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Welding certificates.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with 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 D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.**]

B. Mockups:

1. Before installing duct systems, build mockups representing static-pressure classes in excess of [**3**] <**Insert static-pressure class**> inch wg. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

   a. [**Five**] <**Insert number**> transverse joints.
   b. [**One**] <**Insert number**> access door(s).

c. [**Two**] <**Insert number**> typical branch connections, each with at least one elbow.
d. [**Two**] <**Insert number**> typical flexible duct or flexible-connector connections for each duct and apparatus.
e. [**One**] <**Insert number**> 90-degree turn(s) with turning vanes.
f. [**One**] <**Insert number**> fire damper(s).
g. [**One**] <**Insert number**> smoke damper(s).
h. Perform leakage tests specified in "Field Quality Control" Article. Revise mockup construction and perform additional tests as required to achieve specified minimum acceptable results.

2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports[**and seismic restraints**] are to 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**] <**Insert applicable building code**>. [**Seismically brace duct hangers and supports in accordance with**] [**SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."**] [**SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems - OSHPD Edition."**] <**Insert reference document.**>

1. Seismic Hazard Level (SHL): [**AA**] [**A**] [**B**] [**C**] [**D**].
2. Connection Level: [**1**] [**2**].
3. <**Insert requirement**>.

C. Seismic Performance: Ductwork to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**] <**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. 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. Component Importance Factor: [**1.5**] [**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

D. Wind Performance: Ducts are to withstand the effects of wind determined in accordance with to [**ASCE/SEI 7**] <**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC."

E. Airstream Surfaces: Surfaces in contact with airstream comply with requirements in ASHRAE 62.1.

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

G. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

H. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.
2. For ducts exposed to weather, construct of [**Type 304**] [**Type 316**] stainless steel indicated by manufacturer to be suitable for outdoor installation.

B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
3. [**Where specified for specific applications, all joints are to be welded.**]

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."[**All longitudinal seams are to be Pittsburgh lock seams unless otherwise specified for specific application.**]

1. [**Where specified for specific applications, all joints are to be welded.**]

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.
2. For ducts exposed to weather, construct of [**Type 304**] [**Type 316**] stainless steel indicated by manufacturer to be suitable for outdoor installation.
3. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain single-wall round[**and flat oval**] ducts and fittings from single manufacturer.

C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

D. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than [**60**] <**Insert dimension**> Inches in Diameter: Flanged.

E. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

F. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials are to be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: [**G60**] [**G90**].
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: [**G60**] [**G90**].

2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils thick[**on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil thick on opposite surface**].
3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.

D. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.

E. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish is to be No. 2B, No. 2D, No. 3, or No. 4 as indicated in "Duct Schedule" Article.

F. Aluminum Sheets: Comply with ASTM B209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

G. Factory- or Shop-Applied Antimicrobial Coating:

1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating is to be applied to the exterior surface.
2. Antimicrobial compound is to be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Coating containing the antimicrobial compound is to have a hardness of 2H, minimum, when tested in accordance with ASTM D3363.
4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
5. Shop-Applied Coating Color: [**Black**] [**White**].
6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.

H. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

I. Tie Rods: Galvanized steel, 1/4-inch-minimum diameter for lengths 36 inches or less; 3/8-inch-minimum diameter for lengths longer than 36 inches.

2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets are to be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: [**3 inches**] [**4 inches**] [**6 inches**].
3. Sealant: Modified styrene acrylic.
4. Water resistant.

5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. <Double click to insert sustainable design text for sealant.>
11. <Double click to insert sustainable design text for sealants.>

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. <Double click to insert sustainable design text for sealant.>
9. <Double click to insert sustainable design text for sealants.>
10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. <Double click to insert sustainable design text for sealant.>
7. <Double click to insert sustainable design text for sealants.>

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal is to provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and is to be rated for10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "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: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless Steel Ducts: Stainless steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. 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.

J. Install fire[**, combination fire/smoke,**] and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.

K. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation.[**Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."**]

M. Elbows: Use long-radius elbows wherever they fit.

1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

N. Branch Connections: Use lateral or conical branch connections.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR TYPE 1 COMMERCIAL KITCHEN GREASE HOOD EXHAUST DUCT

A. Install ducts in accordance with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operation"; SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; and SMACNA's "Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines" unless otherwise indicated.

B. Install all ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.

C. All ducts exposed to view are to be constructed of stainless steel as per "Duct Schedule" Article. All ducts concealed from view are to be [**stainless**] [**carbon**] steel as per "Duct Schedule" Article.

D. All joints are to be welded and are to be telescoping, bell, or flange joint as per NFPA 96.

E. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of [**20**] [**12**] <**Insert dimension**> feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings.

F. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.4 ADDITIONAL INSTALLATION REQUIREMENTS FOR EXHAUST DUCTS SERVING COMMERCIAL DISHWASHERS AND OTHER HIGH-HUMIDITY LOCATIONS

A. Install dishwasher exhaust ducts and other exhaust ducts from wet, high-humidity locations without dips and traps that may hold water. Slope ducts a minimum of 2 percent back to dishwasher or toward drain.

B. Provide a drain pocket at each low point and at the base of each riser with a 1-inch trapped copper drain from each drain pocket to open site floor drain.

C. Minimize number of transverse seams.

D. Do not locate longitudinal seams on bottom of duct.

3.5 ADDITIONAL INSTALLATION REQUIREMENTS FOR LABORATORY EXHAUST AND FUME HOOD EXHAUST DUCTS

A. Install ducts in accordance with NFPA 45, "Fire Protection for Laboratories Using Chemicals."

B. Install exhaust ducts without dips and traps that may hold water. Slope ducts a minimum of 2 percent back to hood or inlet. Where indicated on Drawings, install trapped drain piping.

C. Connect duct to fan, fume hood, and other equipment indicated on Drawings.

3.6 DUCTWORK EXPOSED TO WEATHER

A. All external joints are to [**be welded**] [**have secure watertight mechanical connections**]. Seal all openings to provide weatherproof construction.

B. Construct ductwork to resist external loads of wind, snow, ice, and other effects of weather. Provide necessary supporting structures.

C. Single Wall:

1. Ductwork is to be [**Type 304**] [**Type 316**] stainless steel.
2. Ductwork is to be galvanized steel.

   a. If duct outer surface is uninsulated, protect outer surface with suitable paint. Paint materials and application requirements are specified in Section 099113 "Exterior Painting."

3. Where ducts have external insulation, provide weatherproof aluminum jacket. See Section 230713 "Duct Insulation."

D. Double Wall:

1. Ductwork complies with requirements in "Double-Wall Rectangular Ducts and Fittings" or "Double-Wall Round [**and Flat-Oval**]Ducts and Fittings" Article.
2. Ductwork outer wall is to be [**Type 304**] [**Type 316**] stainless steel indicated by manufacturer to be suitable for outdoor installation.
3. Provide interstitial insulation.

3.7 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.8 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints. Coordinate with Section 230548 "Vibration and Seismic Controls for HVAC."

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.9 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. See Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraint installation requirements.

3.10 DUCTWORK CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.11 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

   a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections[**, selected by Architect from sections installed,**] totaling no less than 25 percent of total installed duct area for each designated pressure class.
   b. Supply Ducts with a Pressure Class of [**2-**] [**3-**] [**4-**] <**Insert number**> Inch wg or Higher: Test representative duct sections[**, selected by Architect from sections installed,**] totaling no less than [**50**] [**100**] <**Insert number**> percent of total installed duct area for each designated pressure class.
   c. Return Ducts with a Pressure Class of [**2-**] [**3-**] [**4-**] <**Insert number**> Inch wg or Higher: Test representative duct sections[**, selected by Architect from sections installed,**] totaling no less than [**50**] [**100**] <**Insert number**> percent of total installed duct area for each designated pressure class.
   d. Exhaust Ducts with a Pressure Class of [**2-**] [**3-**] [**4-**] <**Insert number**> Inch wg or Higher: Test representative duct sections[**, selected by Architect from sections installed,**] totaling no less than [**50**] [**100**] <**Insert number**> percent of total installed duct area for each designated pressure class.
   e. Outdoor-Air Ducts with a Pressure Class of [**2-**] [**3-**] [**4-**] <**Insert number**> Inch wg or Higher: Test representative duct sections[**, selected by Architect from sections installed,**] totaling no less than [**50**] [**100**] <**Insert number**> percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
5. Test for leaks before applying external insulation.
6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
7. Give [**seven**] <**Insert number**> days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

   a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media is to not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.13 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. For cleaning of existing ductwork, see Section 230130.52 "Existing HVAC Air Distribution System Cleaning."

C. Use duct cleaning methodology as indicated in NADCA ACR.

D. Use service openings for entry and inspection.

1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

E. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

F. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

G. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.

5. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.14 STARTUP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.15 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.
2. Underground Ducts: Concrete-encased, [**galvanized sheet steel**] [**PVC-coated, galvanized sheet steel with thicker coating on duct exterior**] [**stainless steel**].
3. <**Insert requirements**>.

B. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

   a. Pressure Class: Negative [**1-**] [**2-**] [**3-**] <**Insert number**>inch wg.
   b. Minimum SMACNA Seal Class: [**A**] [**B**] [**C**] if negative pressure, and A if positive pressure.
   c. SMACNA Leakage Class for Rectangular: [**2**] [**4**] [**8**] [**16**].
   d. SMACNA Leakage Class for Round and Flat Oval: [**2**] [**4**] [**8**] [**16**].

2. Ducts Connected to Equipment Not Listed above:

   a. Pressure Class: Positive or negative [**2-**] [**3-**] [**4-**] <**Insert number**>inch wg.
   b. Minimum SMACNA Seal Class: [**A**] [**B**] if negative pressure; A if positive pressure.
   c. SMACNA Leakage Class for Rectangular: [**2**] [**4**] [**8**] [**16**].
   d. SMACNA Leakage Class for Round and Flat Oval: [**2**] [**4**] [**8**] [**16**].

C. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: [**Galvanized steel**] [**Carbon steel coated with zinc-chromate primer**] [**Galvanized steel or carbon steel coated with zinc-chromate primer**].
2. PVC-Coated Ducts:

   a. Exposed to Airstream: Match duct material.
   b. Not Exposed to Airstream: [**Galvanized**] [**Match duct material**].

3. Stainless Steel Ducts:

   a. Exposed to Airstream: Match duct material.

b. Not Exposed to Airstream: [**Galvanized**] [**Match duct material**].

4. Aluminum Ducts: [**Aluminum**] [**or**] [**galvanized steel coated with zinc chromate**].

D. Elbow Configuration:

1. Rectangular Duct - Requirements for Different Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct - Requirements for All Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, [**12**] <**Insert dimension**> Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, [**14**] <**Insert dimension**> Inches and Larger in Diameter: [**Standing seam**] [**Welded**].

E. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Conical spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

   a. Velocity 1000 fpm or Lower: 90-degree tap.
   b. Velocity 1000 to 1500 fpm: Conical tap.
   c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Control dampers.
3. Flange connectors.
4. Turning vanes.
5. Flexible connectors.
6. Duct accessory hardware.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Construction details, material descriptions, and dimensions of individual components.
2. For dampers, include housings, linkages, and operators.
3. For damper operators, include electrical or pneumatic pressure rating and damper size rating.

B. Shop Drawings: For air duct accessories.

1. Plans showing locations, elevations, sections, and attachment details.
2. 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. Control-damper installations.
   d. Diagrams for power, signal, and control wiring.

C. Sustainable Design Submittals:

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, or BIM model, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

B. Source quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories.

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. Fusible Links: Furnish quantity equal to [**10**]<**Insert number**> percent of amount installed.

PART 2 - PRODUCTS

2.1 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**American Warming and Ventilating (AWV); Mestek, Inc.**]
2. [**Cesco Products; MESTEK, Inc.**]
3. [**Greenheck Fan Corporation**]
4. [**Lloyd Industries, Inc.**]
5. [**Nailor Industries Inc**]
6. [**Pottorff**]
7. [**Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.**]
8. [**Safe Air - Dowco**]
9. [**United Enertech Corp.**]
10. [**Vent Products Co., Inc**]
11. <**Insert manufacturer's name**>

B. Performance:

1. Maximum Air Velocity: [**1000 fpm**][**1250 fpm**][**2000 fpm**][**3000 fpm**]<**Insert value**>.
2. Maximum System Pressure:
   [**1 inch wg**][**2 inches wg**][**3 inches wg**][**6 inches wg**]<**Insert value**>.
3. AMCA Certification: Test and rate in accordance with AMCA 511.
4. Leakage:

   a. Class IA: Leakage is not to exceed **3 cfm/sq. ft.** against **1 inch wg** differential static pressure.
   b. Class I: Leakage is not to exceed **4 cfm/sq. ft.** against **1 inch wg**

differential static pressure.
c. Class II: Leakage is not to exceed **10 cfm/sq. ft.** against **1 inch wg** differential static pressure.
d. Class III: Leakage is not to exceed **40 cfm/sq. ft.** against **1 inch wg** differential static pressure.

C. Construction:

1. Frame:

a. Hat shaped.
b. [**16-gauge-thick, galvanized sheet steel**][**10-gauge-thick, galvanized sheet steel**][**0.093-inch-thick extruded aluminum**][**18-gauge-thick stainless steel**]<**Insert value and frame material type**>, with welded or mechanically attached corners[**and mounting flange**].

2. Blades:

a. Multiple single-piece blades.
b. [**Center**][**Off-center**][**End**] pivoted, maximum **6-inch** width, [**16-gauge-thick, galvanized sheet steel**][**0.050-inch-thick aluminum sheet**][**26-gauge Type 304 stainless steel**][**noncombustible, tear-resistant, neoprene-coated fiberglass**]<**Insert value and blade material type**> with sealed edges.

3. Blade Action: Parallel.

D. Blade Seals: [**Felt**][**Vinyl foam**][**Extruded vinyl, mechanically locked**][**Neoprene, mechanically locked**].

E. Blade Axles:

1. Material: [**Nonferrous metal**][**Galvanized steel**][**Plated steel**][**Stainless steel**][**Nonmetallic**][**Aluminum**].
2. Diameter: [**0.20 inch**][**0.50 inch**]<**Insert dimension**>.

F. Tie Bars and Brackets: [**Aluminum**][**Galvanized steel**].

G. Counterbalance: [**Adjustable counterweight**][**Adjustable-tension return spring**][**Motorized actuator**].

H. Bearings: [**Steel ball**][**Brass sleeve**][**or**][**synthetic pivot bushings**].

I. Damper Actuator - Electric:

1. Electric - [**120 V ac**][**24 V ac**].
2. UL 60730-2-14 and UL 2043 plenum rated.
3. Actuator Type: [**Two position**][**Fully modulating**][**with fail-safe spring return**].

a. Sufficient motor torque [**and spring torque**]to drive damper fully closed with adequate force to achieve required damper seal.

b. Minimum 90-degree drive rotation.

4. Clockwise or counterclockwise drive rotation as required for application.
5. Environmental Operating Range:

a. Temperature: **Minus 40 to plus 130 deg F**.
b. Humidity: 5 to 95 percent relative humidity noncondensing.

6. Environmental Enclosure: NEMA 2.
7. Actuator to be factory mounted and provided with a single-point wiring connection.

J. Damper Actuator - Pneumatic:

1. Operated by **0 to 20 psig** pneumatic signal.
2. Actuator Type: [**Two position with**][**Fully modulating with positioner and**] fail-safe spring return.

a. Sufficient power and spring force to drive damper fully closed with adequate force to achieve required damper seal.
b. Maximum 15-second full-stroke closure.

3. Actuator to be factory mounted.

K. Controllers, Electrical Devices, and Wiring:

1. Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
2. Electrical Connection: [**115 V, single phase, 60 Hz**][**24 V, 60 Hz**]<**Insert values**>.

L. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Chain pulls.
4. 90-degree stops.
5. Screen:

a. Mounting:

1) [**Front**][**Rear**] mounted in sleeve.

a) Sleeve Thickness: **20 gauge** minimum.
b) Sleeve Length: **6 inches** minimum.

b. Material: [**Galvanized steel**][**Aluminum**].
c. Type: [**Bird**][**Insect**].

2.2 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CL WARD & Family Inc.**]
2. [**Ductmate Industries, Inc; a DMI company**]
3. [**DynAir; a Carlisle Company**]
4. [**Elgen Manufacturing**]
5. [**Ward Industries; a brand of Hart & Cooley, LLC**]
6. <**Insert manufacturer's name**>

B. Description: [**Add-on**][**or**][**roll-formed**], factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gauge and Shape: Match connecting ductwork.

2.3 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**Aero-Dyne Sound Control Co.**]
2. [**CL WARD & Family Inc.**]
3. [**Ductmate Industries, Inc; a DMI company**]
4. [**Duro Dyne Inc.**]
5. [**DynAir; a Carlisle Company**]
6. [**Elgen Manufacturing**]
7. [**Ward Industries; a brand of Hart & Cooley, LLC**]
8. <**Insert manufacturer's name**>

B. Manufactured Turning Vanes for Metal Ducts: Fabricate curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Turning Vanes: Fabricate [**single**][**double**]-wall curved blades of [**galvanized steel**][**stainless steel**][**aluminum**][**extruded aluminum**].
2. Acoustic Turning Vanes: Fabricate airfoil-shaped [**galvanized steel**][**sheet aluminum**][**extruded aluminum**] 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"; Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

E. Vane Construction:

1. Wall: [**Single**][**Double**].
2. Single wall for ducts up to [**48 inches**]<**Insert dimension**> wide and double wall for larger dimensions.

2.4 DUCT ACCESSORY HARDWARE

A. Manufacturers: Subject to compliance with requirements, [**provide products by the following**][**provide products by one of the following**][**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:

1. [**CL WARD & Family Inc.**]
2. [**Ductmate Industries, Inc; a DMI company**]
3. [**Duro Dyne Inc.**]
4. [**DynAir; a Carlisle Company**]
5. [**Elgen Manufacturing**]
6. [**Hardcast; Carlisle Construction Materials**]
7. [**United Enertech Corp.**]
8. [**Ventfabrics, Inc**]
9. [**Ward Industries; a brand of Hart & Cooley, LLC**]
10. <**Insert manufacturer's name**>

B. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

C. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.5 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: [**G60**][**G90**].
2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a [**No. 2**]<**Insert finish designation**> finish for concealed ducts and <**Insert finish designation**> finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B209/B209M, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with **ASTM B221**, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless steel ducts.

F. Tie Rods: Galvanized steel, [**1/4-inch**]<**Insert dimension**> minimum diameter for lengths **36 inches** or less; [**3/8-inch**]<**Insert dimension**> minimum diameter for lengths longer than **36 inches**.

PART 3 - EXECUTION

3.1 INSTALLATION OF AIR DUCT ACCESSORIES

A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.

C. Install [**backdraft**][**control**] dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having a duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.

G. Connect ducts to duct silencers [**with flexible duct connectors**][**rigidly**].

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream[**and downstream**] from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.

6. 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 are to be pressure-relief access doors and be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum [**50 ft.**]<**Insert value**> spacing.
8. Upstream[**and downstream**] from turning vanes.
9. Upstream or downstream from duct silencers.
10. For grease ducts, install at locations and spacing as required by NFPA 96.
11. Control devices requiring inspection.
12. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Label access doors in accordance with Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of each access door.

K. Install duct test holes where required for testing and balancing purposes.

L. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of **1/4-inch** movement during start and stop of fans.

M. Connect diffusers and light troffer boots to ducts[**directly or**] with maximum [**60-inch**]<**Insert dimension**> lengths of flexible duct clamped or strapped in place.

N. Connect flexible ducts to metal ducts with [**adhesive**][**liquid adhesive plus tape**][**draw bands**][**adhesive plus sheet metal screws**].

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors, and verify that size and location of access doors are adequate to perform required operation.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 233400 - HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fans, tubeaxial.
2. Fans, vaneaxial.
3. Fans, mixed flow.
4. Fans, centrifugal - backward-inclined blades.
5. Fans, centrifugal - forward-curved blades.
6. Fans, centrifugal, inline - square.
7. Fans, centrifugal, inline - tubular.
8. Fans, plenum.
9. Fans, plug.
10. Fans, utility set.
11. Fans, propeller - sidewall mounted.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

   a. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
   b. Rated capacities, furnished specialties, and accessories for each fan.
   c. Fans:

      1) Certified fan performance curves with system operating conditions indicated.
      2) Certified fan sound-power ratings.
      3) Fan construction and accessories.
      4) Motor ratings and electrical characteristics, plus motor and electrical accessories.
      5) Fan speed controllers.

   d. Material thickness and finishes, including color charts.
   e. Dampers, including housings, linkages, and operators.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting vibration isolators [**and seismic restraints**]and for designing vibration isolation bases.

5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittal: For vibration isolation[**, supports,**] [**and seismic restraints**] indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators[**, supports,**] [**, seismic restraints,**] [**and for designing vibration isolation bases**].

D. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for ASHRAE 62.1.>

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans showing fan rooms and fan system layouts, reflected ceiling plans, and other drawings required to illustrate relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

B. Seismic Qualification Data: Certificates, for fans, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline 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 and their installation requirements.

C. Startup service reports.

D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fans and ventilators, include the following:

1. Operation in normal and emergency modes.
2. Operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective coverage for storage and identified with labels describing contents.

1. Belts: [**One**] <**Insert number**> set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation[**, supports,**] [**and seismic restraints**], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

F. Seismic Performance: Fans and ventilators are to withstand the effects of earthquake motions determined in accordance with [**ASCE/SEI 7**] <**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. 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. Component Importance Factor: [**1.5**] [**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

G. Capacities and Characteristics:

1. Fan Type: [**Centrifugal**] [**Square, inline, centrifugal**] [**Tubular, inline, centrifugal**] [**Plenum**] [**Plug**] [**Utility set**].
2. Blade Type: [**Forward curved**] [**Backward inclined, airfoil**] [**Backward inclined, curved**] [**Backward inclined, flat**].
3. Airflow: <**Insert cfm**>.
4. Total Static Pressure: <**Insert inches wg**>.
5. Class: AMCA 99, Section 14, [**Class I**] [**Class II**] [**Class III**].
6. Drive Arrangement: <**Insert AMCA arrangement number**>.
7. Drive Type: [**Belt**] [**Direct**].
8. Discharge Arrangement: <**Insert discharge arrangement configuration**>.
9. Housing Material: [**Reinforced steel**] [**Shaped fiberglass-reinforced plastic**] [**Aluminum**] [**Stainless steel**].
10. Housing Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] <**Insert manufacturer's name and trade name**>.
11. Wheel Size (Diameter): <**Insert inches**>.
12. Fan Diameter: <**Insert inches**>.
13. Wheel Material: [**Steel**] [**Aluminum**] [**One-piece fiberglass-reinforced plastic**] [**Stainless steel**].

14. Wheel Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**]; <**Insert manufacturer's name and trade name**>.
15. Brake Horsepower: <**Insert number**>.
16. Fan rpm: <**Insert value**>.
17. Outlet Velocity: <**Insert fpm**>.
18. Motor:

    a. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Totally enclosed, air over**] [**Explosion proof**] <**Insert motor enclosure type**>.
    b. Enclosure Materials: [**Cast iron**] [**Cast aluminum**] [**Rolled steel**].
    c. Motor Bearings: <**Insert requirements**>.
    d. Efficiency: Premium efficiency.
    e. NEMA Design: <**Insert designation**>.
    f. Service Factor: [**1.15**] <**Insert number**>.
    g. Suitable for Use with Variable-Frequency Drive: [**Yes**] [**No**].
    h. Electrical Characteristics:

        1) Motor Size: <**Insert horsepower**>.
        2) Motor Rpm: <**Insert number**>.
        3) Volts: [**120**] [**208**] [**230**] [**460**] <**Insert number**> V.
        4) Phase: [**Single**] [**Three**].
        5) Hertz: 60 Hz.
        6) Full-Load Amperes: <**Insert number**> A.
        7) Minimum Circuit Ampacity: <**Insert number**> A.
        8) Maximum Overcurrent Protection: <**Insert number**> A.

19. Discharge Sound Power:

    a. 1st Octave: <**Insert dB**>.
    b. 2nd Octave: <**Insert dB**>.
    c. 3rd Octave: <**Insert dB**>.
    d. 4th Octave: <**Insert dB**>.
    e. 5th Octave: <**Insert dB**>.
    f. 6th Octave: <**Insert dB**>.
    g. 7th Octave: <**Insert dB**>.
    h. 8th Octave: <**Insert dB**>.

20. Inlet Sound Power:

    a. 1st Octave: <**Insert dB**>.
    b. 2nd Octave: <**Insert dB**>.
    c. 3rd Octave: <**Insert dB**>.
    d. 4th Octave: <**Insert dB**>.
    e. 5th Octave: <**Insert dB**>.
    f. 6th Octave: <**Insert dB**>.
    g. 7th Octave: <**Insert dB**>.
    h. 8th Octave: <**Insert dB**>.

21. Vibration Isolators: [**Spring**] [**Restrained spring**] <**Insert type**> isolators with a static deflection of [**1 inch**] <**Insert deflection**>.
22. Spark-Resistance Class: Classified in accordance with AMCA 99, Section 8, [**Type A**] [**Type B**] [**Type C**].

H. Service Conditions:

1. Ambient Temperature: <**Insert number**> deg F.
2. Altitude: <**Insert number**> feet above sea level.
3. Humidity: <**Insert number**> deg F wet bulb.

2.2 FANS, TUBEAXIAL

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain tubeaxial fans from single manufacturer.

C. Standards: Comply with UL 705.

D. Description: Fan wheel and housing, factory-mounted motor with [**belt**] [**or**] [**direct**] drive, an inlet cone section, and accessories.

E. Housings: [**Steel**] [**Galvanized steel**] [**Aluminum**] [**Fiberglass-reinforced plastic**] [**Stainless steel**] with flanged inlet and outlet connections.

F. Wheel Assemblies: [**Cast or extruded aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key**] [**Fiberglass-reinforced plastic cured under pressure with airfoil-shaped blades keyed to stainless steel shaft**] [**Cast aluminum; machined and fitted to shaft**].

G. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: [**1.2**] [**1.3**] [**1.4**] [**1.5**].
3. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
4. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
6. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
7. Belt Guards: Fabricate of prime-coated steel to comply with OSHA and SMACNA requirements for motors with exposed drive belt. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
8. Motor Base: Adjustable rail mount motor base with adjustment screw to set belt tension.
9. Shaft Bearings: Radial, self-aligning bearings.

    a. Ball-Bearing Rating Life: ABMA 9, [**L10 of 50,000 hours**] <**Insert life**>.
    b. Roller-Bearing Rating Life: ABMA 11, [**L10 of 50,000 hours**] <**Insert life**>.
    c. Extend lubrication lines to outside of casing and terminate with grease fittings.

H. Accessories:

1. Companion Flanges: Rolled flanges of same material as housing.
2. Inspection Door: Bolted door allowing limited access to internal parts of fan, of same material as housing.
3. Propeller Access Section Door: Short duct section bolted to fan [**inlet**] [**and**] [**outlet**] allowing access to internal parts of fan for inspection and cleaning, of same material as housing.

4. Swingout Construction: Assembly allowing entire fan section to swing out from duct for cleaning and servicing, of same material as housing.
5. Mounting Clips: [**Horizontal ceiling**] [**Vertical mounting**] clips welded to fan housing, of same material as housing.
6. Horizontal Support: Pair of supports bolted to fan housing, of same material as housing.
7. Vertical Support: Short duct section with welded brackets bolted to fan housing, of same material as housing.
8. Inlet Screen: On unducted fan inlet - wire-mesh screen, of same material as housing.
9. Outlet Screen: On unducted fan outlet - wire-mesh screen, of same material as housing.
10. Backdraft Dampers: Butterfly style, for bolting to fan discharge or outlet cone, of same material as housing.
11. Shaft Seal: Elastomeric seal and PTFE wear plate, suitable for up to 300 deg F.
12. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
13. Inlet Vanes: Adjustable; with peripheral control linkage operated from outside of airstream, bronze sleeve bearings on each end of vane support, and provision for manual or automatic operation, of same material as housing.
14. Inlet Bell: Curved inlet for when fan is not attached to duct[**, of same material as housing**] [**; aluminum**].
15. Inlet Cone: Round-to-round transition, of same material as housing.
16. Outlet Cone: Round-to-round transition, of same material as housing.
17. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.
18. Direct-Driven Units: Encase motor in housing outside of airstream. Extend lubrication lines to outside of casing and terminate with grease fittings.
19. [**Factory-wired motor disconnect switch located on outside of fan housing.**]

I. Factory Finishes:

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.
3. Coatings: [**Epoxy**] [**Zinc**] [**Phenolic**] [**Powder-baked enamel**]; <**Insert manufacturer's name and trade name**>.

   a. Apply to finished housings.
   b. Apply to fan wheels.

2.3 FANS, VANEAXIAL

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain vaneaxial fans from single manufacturer.

C. Standards: Comply with UL 705.

D. Description: Fan wheel and housing, straightening vane section, factory-mounted motor with belt or direct drive, an inlet cone section, and accessories.

1. Variable-Pitch Fans: Internally mounted [**electric**] [**electronic**] actuator, externally mounted positive positioner, and mechanical-blade-pitch indicator.

E. Housings: [**Steel**] [**Aluminum**] [**Fiberglass-reinforced plastic**] [**Stainless steel**] <**Insert material**>.

1. Inlet and Outlet Connections: Flanges.
2. Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.

F. Wheel Assemblies: [**Cast aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key**] [**Fiberglass-reinforced plastic cured under pressure with airfoil-shaped blades keyed to stainless steel shaft**] [**Cast-aluminum hub assembly, machined and fitted with threaded bearing wells to receive blade-bearing assemblies with replaceable, cast-aluminum blades; factory mounted and balanced**].

G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: [**1.2**] [**1.3**] [**1.4**] [**1.5**].
2. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
3. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate of prime-coated steel to comply with OSHA and SMACNA requirements for motors with exposed drive belt. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Base: Adjustable rail mount motor base with adjustment screw to set belt tension.
8. Shaft Bearings: Radial, self-aligning bearings.

    a. Ball-Bearing Rating Life: ABMA 9, [**L10 of 100,000 hours**] <**Insert life**>.
    b. Roller-Bearing Rating Life: ABMA 11, [**L10 of 100,000 hours**] <**Insert life**>.
    c. Extend lubrication lines to outside of casing and terminate with grease fittings.

H. Accessories:

1. Companion Flanges: Rolled flanges of same material as housing.
2. Inspection Door: Bolted door allowing limited access to internal parts of fan, of same material as housing.
3. Propeller Access Section Door: Short duct section bolted to fan [**inlet**] [**and**] [**outlet**] allowing access to internal parts of fan for inspection and cleaning, of same material as housing.
4. Swingout Construction: Assembly allowing entire fan section to swing out from duct for cleaning and servicing, of same material as housing.
5. Mounting Clips: [**Horizontal ceiling**] [**Vertical mounting**] clips welded to fan housing, of same material as housing.
6. Horizontal Support: Pair of supports bolted to fan housing, of same material as housing.
7. Vertical Support: Short duct section with welded brackets bolted to fan housing, of same material as housing.
8. Inlet Screen: On unducted fan inlet - wire-mesh screen, of same material as housing.
9. Outlet Screen: On unducted fan outlet - wire-mesh screen, of same material as housing.
10. Backdraft Dampers: Butterfly style, for mounting with flexible connection to fan discharge or direct mounted to discharge diffuser section, of same material as housing.
11. Stall Alarm Probe: Sensing probe capable of detecting fan operation in stall and signaling control devices. Control devices and sequence of operation are specified in Section 230923.23 "Pressure Instruments" and Section 230993.11 "Sequence of Operations for HVAC DDC."
12. Flow Measurement Port: Pressure measurement taps installed in fan inlet to detect and signal airflow readings to temperature-control systems. Control devices and sequence of

operation are specified in Section 230923.14 "Flow Instruments" and Section 230993.11 "Sequence of Operations for HVAC DDC."

13. Shaft Seal: Elastomeric seal and PTFE wear plate, suitable for up to 300 deg F.
14. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
15. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
16. Inlet Cone: Round-to-round transition, of same material as housing.
17. Outlet Cone: Round-to-round transition, of same material as housing.
18. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.
19. Direct-Driven Units: Encase motor in housing outside of airstream. Extend lubrication lines to outside of casing and terminate with grease fittings.
20. [**Factory-wired motor disconnect switch located on outside of fan housing.**]

I. Factory Finishes:

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.
3. Coatings: [**Epoxy**] [**Zinc**] [**Phenolic**] [**Powder-baked enamel**]; <**Insert manufacturer's name and trade name**>.

   a. Apply to finished housings.
   b. Apply to fan wheels.

2.4 FANS, MIXED FLOW

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain mixed-flow fans from single manufacturer.

C. Standards: Comply with UL 705.

D. Description: Fan wheel and housing,[**straightening vane section,**] factory-mounted motor with [**belt drive**] [**or**] [**direct drive**], and accessories.

E. Housings: [**Steel**] [**Galvanized steel**] [**Aluminum**].

1. Inlet and Outlet Connections: Outer mounting frame and companion flanges.
2. Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.
3. Mixed-Flow Outlet Connection: [**One**] [**Two**] flanged discharge(s) perpendicular to fan inlet.

F. Wheel Assemblies: Cast aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key.

G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: [**1.2**] [**1.3**] [**1.4**] [**1.5**].
2. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
3. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.

4. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Motor Base: Adjustable rail mount motor base with adjustment screw to set belt tension.
7. Shaft Bearings: Radial, self-aligning bearings.

    a. Ball-Bearing Rating Life: ABMA 9, [**L10 of 100,000 hours**] <**Insert life**>.
    b. Roller-Bearing Rating Life: ABMA 11, [**L10 of 100,000 hours**] <**Insert life**>.
    c. Extend lubrication lines to outside of casing and terminate with grease fittings.

H. Accessories:

1. Mounting Clips: [**Horizontal ceiling**] [**Vertical mounting**] clips welded to fan housing, of same material as housing.
2. Inlet and Outlet Screens: On unducted fan inlet and outlet - wire-mesh screen, of same material as housing.
3. Backdraft Dampers: Butterfly style, for mounting with flexible connection to fan discharge or direct mounted to discharge diffuser section, of same material as housing.
4. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
5. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
6. Inlet Cones: Round-to-round transition, of same material as housing.
7. Outlet Cones: Round-to-round transition, of same material as housing.
8. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.
9. Belt Guard: Fabricate of prime-coated steel to comply with OSHA and SMACNA requirements for motors with exposed drive belt. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
10. Direct-Driven Units: Encase motor in housing outside of airstream.
11. [**Factory-wired motor disconnect switch located on outside of fan housing.**]

I. Factory Finishes:

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.
3. Coatings: [**Epoxy**] [**Zinc**] [**Phenolic**] [**Powder-baked enamel**]; <**Insert manufacturer's name and trade name**>.

    a. Apply to finished housings.
    b. Apply to fan wheels.

2.5 FANS, CENTRIFUGAL - BACKWARD-INCLINED BLADES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain backward-inclined centrifugal fans from single manufacturer.

C. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, [**belt-**][**direct-**]driven centrifugal fans, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.

2. Factory-installed and -wired disconnect switch.

D. Standards: Comply with UL 705.

E. Housings:

1. Housing Material: [**Reinforced steel**] [**Shaped fiberglass-reinforced plastic**] [**Aluminum**] [**Stainless steel**] [**See schedule**] <**Insert material**>.
2. Housing Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.
3. Housing Assembly: Sideplates[**continuously welded**][**or**][**spot welded**][**or**][**attached by continuous Pittsburgh lock seal or similar seal**].
4. Formed panels to make curved-scroll housings with shaped cutoff.
5. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
6. Horizontally split, bolted-flange housing.
7. Spun inlet cone with flange.
8. Outlet flange.
9. Discharge Arrangement: Fan scroll housing is field rotatable to any of [**seven**] [**eight**] discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

F. Wheels:

1. Wheel Configuration: [**SWSI**] [**DWDI**] construction with a precision-spun curved inlet flange and a backplate fastened to shaft with setscrews. Wheels are to be statically and dynamically balanced, and nonoverloading.
2. Wheel and Blade Material: [**Steel**] [**Aluminum**] [**One-piece fiberglass-reinforced plastic**] [**Stainless steel**] [**See schedule**].
3. Spark-Resistant Construction: Classified in accordance with AMCA 99, Section 8, [**Type A**] [**Type B**] [**Type C**].
4. Wheel and Blade Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.
5. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
6. Backward-Inclined Airfoil Blades:

   a. Aerodynamic design.
   b. Heavy backplate.
   c. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

7. Backward-Inclined Curved Blades:

   a. Curved design.
   b. Heavy backplate.
   c. Single-thickness blades continuously welded at tip flange and backplate.

G. Shafts:

1. Statically and dynamically balanced, and selected for continuous operation at maximum-rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.

3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

H. Bearings:

1. Prelubricated and Sealed Shaft Bearings:

   a. Self-aligning, pillow-block-type ball bearings.
   b. Ball-Bearing Rating Life: ABMA 9, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.
   c. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.

2. Grease-Lubricated Shaft Bearings, Tapered Roller:

   a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
   b. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.
   c. Extended Lubrication Lines: Extend lines to accessible location.

3. Grease-Lubricated Shaft Bearings, Ball or Roller:

   a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
   b. Ball-Bearing Rating Life: ABMA 9, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.
   c. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.
   d. Extended Lubrication Lines: Extend lines to accessible location.

I. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: [**1.5**] [**1.4**] [**1.3**] [**1.2**].
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch pulleys for use with motors larger than [**5**] <**Insert number**> hp.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; [**0.146-inch-**] <**Insert dimension**> thick, [**3/4-inch**] <**Insert dimension**> diamond-mesh wire screen, welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

J. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Explosion proof**] [**Totally enclosed, air over**] <**Insert motor enclosure type**>.

K. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Discharge Dampers: Assembly with [**parallel**] [**opposed**] blades constructed of two plates formed around, and to, shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
5. Inlet Screens: Grid screen of same material as housing.
6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
8. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
9. Piezometer Ring: Piezometer ring mounted at fan inlet cone for airflow measurement.

2.6 FANS, CENTRIFUGAL - FORWARD-CURVED BLADES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain forward-curved blade centrifugal fans from single manufacturer.

C. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, [**belt-**] [**direct-**]driven centrifugal fans, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

D. Standards: Comply with UL 705.

E. Housings:

1. Housing Material: [**Reinforced steel**] [**Shaped fiberglass-reinforced plastic**] [**Aluminum**] [**Stainless steel**] [**See schedule**].
2. Housing Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.
3. Housing Assembly: Sideplates [**continuously welded**][**or**][**spot welded**][**or**][**attached by continuous Pittsburgh lock seal or similar seal**].
4. Formed panels to make curved-scroll housings with shaped cutoff.
5. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
6. Horizontally split, bolted-flange housing.
7. Spun inlet cone with flange.
8. Outlet flange.
9. Discharge Arrangement: Fan scroll housing field rotatable to any of [**seven**] [**eight**] discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

F. Wheels:

1. Wheel Configuration: [**SWSI**] [**DWDI**] construction with a curved inlet flange and a backplate fastened to shaft with setscrews.

2. Wheel and Blade Material: [**Steel**] [**Aluminum**] [**One-piece fiberglass-reinforced plastic**] [**Stainless steel**] [**See schedule**].

    a. Spark-Resistant Construction: Classified in accordance with AMCA 99, Section 8, [**Type A**] [**Type B**] [**Type C**].

3. Wheel and Blade Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.
4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with setscrews.
5. Forward-Curved Wheels:

    a. Black-enameled or galvanized-steel construction with inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow.
    b. Mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with setscrews.

G. Shafts:

1. Statically and dynamically balanced and selected for continuous operation at maximum-rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

H. Bearings:

1. Prelubricated and Sealed Shaft Bearings:

    a. Self-aligning, pillow-block-type [**ball**] [**roller**] bearings.
    b. Ball-Bearing Rating Life: ABMA 9, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.
    c. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.

2. Grease-Lubricated Shaft Bearings, Tapered Roller:

    a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
    b. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.
    c. Extended Lubrication Lines: Extend lines to accessible location.

3. Grease-Lubricated Shaft Bearings, Ball or Roller:

    a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
    b. Ball-Bearing Rating Life: ABMA 9, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.
    c. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.
    d. Extended Lubrication Lines: Extend lines to accessible location.

I. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: [**1.5**] [**1.4**] [**1.3**] [**1.2**].
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than [**5**] <**Insert number**> hp.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; [**0.146-inch-**] <**Insert dimension**> thick, [**3/4-inch**] <**Insert dimension**> diamond-mesh wire screen, welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

J. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Totally enclosed, air over**] [**Explosion proof**].

K. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Discharge Dampers: Assembly with [**parallel**] [**opposed**] blades constructed of two plates formed around, and to, shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
5. Inlet Screens: Grid screen of same material as housing.
6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
8. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
9. Piezometer Ring: Piezometer ring mounted at fan inlet cone for airflow measurement.

2.7 FANS, CENTRIFUGAL, INLINE - SQUARE

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain square inline centrifugal fans from single manufacturer.

C. Description: Square-housing in-line centrifugal fans.

D. Standards: Comply with UL 705.

E. Housing:

1. Housing Material: [**Reinforced steel**] [**Aluminum**] [**Stainless steel**] [**See schedule**] <**Insert material**>.

2. Housing Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.
3. Housing Construction: Side panels are to be easily removable for service. Include inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

F. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing[**; with wheel, inlet cone, and motor on swing-out service door**].

G. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosures around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

H. Fan Wheels: Aluminum airfoil blades welded to aluminum hub.

I. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Totally enclosed, air over**] [**Explosion-proof**] <**Insert motor enclosure type**>.

J. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
3. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
4. Companion Flanges: For inlet and outlet duct connections.
5. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
6. Motor: Epoxy-coated steel.
7. Belt Guards: Fabricate of prime-coated steel to comply with OSHA and SMACNA requirements for motors with exposed drive belt. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
8. Side Discharge: Flange connector and attachment hardware to provide right-angle discharge on side of unit.

2.8 FANS, CENTRIFUGAL, INLINE - TUBULAR

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain tubular in-line centrifugal fans from single manufacturer.

C. Description: Tubular-housing in-line centrifugal fans.

D. Housing:

1. Housing Material: [**Reinforced steel**] [**Shaped fiberglass-reinforced plastic**] [**Aluminum**] [**Stainless steel**] [**See schedule**] <**Insert material**>.
2. Housing Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.
3. Housing Construction: Split, [**spun aluminum**]with [**aluminum**]straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

E. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing[**; with wheel, inlet cone, and motor on swing-out service door**].

F. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

G. Fan Wheels: [**Steel**] [**Aluminum**], airfoil blades welded to aluminum hub.

H. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Totally enclosed, air over**] [**Explosion proof**] <**Insert motor enclosure type**>.

I. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
3. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
4. Companion Flanges: For inlet and outlet duct connections.
5. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
6. Motor Cover: Epoxy-coated steel.
7. Belt Guard: Fabricate of prime-coated steel to comply with OSHA and SMACNA requirements for motors with exposed drive belt. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

2.9 FANS, PLENUM

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain plenum fans from single manufacturer.

C. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, [**belt-**] [**direct-**]driven centrifugal fans, consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. [**Factory-installed and -wired disconnect switch.**]

D. Standards: Comply with UL 705.

E. Wheels:

1. Wheel Configuration: SWSI construction with curved inlet flange and heavy backplate; fastened to shaft with setscrews.
2. Wheel and Blade Material: [**Steel**] [**Aluminum**] [**One-piece fiberglass-reinforced plastic**] [**Stainless steel**] [**See schedule**].

a. Spark-Resistant Construction: Classified in accordance with AMCA 99, Section 8, [**Type A**] [**Type B**] [**Type C**].

3. Wheel and Blade Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.
4. Backward-Inclined Airfoil Blades: Hollow, die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

F. Shafts:

1. Statically and dynamically balanced, and selected for continuous operation at maximum-rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

G. Bearings:

1. Prelubricated and Sealed Shaft Bearings:

   a. Self-aligning, pillow-block-type ball bearings.
   b. Ball-Bearing Rating Life: ABMA 9, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.
   c. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.

2. Grease-Lubricated Shaft Bearings, Tapered Roller:

   a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
   b. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.
   c. Extended Lubrication Lines: Extend lines to accessible location.

3. Grease-Lubricated Shaft Bearings, Ball or Roller:

   a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
   b. Ball-Bearing Rating Life: ABMA 9, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.
   c. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.
   d. Extended Lubrication Lines: Extend lines to accessible location.

H. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: [**1.5**] [**1.4**] [**1.3**] [**1.2**].
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than [**5**] <**Insert number**> hp.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; [**0.146-inch-**] <**Insert dimension**> thick, [**3/4-inch**]

diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

7. Motor Mount: Adjustable for belt tensioning.

I. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Totally enclosed, air over**] [**Explosion proof**].

J. Accessories:

1. Inlet Safety Screen: Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
2. Safety Enclosure: Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
3. Belt Guard: Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
4. Inlet Companion Flange: Rolled flanges for duct connections of same material as housing.
5. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
6. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
7. Piezometer Ring: Piezometer ring mounted at fan inlet cone for airflow measurement.

2.10 FANS, PLUG

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain plug fans from single manufacturer.

C. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans, consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

D. Standards: Comply with UL 705.

E. Wheels:

1. Wheel Configuration: SWSI construction with curved inlet flange and heavy backplate; fastened to shaft with setscrews.
2. Wheel and Blade Material: [**Steel**] [**Aluminum**] [**One-piece fiberglass-reinforced plastic**] [**Stainless steel**] [**See schedule**].

   a. Spark-Resistant Construction: Classified in accordance with AMCA 99, Section 8 [**Type A**] [**Type B**] [**Type C**].

3. Wheel and Blade Coating: [**None**] [**Themoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.
4. Backward-Inclined Airfoil Blades: Hollow, die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

F. Shafts:

1. Statically and dynamically balanced, and selected for continuous operation at maximum-rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

G. Bearings:

1. Prelubricated and Sealed Shaft Bearings:

   a. Self-aligning, pillow-block-type ball bearings.
   b. Ball-Bearing Rating Life: ABMA 9, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.
   c. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.

2. Grease-Lubricated Shaft Bearings, Tapered Roller:

   a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
   b. Ball-Bearing Rating Life: ABMA 9, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.
   c. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.
   d. Extended Lubrication Lines: Extend lines to accessible location.

3. Grease-Lubricated Shaft Bearings, Ball or Roller:

   a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
   b. Ball-Bearing Rating Life: ABMA 9, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.
   c. Roller-Bearing Rating Life: ABMA 11, L10 at [**50,000**] [**120,000**] <**Insert number**> hours.
   d. Extended Lubrication Lines: Extend lines to accessible location.

H. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: [**1.5**] [**1.4**] [**1.3**] [**1.2**].
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with larger motors.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

6. Belt Guards: Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; [**0.146-inch-**] <**Insert dimension**> thick, [**3/4-inch**] <**Insert dimension**> diamond-mesh wire screen, welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

I. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Totally enclosed, air over**] [**Explosion proof**].

J. Accessories:

1. Inlet Safety Screen: Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
2. Safety Enclosure: Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
3. Belt Guard: Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
4. Inlet Companion Flange: Rolled flanges for duct connections of same material as housing.
5. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
6. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

2.11 FANS, UTILITY SET

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain fan utility sets from single manufacturers.

C. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, [**belt-**] [**direct-**]driven centrifugal fan utility vent sets, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.

D. Standards: Comply with UL 705.

E. Housings:

1. Housing Material: [**Reinforced steel**] [**Shaped fiberglass-reinforced plastic**] [**Aluminum**] [**Stainless steel**] [**See schedule**] <**Insert material**>.
2. Housing Coating: [**None**] [**Themoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.
3. Formed panels to make curved-scroll housings with shaped cutoff.
4. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.

5. Discharge Arrangement: Fan scroll housing field rotatable to any of [**seven**] [**eight**] discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

F. Wheels:

1. Wheel Configuration: SWSI, with hub keyed to shaft.
2. Wheel and Blade Materials: [**Steel**] [**Aluminum**] [**One-piece fiberglass-reinforced plastic**] [**Stainless steel**] [**See schedule**].

   a. Spark-Resistant Construction: Classified in accordance with AMCA 99, Section 8 [**Type A**] [**Type B**] [**Type C**].

3. Wheel and Blade Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.
4. Backward-Inclined Airfoil Blades:

   a. Aerodynamic design.
   b. Heavy backplate.
   c. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

5. Backward-Inclined Curved Blades:

   a. Curved design.
   b. Heavy backplate.
   c. Single-thickness blades continuously welded at tip flange and backplate.

6. Backward-Inclined Flat Blades:

   a. Flat design.
   b. Heavy backplate.
   c. Single-thickness blades continuously welded at tip flange and backplate.

7. Forward-Curved Blades:

   a. Curved design.
   b. Heavy backplate.
   c. Single-thickness blades continuously welded or riveted at tip flange and backplate.

G. Shafts:

1. Turned, ground, and polished steel; keyed to wheel hub. First critical speed at least 1.4 times maximum class speed.

H. Bearings:

1. Heavy-duty regreasable ball or roller type in a cast-iron pillowblock housing.
2. Ball-Bearing Rating Life: ABMA 9, [**L50 of 200,000 hours**] [**L10 of 80,000 hours**] <**Insert life**>.
3. Roller-Bearing Rating Life: ABMA 11, [**L50 of 200,000 hours**] [**L10 of 80,000 hours**] <**Insert life**>.
4. Extend grease fitting to accessible location outside of unit.

I. Belt Drive:

1. Factory mounted, with final alignment and belt adjustment made after installation.
2. Service Factor Based on Fan Motor Size: [**1.5**] [**1.4**] [**1.3**] [**1.2**].
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert value**> hp; fixed pitch for use with motors larger than [**5**] <**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," [**0.146-inch-**] <**Insert dimension**> thick, [**3/4-inch**] <**Insert dimension**> diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

J. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Explosion proof**] <**Insert motor enclosure type**>.

K. Accessories:

1. Inlet and Outlet: Flanged.
2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
3. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades, with felt edges in steel frame installed on fan discharge.
4. Access Door: Gasketed door in scroll with latch-type handles.
5. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.
6. Inlet Screens: Removable wire mesh.
7. Outlet Screens: Removable wire mesh.
8. Belt Guard: OSHA-compliant, fabricated in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Diamond mesh wire screen welded to steel angle frame or equivalent, prime coated.
9. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
10. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
11. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.
12. Discharge Dampers: Assembly with [**parallel**] [**opposed**] blades constructed of two plates formed around, and to, shaft, channel frame, and sealed ball bearings, with blades linked outside of airstream to single control lever of same material as housing.
13. Grease Collection Trough and Receiver: For restaurant exhaust application.
14. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

2.12 FANS, PROPELLER - SIDEWALL MOUNTED

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain sidewall-mounted propeller fans from single manufacturer.

C. Standards: Comply with UL 705.

D. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring, with baked-enamel finish coat applied after assembly.

E. Fan Wheels: Formed-steel blades riveted to heavy-gauge steel spider bolted to cast-iron hub.

F. Fan Wheel: Replaceable, [**cast**] [**extruded**]-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

G. Fan Drive, Direct: Direct-drive motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

H. Fan Drive, Belt:

1. Belt drive.
2. Resiliently mounted to housing.
3. Statically and dynamically balanced.
4. Selected for continuous operation at maximum-rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
5. Extend grease fitting to accessible location outside of unit.
6. Service Factor Based on Fan Motor Size: 1.4.
7. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
8. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

    a. Ball-Bearing Rating Life: ABMA 9, [**L10 of 100,000 hours**] <**Insert life**>.

9. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
10. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**insert value**> hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
11. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

I. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
2. Dampers: Counterbalanced, parallel-blade, backdraft dampers factory set to close when fan stops.
3. Motorized Dampers: Parallel-blade dampers with electric actuator wired to close when fan stops.
4. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
5. Wall Sleeve: Galvanized steel to match fan and accessory size.
6. Weathershield Hood: Galvanized steel to match fan and accessory size.
7. Weathershield Front Guard: Galvanized steel with expanded metal screen.
8. Belt Guard: For motor mounted on outside of fan cabinet. Comply with OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; [**0.146-inch-**] <**Insert dimension**> thick, [**3/4-inch**] <**Insert dimension**> diamond-mesh wire screen, welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

2.13 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

B. Where variable-frequency drives are indicated or scheduled, provide fan motor compatible with variable-frequency drive.

2.14 SOURCE QUALITY CONTROL

A. [**AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.**]

B. [**AMCA Certification for Fan Aerodynamic Performance Ratings: Test, rate, and label in accordance with AMCA 211.**]

C. [**AMCA Certification for Fan Energy Index (FEI): Test, rate, and label in accordance with AMCA 211.**]

D. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, in accordance with manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:

1. Install floor-mounted fans on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Install roof-mounted fans on roof curbs or support steel. See Drawings for specific requirements.
3. Unit Support: Install fans level on structural curbs. Coordinate with duct connections. [**Coordinate wall penetrations and flashing with wall construction.**] [**Secure units to structural support with anchor bolts.**]
4. Support duct-mounted and other hanging fans directly from the building structure, using suitable hanging systems as specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
5. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
6. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Curb Support, Prefabricated: Rail-type wood support provided by fan manufacturer.

F. Unit Support: Install centrifugal fans level on structural [**curbs**] [**pilings**]. Coordinate with duct connections. [**Coordinate wall penetrations and flashing with wall construction.**] [**Secure units to structural support with anchor bolts.**]

G. Isolation Curb Support: Install centrifugal fans on isolation curbs, and install flexible duct connectors and vibration-isolation[**and seismic-control**] devices.

1. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements in Section 230548.13 "Vibration Controls for HVAC."

H. Install units with adequate clearances for service and maintenance.

I. Label fans in accordance with requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Where installing ducts adjacent to fans, allow space for service and maintenance.

3.3 PIPING CONNECTIONS

A. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

B. Install heat tracing on all drain piping subject to freezing temperature and as indicated on Drawings. Furnish and install heat tracing in accordance with Section 230533 "Heat Tracing for HVAC Piping."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.6 STARTUP SERVICE:

A. [**Engage a factory-authorized service representative to perform**] [**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
6. For belt-drive fans, disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
7. Adjust belt tension.
8. Adjust damper linkages for proper damper operation.
9. Verify lubrication for bearings and other moving parts.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
12. Shut unit down and reconnect automatic temperature-control operators.
13. Remove and replace malfunctioning units and retest as specified above.

3.7 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.8 CLEANING

A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner**] [**Contractor**] will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties.
3. Fans and components will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**] [**Train**] Owner's maintenance personnel to adjust, operate, and maintain HVAC fans.

END OF SECTION 233400

SECTION 233413 - AXIAL HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Tubeaxial fans.
2. Vaneaxial fans.
3. Mixed-flow fans.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
2. Include rated capacities, furnished specialties, and accessories for each fan.
3. Fans:

a. Certified fan performance curves with system operating conditions indicated.
b. Certified fan sound-power ratings.
c. Fan construction and accessories.
d. Motor ratings and electrical characteristics, plus motor and electrical accessories.
e. Fan speed controllers.

4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for ASHRAE 62.1.>

C. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

D. Delegated Design Submittal: For vibration isolation[**, supports,**] [**and seismic restraints**] indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators[**, supports,**] [**, seismic restraints,**] [**and for designing vibration isolation bases**].

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

B. Seismic Qualification Data: Certificates, for fans, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline 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 and their installation requirements.

C. Startup service reports.

D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fans, include the following:

1. Operation in normal and emergency modes.
2. Operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective coverage for storage and identified with labels describing contents.

1. Belts: [**One**] <**Insert number**> set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation[**, supports,**] [**and seismic restraints**], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

F. Seismic Performance: Axial HVAC fans shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] <**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. 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. Component Importance Factor: [**1.5**] [**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

G. Capacities and Characteristics:

1. Airflow: <**Insert number**> cfm.
2. Total Static Pressure: <**Insert number**> inches wg.
3. Fan Diameter: <**Insert number**> inches.
4. Brake Horsepower: <**Insert number**>.
5. Drive Type: [**Direct**] [**Belt**].
6. Fan Rpm: <**Insert number**>.
7. Motor:

   a. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Totally enclosed, air over**] [**Totally enclosed, nonventilated**] [**Explosion proof**].
   b. Enclosure Materials: [**Cast iron**] [**Cast aluminum**] [**Rolled steel**].
   c. Motor Bearings: <**Insert requirements**>.
   d. Efficiency: Premium efficiency.
   e. NEMA Design: <**Insert designation**>.
   f. Service Factor: <**Insert number**>.
   g. Electrical Characteristics:

      1) Motor Size: <**Insert horsepower**>.
      2) Motor Rpm: <**Insert number**>.
      3) Volts: [**120**] [**208**] [**230**] [**460**] <**Insert number**> V.
      4) Phase: [**Single**] [**Three**].
      5) Hertz: 60 Hz.
      6) Full-Load Amperes: <**Insert number**> A.
      7) Minimum Circuit Ampacity: <**Insert number**> A.
      8) Maximum Overcurrent Protection: <**Insert number**> A.

8. Sound Power:

   a. 1st Octave: <**Insert dB**>.
   b. 2nd Octave: <**Insert dB**>.
   c. 3rd Octave: <**Insert dB**>.
   d. 4th Octave: <**Insert dB**>.
   e. 5th Octave: <**Insert dB**>.
   f. 6th Octave: <**Insert dB**>.

g. 7th Octave: <**Insert dB**>.
h. 8th Octave: <**Insert dB**>.

9. Vibration Isolators: [**Spring**] [**Restrained spring**] <**Insert type**> isolators with a static deflection of [**1 inch**] <**Insert deflection**>.
10. Spark Resistance Class: Classified in accordance with AMCA 99, Section 8, [**Type A**] [**Type B**] [**Type C**].

H. Service Conditions:

1. Ambient Temperature: <**Insert number**> deg F.
2. Altitude: <**Insert number**> feet above sea level.
3. Humidity: <**Insert number**> deg F wet bulb.

2.2 TUBEAXIAL FANS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain tubeaxial fans from single manufacturer.

C. Description: Fan wheel and housing, factory-mounted motor with [**belt**] [**or**] [**direct**] drive, an inlet cone section, and accessories.

D. Housings: [**Steel**] [**Galvanized steel**] [**Aluminum**] [**Fiberglass-reinforced plastic**] [**Stainless steel**] with flanged inlet and outlet connections.

E. Wheel Assemblies: [**Cast or extruded aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key**] [**Fiberglass-reinforced plastic cured under pressure with airfoil-shaped blades keyed to stainless steel shaft**] [**Cast aluminum; machined and fitted to shaft**].

F. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: [**1.2**] [**1.3**] [**1.4**] [**1.5**].
3. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
4. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
6. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
7. Belt Guards: Fabricate of prime-coated steel to comply with OSHA and SMACNA requirements for motors with exposed drive belt. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
8. Motor Base: Adjustable rail mount motor base with adjustment screw to set belt tension.
9. Shaft Bearings: Radial, self-aligning bearings.

a. Ball-Bearing Rating Life: ABMA 9, [**L10 of 50,000 hours**] <**Insert life**>.
b. Roller-Bearing Rating Life: ABMA 11, [**L10 of 50,000 hours**] <**Insert life**>.
c. Extend lubrication lines to outside of casing and terminate with grease fittings.

G. Accessories:

1. Companion Flanges: Rolled flanges of same material as housing.
2. Inspection Door: Bolted door allowing limited access to internal parts of fan, of same material as housing.
3. Propeller Access Section Door: Short duct section bolted to fan [**inlet**] [**and**] [**outlet**] allowing access to internal parts of fan for inspection and cleaning, of same material as housing.
4. Swingout Construction: Assembly allowing entire fan section to swing out from duct for cleaning and servicing, of same material as housing.
5. Mounting Clips: [**Horizontal ceiling**] [**Vertical mounting**] clips welded to fan housing, of same material as housing.
6. Horizontal Support: Pair of supports bolted to fan housing, of same material as housing.
7. Vertical Support: Short duct section with welded brackets bolted to fan housing, of same material as housing.
8. Inlet Screen: On unducted fan inlet - wire-mesh screen, of same material as housing.
9. Outlet Screen: On unducted fan outlet - wire-mesh screen, of same material as housing.
10. Backdraft Dampers: Butterfly style, for bolting to fan discharge or outlet cone, of same material as housing.
11. Shaft Seal: Elastomeric seal and PTFE wear plate, suitable for up to 300 deg F.
12. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
13. Inlet Vanes: Adjustable; with peripheral control linkage operated from outside of airstream, bronze sleeve bearings on each end of vane support, and provision for manual or automatic operation, of same material as housing.
14. Inlet Bell: Curved inlet for when fan is not attached to duct[**, of same material as housing**] [**; aluminum**].
15. Inlet Cone: Round-to-round transition, of same material as housing.
16. Outlet Cone: Round-to-round transition, of same material as housing.
17. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.
18. Direct-Driven Units: Encase motor in housing outside of airstream. Extend lubrication lines to outside of casing and terminate with grease fittings.
19. [**Factory-wired motor disconnect switch located on outside of fan housing.**]

H. Factory Finishes:

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.
3. Coatings: [**Epoxy**] [**Zinc**] [**Phenolic**] [**Powder-baked enamel**]; <**Insert manufacturer's name and trade name**>.

   a. Apply to finished housings.
   b. Apply to fan wheels.

2.3 VANEAXIAL FANS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain vaneaxial fans from single manufacturer.

C. Description: Fan wheel and housing, straightening vane section, factory-mounted motor with belt or direct drive, an inlet cone section, and accessories.

1. Variable-Pitch Fans: Internally mounted [**electric**] [**electronic**] actuator, externally mounted positive positioner, and mechanical-blade-pitch indicator.

D. Housings: [**Steel**] [**Aluminum**] [**Fiberglass-reinforced plastic**] [**Stainless steel**] <**Insert material**>.

1. Inlet and Outlet Connections: Flanges.
2. Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.

E. Wheel Assemblies: [**Cast aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key**] [**Fiberglass-reinforced plastic cured under pressure with airfoil-shaped blades keyed to stainless steel shaft**] [**Cast-aluminum hub assembly, machined and fitted with threaded bearing wells to receive blade-bearing assemblies with replaceable, cast-aluminum blades; factory mounted and balanced**].

F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: [**1.2**] [**1.3**] [**1.4**] [**1.5**].
2. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
3. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.
7. Motor Base: Adjustable rail mount motor base with adjustment screw to set belt tension.
8. Shaft Bearings: Radial, self-aligning bearings.

   a. Ball-Bearing Rating Life: ABMA 9, [**L10 of 100,000 hours**] <**Insert life**>.
   b. Roller-Bearing Rating Life: ABMA 11, [**L10 of 100,000 hours**] <**Insert life**>.
   c. Extend lubrication lines to outside of casing and terminate with grease fittings.

G. Accessories:

1. Companion Flanges: Rolled flanges of same material as housing.
2. Inspection Door: Bolted door allowing limited access to internal parts of fan, of same material as housing.
3. Propeller Access Section Door: Short duct section bolted to fan [**inlet**] [**and**] [**outlet**] allowing access to internal parts of fan for inspection and cleaning, of same material as housing.
4. Swingout Construction: Assembly allowing entire fan section to swing out from duct for cleaning and servicing, of same material as housing.
5. Mounting Clips: [**Horizontal ceiling**] [**Vertical mounting**] clips welded to fan housing, of same material as housing.
6. Horizontal Support: Pair of supports bolted to fan housing, of same material as housing.
7. Vertical Support: Short duct section with welded brackets bolted to fan housing, of same material as housing.
8. Inlet Screen: On unducted fan inlet - wire-mesh screen, of same material as housing.
9. Outlet Screen: On unducted fan outlet - wire-mesh screen, of same material as housing.
10. Backdraft Dampers: Butterfly style, for mounting with flexible connection to fan discharge or direct mounted to discharge diffuser section, of same material as housing.
11. Stall Alarm Probe: Sensing probe capable of detecting fan operation in stall and signaling control devices. Control devices and sequence of operation are specified in Section 230923.23 "Pressure Instruments" and Section 230993.11 "Sequence of Operations for HVAC DDC."

12. Flow Measurement Port: Pressure measurement taps installed in fan inlet to detect and signal airflow readings to temperature-control systems. Control devices and sequence of operation are specified in Section 230923.14 "Flow Instruments" and Section 230993.11 "Sequence of Operations for HVAC DDC."
13. Shaft Seal: Elastomeric seal and PTFE wear plate, suitable for up to 300 deg F.
14. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
15. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
16. Inlet Cone: Round-to-round transition, of same material as housing.
17. Outlet Cone: Round-to-round transition, of same material as housing.
18. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.
19. Direct-Driven Units: Encase motor in housing outside of airstream. Extend lubrication lines to outside of casing and terminate with grease fittings.
20. [**Factory-wired motor disconnect switch located on outside of fan housing.**]

H. Factory Finishes:

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.
3. Coatings: [**Epoxy**] [**Zinc**] [**Phenolic**] [**Powder-baked enamel**]; <**Insert manufacturer's name and trade name**>.

   a. Apply to finished housings.
   b. Apply to fan wheels.

2.4 MIXED-FLOW FANS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain mixed-flow fans from single manufacturer.

C. Description: Fan wheel and housing,[**straightening vane section,**] factory-mounted motor with [**belt drive**] [**or**] [**direct drive**], and accessories.

D. Housings: [**Steel**] [**Galvanized steel**] [**Aluminum**].

1. Inlet and Outlet Connections: Outer mounting frame and companion flanges.
2. Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.
3. Mixed-Flow Outlet Connection: [**One**] [**Two**] flanged discharge(s) perpendicular to fan inlet.

E. Wheel Assemblies: Cast aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key.

F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: [**1.2**] [**1.3**] [**1.4**] [**1.5**].
2. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
3. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.

4. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Motor Base: Adjustable rail mount motor base with adjustment screw to set belt tension.
7. Shaft Bearings: Radial, self-aligning bearings.

    a. Ball-Bearing Rating Life: ABMA 9, [**L10 of 100,000 hours**] <**Insert life**>.
    b. Roller-Bearing Rating Life: ABMA 11, [**L10 of 100,000 hours**] <**Insert life**>.
    c. Extend lubrication lines to outside of casing and terminate with grease fittings.

G. Accessories:

1. Mounting Clips: [**Horizontal ceiling**] [**Vertical mounting**] clips welded to fan housing, of same material as housing.
2. Inlet and Outlet Screens: On unducted fan inlet and outlet - wire-mesh screen, of same material as housing.
3. Backdraft Dampers: Butterfly style, for mounting with flexible connection to fan discharge or direct mounted to discharge diffuser section, of same material as housing.
4. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
5. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
6. Inlet Cones: Round-to-round transition, of same material as housing.
7. Outlet Cones: Round-to-round transition, of same material as housing.
8. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.
9. Direct-Driven Units: Encase motor in housing outside of airstream.
10. [**Factory-wired motor disconnect switch located on outside of fan housing.**]

H. Factory Finishes:

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.
3. Coatings: [**Epoxy**] [**Zinc**] [**Phenolic**] [**Powder-baked enamel**]; <**Insert manufacturer's name and trade name**>.

    a. Apply to finished housings.
    b. Apply to fan wheels.

2.5 SOURCE QUALITY CONTROL

A. [**AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.**]

B. [**AMCA Certification for Fan Aerodynamic Performance Ratings: Test, rate, and label in accordance with AMCA 211.**]

C. [**AMCA Certification for Fan Energy Index (FEI): Test, rate, and label in accordance with AMCA 211.**]

D. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install axial fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, in accordance with manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:

1. Install floor-mounted axial fans on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Unit Support: Install axial fans level on structural curbs. Coordinate with duct connections. [**Coordinate wall penetrations and flashing with wall construction.**] [**Secure units to structural support with anchor bolts.**]
3. Support duct-mounted and other hanging axial fans directly from the building structure, using suitable hanging systems as specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
4. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
5. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Install units with adequate clearances for service and maintenance.

F. Label fans in accordance with requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Where installing ducts adjacent to fans, allow space for service and maintenance.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 STARTUP SERVICE:

A. [**Engage a factory-authorized service representative to perform**] [**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
6. For belt-drive fans, disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
7. Adjust belt tension.
8. Adjust damper linkages for proper damper operation.
9. Verify lubrication for bearings and other moving parts.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
12. Shut unit down and reconnect automatic temperature-control operators.
13. Remove and replace malfunctioning units and retest as specified above.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner**] [**Contractor**] will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties.
3. Fans and components will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**] [**Train**] Owner's maintenance personnel to adjust, operate, and maintain axial HVAC fans.

END OF SECTION 233413

SECTION 233416 - CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backward-inclined centrifugal fans, including airfoil and curved blade fans.
2. Forward-curved centrifugal fans.
3. Square in-line centrifugal fans.
4. Tubular in-line centrifugal fans.
5. Plenum fans.
6. Plug fans.
7. Utility set fans.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
2. Rated capacities, operating characteristics, and furnished specialties and accessories.
3. Certified fan performance curves with system operating conditions indicated.
4. Certified fan sound-power ratings.
5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
6. Material thickness and finishes, including color charts.
7. Dampers, including housings, linkages, and operators.
8. Fan speed controllers.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting vibration isolators [**and seismic restraints**]and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for ASHRAE 62.1.>

D. Delegated Design Submittal: For vibration isolation[**, supports,**] [**and seismic restraints**] indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators[**, supports,**] [**, seismic restraints,**] [**and for designing vibration isolation bases**].

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Fan room layout and relationships between components and adjacent structural and mechanical elements, drawn to scale, and coordinated with each other, using input from installers of the items involved.

B. Seismic Qualification Data: For fans, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline 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 and their installation requirements.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For centrifugal fans to include in normal operation, emergency operation, and maintenance manuals with replacement parts listing.

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. Belts: [**One**] <**Insert number**> set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Unusual Service Conditions

1. Base fan-performance ratings on the following:

a. Ambient Temperature: <**Insert deg F dry bulb**>.
b. Altitude: <**Insert feet**> above sea level.
c. Humidity: <**Insert deg F wet bulb**>.
d. <**Insert conditions**>.

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 Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

D. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Startup."

E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation[**, supports**] [**and seismic restraints**], including comprehensive engineering analysis by a qualified professional engineer, using performance and design criteria indicated.

G. Seismic Performance: Centrifugal fans shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] <**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**] [**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

H. Capacities and Characteristics:

1. Fan Type: [**Centrifugal**] [**Square in-line centrifugal**] [**Tubular in-line centrifugal**] [**Plenum**] [**Plug**] [**Utility set**].
2. Blade Type: [**Forward curved**] [**Backward inclined airfoil**] [**Backward inclined curved**] [**Backward inclined flat**].
3. Airflow: <**Insert cfm**>.
4. Total Static Pressure: <**Insert inches wg**>.
5. Class: AMCA 99, Section 14, [**Class I**] [**Class II**] [**Class III**].
6. Drive Arrangement: <**Insert AMCA arrangement number**>.
7. Drive Type: [**Belt**] [**Direct**].
8. Discharge Arrangement: <**Insert discharge arrangement configuration**>.
9. Housing Material: [**Reinforced steel**] [**Shaped fiberglass-reinforced plastic**] [**Aluminum**] [**Stainless steel**].
10. Housing Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] <**Insert manufacturer's name and trade name**>.
11. Wheel Size (Diameter): <**Insert inches**>.
12. Wheel Material: [**Steel**] [**Aluminum**] [**One-piece fiberglass-reinforced plastic**] [**Stainless steel**].
13. Wheel Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**]; <**Insert manufacturer's name and trade name**>.
14. Brake Horsepower: <**Insert number**>.
15. Fan rpm: <**Insert value**>.
16. Outlet Velocity: <**Insert fpm**>.
17. Motor:

    a. Motor Enclosure Type: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Explosion proof**] [**Totally enclosed, air over**] <**Insert motor enclosure type**>.

b. Efficiency: [**Insert number**] percent.
c. Service Factor: [**100**] <**Insert number**> percent.
d. Suitable for Use with Variable-Frequency Drive: [**Yes**] [**No**].
e. Electrical Characteristics:

1) Horsepower: <**Insert horsepower**>.
2) RPM: <**Insert number**>.
3) Volts: [**120**] [**208**] [**230**] [**460**] <**Insert number**>.
4) Phase: [**Single**] [**Poly**].
5) Hertz: 60.
6) Full-Load Amperes: <**Insert number**> A.
7) Minimum Circuit Ampacity: <**Insert number**> A.
8) Maximum Overcurrent Protection: <**Insert number**> A.

18. Discharge Sound Power:

a. 1st Octave: <**Insert dB**>.
b. 2nd Octave: <**Insert dB**>.
c. 3rd Octave: <**Insert dB**>.
d. 4th Octave: <**Insert dB**>.
e. 5th Octave: <**Insert dB**>.
f. 6th Octave: <**Insert dB**>.
g. 7th Octave: <**Insert dB**>.
h. 8th Octave: <**Insert dB**>.

19. Inlet Sound Power:

a. 1st Octave: <**Insert dB**>.
b. 2nd Octave: <**Insert dB**>.
c. 3rd Octave: <**Insert dB**>.
d. 4th Octave: <**Insert dB**>.
e. 5th Octave: <**Insert dB**>.
f. 6th Octave: <**Insert dB**>.
g. 7th Octave: <**Insert dB**>.
h. 8th Octave: <**Insert dB**>.

20. Vibration Isolators:

a. Type: [**Spring**] [**Restrained spring**] <**Insert type**>.
b. Static Deflection: [**1 inch**] <**Insert inches**>.

21. Spark-Resistance Class: Classified according to AMCA 99, Section 8 [**Type A**] [**Type B**] [**Type C**].

2.2 BACKWARD-INCLINED CENTRIFUGAL FANS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, [**belt-**][**direct-**]driven centrifugal fans, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and

support structure. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.

2. Factory-installed and -wired disconnect switch.

C. Housings:

1. Housing Material: [**Reinforced steel**] [**Shaped fiberglass-reinforced plastic**] [**Aluminum**] [**Stainless steel**] [**See schedule**] <**Insert material**>.
2. Housing Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.
3. Housing Assembly: Sideplates[**continuously welded**][**or**][**spot welded**][**or**][**attached by continuous Pittsburgh lock seal or similar seal**].
4. Formed panels to make curved-scroll housings with shaped cutoff.
5. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
6. Horizontally split, bolted-flange housing.
7. Spun inlet cone with flange.
8. Outlet flange.
9. Discharge Arrangement: Fan scroll housing is field rotatable to any of [**seven**] [**eight**] discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

D. Wheels:

1. Wheel Configuration: [**SWSI**] [**DWDI**] construction with a precision-spun curved inlet flange and a backplate fastened to shaft with setscrews. Wheels shall be statically and dynamically balanced, and nonoverloading.
2. Wheel and Blade Material: [**Steel**] [**Aluminum**] [**One-piece fiberglass-reinforced plastic**] [**Stainless steel**] [**See schedule**].

   a. Spark-Resistant Construction: Classified according to AMCA 99, Section 8, [**Type A**] [**Type B**] [**Type C**].

3. Wheel and Blade Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.
4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
5. Backward-Inclined Airfoil Blades:

   a. Aerodynamic design.
   b. Heavy backplate.
   c. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

6. Backward-Inclined Curved Blades:

   a. Curved design.
   b. Heavy backplate.
   c. Single-thickness blades continuously welded at tip flange and backplate.

E. Shafts:

1. Statically and dynamically balanced, and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.

2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Bearings:

1. Prelubricated and Sealed Shaft Bearings:

   a. Self-aligning, pillow-block-type ball bearings.
   b. Ball-Bearing Rating Life: ABMA 9, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.
   c. Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

2. Grease-Lubricated Shaft Bearings, Tapered Roller:

   a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
   b. Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.
   c. Extended Lubrication Lines: Extend lines to accessible location.

3. Grease-Lubricated Shaft Bearings, Ball or Roller:

   a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
   b. Ball-Bearing Rating Life: ABMA 9, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.
   c. Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.
   d. Extended Lubrication Lines: Extend lines to accessible location.

G. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: [**1.5**] [**1.4**] [**1.3**] [**1.2**].
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch pulleys for use with motors larger than [**5**] <**Insert number**> hp.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; [**0.146 inch-**] <**Insert dimension**> thick, [**3/4-inch**] <**Insert dimension**> diamond-mesh wire screen, welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

H. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Explosion proof**] [**Totally enclosed, air over**] <**Insert motor enclosure type**>.

I. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Discharge Dampers: Assembly with [**parallel**] [**opposed**] blades constructed of two plates formed around, and to, shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
5. Inlet Screens: Grid screen of same material as housing.
6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
8. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
9. Piezometer Ring: Piezometer ring mounted at fan inlet cone for airflow measurement.

2.3 FORWARD-CURVED CENTRIFUGAL FANS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, [**belt-**] [**direct-**]driven centrifugal fans, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

C. Housings:

1. Housing Material: [**Reinforced steel**] [**Shaped fiberglass-reinforced plastic**] [**Aluminum**] [**Stainless steel**] [**See schedule**].
2. Housing Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.
3. Housing Assembly: Sideplates [**continuously welded**][**or**][**spot welded**][**or**][**attached by continuous Pittsburgh lock seal or similar seal**].
4. Formed panels to make curved-scroll housings with shaped cutoff.
5. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
6. Horizontally split, bolted-flange housing.
7. Spun inlet cone with flange.
8. Outlet flange.
9. Discharge Arrangement: Fan scroll housing field rotatable to any of [**seven**] [**eight**] discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

D. Wheels:

1. Wheel Configuration: [**SWSI**] [**DWDI**] construction with a curved inlet flange, and a backplate fastened to shaft with setscrews.
2. Wheel and Blade Material: [**Steel**] [**Aluminum**] [**One-piece fiberglass-reinforced plastic**] [**Stainless steel**] [**See schedule**].

a. Spark-Resistant Construction: Classified according to AMCA 99, Section 8, [**Type A**] [**Type B**] [**Type C**].

3. Wheel and Blade Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.
4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with setscrews.
5. Forward-Curved Wheels:

a. Black-enameled or galvanized-steel construction with inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow.
b. Mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with setscrews.

E. Shafts:

1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Bearings:

1. Prelubricated and Sealed Shaft Bearings:

a. Self-aligning, pillow-block-type [**ball**] [**roller**] bearings.
b. Ball-Bearing Rating Life: ABMA 9, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.
c. Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

2. Grease-Lubricated Shaft Bearings, Tapered Roller:

a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
b. Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.
c. Extended Lubrication Lines: Extend lines to accessible location.

3. Grease-Lubricated Shaft Bearings, Ball or Roller:

a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
b. Ball-Bearing Rating Life: ABMA 9, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.
c. Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.
d. Extended Lubrication Lines: Extend lines to accessible location.

G. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.

2. Service Factor Based on Fan Motor Size: [**1.5**] [**1.4**] [**1.3**] [**1.2**].
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than [**5**] <**Insert number**> hp.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; [**0.146 inch-**] <**Insert dimension**> thick, [**3/4-inch**] <**Insert dimension**> diamond-mesh wire screen, welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

H. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Totally enclosed, air over**] [**Explosion-proof**].

I. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Discharge Dampers: Assembly with [**parallel**] [**opposed**] blades constructed of two plates formed around, and to, shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
5. Inlet Screens: Grid screen of same material as housing.
6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
8. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
9. Piezometer Ring: Piezometer ring mounted at fan inlet cone for airflow measurement.

2.4 SQUARE IN-LINE CENTRIFUGAL FANS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Square in-line centrifugal fans.

C. Housing:

1. Housing Material: [**Reinforced steel**] [**Aluminum**] [**Stainless steel**] [**See schedule**] <**Insert material**>.
2. Housing Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.
3. Housing Construction: Side panels shall be easily removable for service. Include inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

D. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing[**; with wheel, inlet cone, and motor on swing-out service door**].

E. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosures around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

F. Fan Wheels: Aluminum airfoil blades welded to aluminum hub.

G. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Totally enclosed, air over**] [**Explosion-proof**] <**Insert motor enclosure type**>.

H. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
3. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
4. Companion Flanges: For inlet and outlet duct connections.
5. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
6. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
7. Side Discharge: Flange connector and attachment hardware to provide right-angle discharge on side of unit.

2.5 TUBULAR IN-LINE CENTRIFUGAL FANS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Tubular in-line centrifugal fans.

C. Housing:

1. Housing Material: [**Reinforced steel**] [**Shaped fiberglass-reinforced plastic**] [**Aluminum**] [**Stainless steel**] [**See schedule**] <**Insert material**>.
2. Housing Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.
3. Housing Construction: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

D. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing[**; with wheel, inlet cone, and motor on swing-out service door**].

E. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

F. Fan Wheels: [**Steel**] [**Aluminum**], airfoil blades welded to aluminum hub.

G. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Totally enclosed, air over**] [**Explosion-proof**] <**Insert motor enclosure type**>.

H. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
3. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
4. Companion Flanges: For inlet and outlet duct connections.
5. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
6. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.6 PLENUM FANS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, [**belt-**] [**direct-**]driven centrifugal fans, consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. [**Factory-installed and -wired disconnect switch.**]

C. Wheels:

1. Wheel Configuration: SWSI construction with curved inlet flange and heavy backplate; fastened to shaft with setscrews.
2. Wheel and Blade Material: [**Steel**] [**Aluminum**] [**One-piece fiberglass-reinforced plastic**] [**Stainless steel**] [**See schedule**].

   a. Spark-Resistant Construction: Classified according to AMCA 99, Section 8, [**Type A**] [**Type B**] [**Type C**].

3. Wheel and Blade Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.
4. Backward-Inclined Airfoil Blades: Hollow, die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

D. Shafts:

1. Statically and dynamically balanced, and selected for continuous operation at maximum-rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

E. Bearings:

1. Prelubricated and Sealed Shaft Bearings:

   a. Self-aligning, pillow-block-type ball bearings.

b. Ball-Bearing Rating Life: ABMA 9, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.
c. Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

2. Grease-Lubricated Shaft Bearings, Tapered Roller:

a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
b. Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.
c. Extended Lubrication Lines: Extend lines to accessible location.

3. Grease-Lubricated Shaft Bearings, Ball or Roller:

a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
b. Ball-Bearing Rating Life: ABMA 9, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.
c. Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.
d. Extended Lubrication Lines: Extend lines to accessible location.

F. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: [**1.5**] [**1.4**] [**1.3**] [**1.2**].
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than [**5**] <**Insert number**> hp.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate to SMACNA's "HVAC Duct Construction Standards"; [**0.146 inch-**] <**Insert dimension**> thick, [**3/4-inch**] diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

G. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Totally enclosed, air over**] [**Explosion proof**].

H. Accessories:

1. Inlet Safety Screen: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
2. Safety Enclosure: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
3. Belt Guard: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.

4. Inlet Companion Flange: Rolled flanges for duct connections of same material as housing.
5. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
6. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
7. Piezometer Ring: Piezometer ring mounted at fan inlet cone for airflow measurement.

2.7 PLUG FANS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans, consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

C. Wheels:

1. Wheel Configuration: SWSI construction with curved inlet flange and heavy backplate; fastened to shaft with setscrews.
2. Wheel and Blade Material: [**Steel**] [**Aluminum**] [**One-piece fiberglass-reinforced plastic**] [**Stainless steel**] [**See schedule**].

   a. Spark-Resistant Construction: Classified according to AMCA 99, Section 8 [**Type A**] [**Type B**] [**Type C**].

3. Wheel and Blade Coating: [**None**] [**Themoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.
4. Backward-Inclined Airfoil Blades: Hollow, die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

D. Shafts:

1. Statically and dynamically balanced, and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

E. Bearings:

1. Prelubricated and Sealed Shaft Bearings:

   a. Self-aligning, pillow-block-type ball bearings.
   b. Ball-Bearing Rating Life: ABMA 9, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.
   c. Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.

2. Grease-Lubricated Shaft Bearings, Tapered Roller:

    a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
    b. Ball-Bearing Rating Life: ABMA 9, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.
    c. Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.
    d. Extended Lubrication Lines: Extend lines to accessible location.

3. Grease-Lubricated Shaft Bearings, Ball or Roller:

    a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
    b. Ball-Bearing Rating Life: ABMA 9, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.
    c. Roller-Bearing Rating Life: ABMA 11, L(10) at [**50,000**] [**120,000**] <**Insert number**> hours.
    d. Extended Lubrication Lines: Extend lines to accessible location.

F. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: [**1.5**] [**1.4**] [**1.3**] [**1.2**].
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with larger motors.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; [**0.146 inch-**] <**Insert dimension**> thick, [**3/4-inch**] <**Insert dimension**> diamond-mesh wire screen, welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

G. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Totally enclosed, air over**] [**Explosion-proof**].

H. Accessories:

1. Inlet Safety Screen: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
2. Safety Enclosure: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
3. Belt Guard: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
4. Inlet Companion Flange: Rolled flanges for duct connections of same material as housing.

5. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
6. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

2.8 UTILITY SET FANS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, [**belt-**] [**direct-**]driven centrifugal fan utility vent sets, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.

C. Housings:

1. Housing Material: [**Reinforced steel**] [**Shaped fiberglass-reinforced plastic**] [**Aluminum**] [**Stainless steel**] [**See schedule**] <**Insert material**>.
2. Housing Coating: [**None**] [**Themoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.
3. Formed panels to make curved-scroll housings with shaped cutoff.
4. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
5. Discharge Arrangement: Fan scroll housing field rotatable to any of [**seven**] [**eight**] discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

D. Wheels:

1. Wheel Configuration: SWSI, with hub keyed to shaft.
2. Wheel and Blade Materials: [**Steel**] [**Aluminum**] [**One-piece fiberglass-reinforced plastic**] [**Stainless steel**] [**See schedule**].

   a. Spark-Resistant Construction: Classified according to AMCA 99, Section 8 [**Type A**] [**Type B**] [**Type C**].

3. Wheel and Blade Coating: [**None**] [**Thermoplastic vinyl**] [**Epoxy**] [**Synthetic resin**] [**Phenolic**] [**Hot-dip galvanized**] [**Powder-baked enamel**] [**See schedule**] <**Insert manufacturer's name and trade name**>.
4. Backward-Inclined Airfoil Blades:

   a. Aerodynamic design.
   b. Heavy backplate.
   c. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

5. Backward-Inclined Curved Blades:

   a. Curved design.
   b. Heavy backplate.
   c. Single-thickness blades continuously welded at tip flange and backplate.

6. Backward-Inclined Flat Blades:

    a. Flat design.
    b. Heavy backplate.
    c. Single-thickness blades continuously welded at tip flange and backplate.

7. Forward-Curved Blades:

    a. Curved design.
    b. Heavy backplate.
    c. Single-thickness blades continuously welded or riveted at tip flange and backplate.

E. Shafts:

1. Turned, ground, and polished steel; keyed to wheel hub. First critical speed at least 1.4 times maximum class speed.

F. Bearings:

1. Heavy-duty regreasable ball or roller type in a cast iron pillowblock housing.
2. Ball-Bearing Rating Life: ABMA 9, [**L(50) of 200,000 hours**] [**L(10) of 80,000 hours**] <**Insert life**>.
3. Roller-Bearing Rating Life: ABMA 11, [**L(50) of 200,000 hours**] [**L(10) of 80,000 hours**] <**Insert life**>.
4. Extend grease fitting to accessible location outside of unit.

G. Belt Drive:

1. Factory mounted, with final alignment and belt adjustment made after installation.
2. Service Factor Based on Fan Motor Size: [**1.5**] [**1.4**] [**1.3**] [**1.2**].
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert value**> hp; fixed pitch for use with motors larger than [**5**] <**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards," [**0.146 inch-**] <**Insert dimension**> thick, [**3/4-inch**] <**Insert dimension**> diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

H. Motor Enclosure: [**Open, dripproof**] [**Totally enclosed, fan cooled**] [**Explosion-proof**] <**Insert motor enclosure type**>.

I. Accessories:

1. Inlet and Outlet: Flanged.
2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
3. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades, with felt edges in steel frame installed on fan discharge.
4. Access Door: Gasketed door in scroll with latch-type handles.
5. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.

6. Inlet Screens: Removable wire mesh.
7. Outlet Screens: Removable wire mesh.
8. Belt Guard: OSHA-compliant, completely enclosed shaft and drive components.
9. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
10. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
11. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.
12. Discharge Dampers: Assembly with [**parallel**] [**opposed**] blades constructed of two plates formed around, and to, shaft, channel frame, and sealed ball bearings, with blades linked outside of airstream to single control lever of same material as housing.
13. Grease Collection Trough and Receiver: For restaurant exhaust application.
14. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

2.9 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

B. Where variable-frequency drives are indicated or scheduled, provide fan motor compatible with variable-frequency drive.

2.10 SOURCE QUALITY CONTROL

A. [**AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.**]

B. [**AMCA Certification for Fan Aerodynamic Performance Ratings: Test, rate, and label in accordance with AMCA 211.**]

C. [**AMCA Certification for Fan Energy Index (FEI): Test, rate, and label in accordance with AMCA 211.**]

D. Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install centrifugal fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:

1. Install floor- or roof-mounted centrifugal fans on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Support duct-mounted and other hanging centrifugal fans directly from the building structure, using suitable hanging systems as specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
3. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
4. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Curb Support, Field Built-Up: Install roof curb on roof structure, level and secure, according to "The NRCA Roofing and Waterproofing Manual," detail "Equipment Support Curb," number "SPF-9" (page 1409) and detail "Equipment Support Curb," number "SPF-9S" (page 1410). Install and secure centrifugal fans on curbs, and coordinate roof penetrations and flashing with roof construction.[**Secure units to curb support with anchor bolts.**]

F. Curb Support, Prefabricated: Rail-type wood support provided by fan manufacturer.

G. Unit Support: Install centrifugal fans level on structural [**curbs**] [**pilings**]. Coordinate with duct connections. [**Coordinate wall penetrations and flashing with wall construction.**] [**Secure units to structural support with anchor bolts.**]

H. Isolation Curb Support: Install centrifugal fans on isolation curbs, and install flexible duct connectors and vibration-isolation[**and seismic-control**] devices.

1. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements in Section 230548.13 "Vibration Controls for HVAC."

I. Install units with clearances for service and maintenance.

J. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK AND PIPING CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to fans to allow service and maintenance.

C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

D. Install heat tracing on all drain piping subject to freezing temperature and as indicated on Drawings. Furnish and install heat tracing according to Section 230533 "Heat Tracing for HVAC Piping."

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.5 STARTUP SERVICE:

A. [**Engage a factory-authorized service representative to perform**] [**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
6. For belt-drive fans, disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
7. Adjust belt tension.
8. Adjust damper linkages for proper damper operation.
9. Verify lubrication for bearings and other moving parts.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
12. Shut unit down and reconnect automatic temperature-control operators.
13. Remove and replace malfunctioning units and retest as specified above.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner**] [**Contractor**] will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Fans and components will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**] [**Train**] Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233416

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Axial roof ventilators.
2. Ceiling-mounted ventilators.
3. Centrifugal ventilators - roof downblast.
4. Centrifugal ventilators - roof upblast or sidewall.
5. Sidewall propeller fans.
6. Upblast propeller roof exhaust fans.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
2. Rated capacities, operating characteristics, and furnished specialties and accessories.
3. Certified fan performance curves with system operating conditions indicated.
4. Certified fan sound-power ratings.
5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
6. Material thickness and finishes, including color charts.
7. Dampers, including housings, linkages, and operators.
8. Prefabricated roof curbs.
9. Fan speed controllers.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting vibration isolators[**and seismic restraints**].

C. Delegated Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators[**and seismic restraints**] and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Seismic Qualification Data: For fans, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline 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 and their installation requirements.

C. Product Certificates: Submit certificates that specified equipment will withstand required wind forces, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and emergency operation, and 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. Belts: [**One**] <**Insert number**> set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Unusual Service Conditions:

1. Base fan-performance ratings on the following:

a. Ambient Temperature: <**Insert deg F**>.
b. Altitude: <**Insert feet**> above sea level.
c. Humidity: <**Insert wet bulb deg F**>.

d. <**Insert conditions**>.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

D. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation[**, supports,**] [**and seismic restraints**], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

G. Seismic Performance: HVAC power ventilators shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] <**Insert requirement**>. See Section 230548 "Vibration and Seismic Controls for HVAC."

1. 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. Component Importance Factor: [**1.5**] [**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

H. Wind Performance: Air-handling units shall withstand the effects of wind determined in accordance with to [**ASCE/SEI 7**] <**Insert requirement**>. See [**Section 230548 "Vibration and Seismic Controls for HVAC."**] [**Section 230548.13 "Vibration Controls for HVAC."**]

I. Capacities and Characteristics:

1. Airflow: <**Insert cfm**>.
2. Total Static Pressure: <**Insert inches wg**>.
3. Fan Diameter: <**Insert inches**>.
4. Drive Type: [**Direct**] [**Belt**].
5. Fan rpm: <**Insert number**>.
6. Tip Speed: <**Insert fpm**>.
7. Sound: <**Insert number**> sones.
8. Curb Height: <**Insert inches**>.
9. Damper: [**Backdraft**] [**Motorized**] [**None**].
10. Brake Horsepower: <**Insert number**>.
11. Motor Size: <**Insert number**> hp.
12. Motor rpm: <**Insert number**>.
13. Motor Enclosure: [**Open dripproof**] [**Totally enclosed, fan cooled**] [**Explosion-proof**].
14. Electrical Characteristics:

    a. Volts: <**Insert number**> V.
    b. Phase: [**Single**] [**Poly**].
    c. Hertz: [**60**] <**Insert number**>.

15. Accessories: <**Insert accessory description**>.

2.2 AXIAL ROOF VENTILATORS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Housing: Heavy-gauge, removable, spun-aluminum dome top and outlet baffle; square, one-piece, hinged, aluminum base.

C. Fan Wheel: [**Aluminum**] [**Steel**] hub and blades. [**Spark-resistant construction classified in accordance with AMCA 99, Section 8,**] [**Type A**] [**Type B**] [**Type C**].

D. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than [**5**] <**Insert number**> hp.

E. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted [**inside**] [**outside**] fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
5. Stack hood with built-in backdraft dampers.
6. Extended lubrication lines.

F. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: [**Self-flashing without a cant strip, with mounting flange**] [**Built-in cant and mounting flange**] [**Built-in raised cant and mounting flange**].
2. Overall Height: [**8 inches**] [**9-1/2 inches**] [**12 inches**] [**16 inches**] [**18 inches**].
3. Sound Curb: Curb with sound-absorbing insulation.
4. Pitch Mounting: Manufacture curb for roof slope.
5. Metal Liner: Galvanized steel.
6. Burglar Bars: [**1/2-inch-**] [**5/8-inch-**] [**3/4-inch-**] thick steel bars welded in place to form 6-inch squares.
7. Mounting Pedestal: Galvanized steel with removable access panel.

2.3 CEILING-MOUNTED VENTILATORS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Housing: Steel, lined with acoustical insulation.

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel removable for service.

D. Back-draft damper: Integral.

E. Grille: [**Plastic**] [**Stainless steel**] [**Aluminum**] [**Painted aluminum**], louvered grille with flange on intake and thumbscrew or spring retainer attachment to fan housing.

F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

G. Accessories:

1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
4. Motion Sensor: Motion detector with adjustable shutoff timer.
5. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless steel springs, and fusible link.
6. Filter: Washable aluminum to fit between fan and grille.
7. Isolation: Rubber-in-shear vibration isolators.
8. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.4 CENTRIFUGAL VENTILATORS - ROOF DOWNBLAST

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Housing: Downblast; removable [**spun-aluminum dome top and outlet baffle**] [**extruded-aluminum rectangular top**] [**galvanized-steel mushroom-domed top**] [**spun aluminum**]; square, one-piece aluminum base with venturi inlet cone.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades[**; spark-resistant construction classified in accordance with AMCA 99, Section 8,**] [**Type A**] [**Type B**] [**Type C**].

D. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than [**5**] <**Insert number**> hp.
6. Fan and motor isolated from exhaust airstream.

E. Accessories:

1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted [**inside**] [**outside**] fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
6. Spark-resistant, all-aluminum wheel construction.
7. Mounting Pedestal: Galvanized steel with removable access panel.

F. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: [**Self-flashing without a cant strip, with mounting flange**] [**Built-in cant and mounting flange**] [**Built-in raised cant and mounting flange**] [**Manufactured to accommodate roof slope**].
2. Overall Height: [**8 inches**] [**9-1/2 inches**] [**12 inches**] [**16 inches**] [**18 inches**].
3. Sound Curb: Curb with sound-absorbing insulation.
4. Hinged sub-base to provide access to damper or as cleanout for grease applications.
5. Burglar Bars: [**1/2-inch-**] [**5/8-inch-**] [**3/4-inch-**] thick steel bars welded in place to form 6-inch squares.
6. Pitch Mounting: Manufacture curb for roof slope.
7. Metal Liner: Galvanized steel.
8. Mounting Pedestal: Galvanized steel with removable access panel.

2.5 CENTRIFUGAL VENTILATORS - ROOF UPBLAST OR SIDEWALL

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Configuration: Centrifugal [**roof upblast**] [**roof upblast, grease hood kitchen**] [**sidewall**] ventilator.

C. Housing: Removable [**spun-aluminum dome top and outlet baffle**] [**extruded-aluminum rectangular top**] [**galvanized-steel, mushroom-domed top**] [**spun aluminum**]; square, one-piece aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
2. [**Provide grease collector.**]

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades[**; spark-resistant construction classified in accordance with AMCA 99, Section 8,**] [**Type A**] [**Type B**] [**Type C**].

E. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings; minimum ABMA9, [**L(10) of 100,000 hours**] <**Insert life**>.

4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than [**5**] <**Insert number**> hp.
6. Fan and motor isolated from exhaust airstream.

F. Accessories:

1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted [**inside**] [**outside**] fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
6. Spark-resistant, all-aluminum wheel construction.
7. Mounting Pedestal: Galvanized steel with removable access panel.
8. Wall Mount Adapter: Attach wall-mounted fan to wall.
9. Restaurant Kitchen Exhaust: UL 762 listed for grease-laden air exhaust.

G. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: [**Self-flashing without a cant strip, with mounting flange**] [**Built-in cant and mounting flange**] [**Built-in raised cant and mounting flange**] [**Manufactured to accommodate roof slope**].

H. Prefabricated Kitchen Exhaust Roof Curbs: Galvanized steel; mitered and welded corners; ventilation openings on all sides to ventilate curb interstitial space. Size as required to suit roof opening and fan base.

1. Configuration: [**Self-flashing without a cant strip, with mounting flange**] [**Built-in cant and mounting flange**] [**Built-in raised cant and mounting flange**] [**manufactured to accommodate roof slope**].
2. Overall Height: [**8 inches**] [**9-1/2 inches**] [**12 inches**] [**16 inches**] [**18 inches**].
3. Sound Curb: Curb with sound-absorbing insulation[**and galvanized metal liner**].
4. Hinged sub-base to provide access to damper or as cleanout for grease applications.
5. Burglar Bars: [**1/2-inch-**] [**5/8-inch-**] [**3/4-inch-**] thick steel bars welded in place to form 6-inch squares.
6. Pitch Mounting: Manufacture curb for roof slope.
7. Metal Liner: Galvanized steel.
8. Mounting Pedestal: Galvanized steel with removable access panel.
9. Vented Curb: For kitchen exhaust; 12-inch-high galvanized steel; unlined, with louvered vents in vertical sides.
10. NFPA 96 code requirements for commercial cooking operations.
11. Kitchen Hood Exhaust: UL 762 listed for grease-laden air.

2.6 SIDEWALL PROPELLER FANS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring, with baked-enamel finish coat applied after assembly.

C. Fan Wheels: Formed-steel blades riveted to heavy-gauge steel spider bolted to cast-iron hub.

D. Fan Wheel: Replaceable, [**cast**] [**extruded**]-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

E. Fan Drive, Direct: Direct-drive motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

F. Fan Drive, Belt:

1. Belt drive.
2. Resiliently mounted to housing.
3. Statically and dynamically balanced.
4. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
5. Extend grease fitting to accessible location outside of unit.
6. Service Factor Based on Fan Motor Size: 1.4.
7. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
8. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

   a. Ball-Bearing Rating Life: ABMA 9, [**L(10) of 100,000 hours**] <**Insert life**>.

9. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
10. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**insert value**> hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
11. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
12. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

G. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
2. Dampers: Counterbalanced, parallel-blade, backdraft dampers factory set to close when fan stops.
3. Motorized Dampers: Parallel-blade dampers with electric actuator wired to close when fan stops.
4. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
5. Wall Sleeve: Galvanized steel to match fan and accessory size.
6. Weathershield Hood: Galvanized steel to match fan and accessory size.
7. Weathershield Front Guard: Galvanized steel with expanded metal screen.

2.7 UPBLAST PROPELLER ROOF EXHAUST FANS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Configuration: Upblast propeller[**grease hood kitchen**] ventilator.

C. Wind Band, Fan Housing, and Base: Reinforced and braced [**galvanized steel**] [**aluminum**], containing [**galvanized-steel**] [**aluminum**] butterfly dampers and rain trough, motor and drive assembly, and fan wheel.

1. Damper Rods: Steel with [**bronze**] [**nylon**] bearings.
2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
3. [**Provide grease collector.**]

D. Fan Wheel: Replaceable, [**cast**] [**extruded**]-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades[**; spark-resistant construction classified in accordance with AMCA 99, Section 8,**] [**Type A**] [**Type B**] [**Type C**].

E. Belt Drives:

1. Resiliently mounted to housing.
2. Weatherproof housing of same material as fan housing.
3. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
4. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings.
5. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
6. Motor Pulleys: Adjustable pitch for use with motors through [**5**] <**Insert number**> hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than [**5**] <**Insert number**> hp.
7. Motor Mount: On outside of fan cabinet, adjustable base for belt tensioning.

F. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted [**inside**] [**outside**] fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Inspection Door: Hinged.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
6. Extended Lubrication Lines.
7. Kitchen Hood Exhaust: UL 762 listed for grease-laden air exhaust**.**

G. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: [**Self-flashing without a cant strip, with mounting flange**] [**Built-in cant and mounting flange**] [**Built-in raised cant and mounting flange**].

H. Prefabricated Kitchen Exhaust Roof Curbs: Galvanized steel; mitered and welded corners; ventilation openings on all sides to ventilate curb interstitial space. Size as required to suit roof opening and fan base.

1. Configuration: [**Self-flashing without a cant strip, with mounting flange**] [**Built-in cant and mounting flange**] [**Built-in raised cant and mounting flange**] [**manufactured to accommodate roof slope**].
2. Overall Height: [**8 inches**] [**9-1/2 inches**] [**12 inches**] [**16 inches**] [**18 inches**].
3. Sound Curb: Curb with sound-absorbing insulation.

4. Hinged sub-base to provide access to damper or as cleanout for grease applications.
5. Burglar Bars: [**1/2-inch-**] [**5/8-inch-**] [**3/4-inch-**] thick steel bars welded in place to form 6-inch squares.
6. Pitch Mounting: Manufacture curb for roof slope.
7. Metal Liner: Galvanized steel.
8. Mounting Pedestal: Galvanized steel with removable access panel.
9. Vented Curb: For kitchen exhaust; 12-inch-high galvanized steel; unlined, with louvered vents in vertical sides.
10. NFPA 96 code requirements for commercial cooking operations.
11. UL 762 listed for grease-laden air.

2.8 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.9 SOURCE QUALITY CONTROL

A. [**AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.**]

B. [**AMCA Certification for Fan Aerodynamic Performance Ratings: Test, rate, and label in accordance with AMCA 211.**]

C. [**AMCA Certification for Fan Energy Index (FEI): Test, rate, and label in accordance with AMCA 211.**]

D. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install power ventilators level and plumb.

B. Equipment Mounting:

1. Secure roof-mounted fans to roof curbs with zinc-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.
2. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
3. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
4. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.5 STARTUP SERVICE:

A. [**Engage a factory-authorized service representative to perform**] [**Perform**] startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
6. For belt-drive fans, disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
7. Adjust belt tension.
8. Adjust damper linkages for proper damper operation.
9. Verify lubrication for bearings and other moving parts.

10. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
12. Shut unit down and reconnect automatic temperature-control operators.
13. Remove and replace malfunctioning units and retest as specified above.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner**] [**Contractor**] will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[**with the assistance of a factory-authorized service representative**].

1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties.
3. Fans and components will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**] [**Train**] Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233423

SECTION 233439 - HIGH-VOLUME, LOW-SPEED FANS

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 high-volume, low-speed fans.

1.3 DEFINITIONS

A. HVLS - High volume, low speed.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, furnished specialties, and accessories for each fan.
2. Certified fan performance curves with system operating conditions indicated.
3. Certified fan sound-power ratings.
4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
5. Material thickness and finishes, including color charts.
6. Fan speed controllers.

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for HVAC units.>
2. <Double click to insert sustainable design text for minimum energy performance requirements.>
3. <Double click to insert sustainable design text for thermal comfort requirements.>
4. <Double click to insert sustainable design text for thermal comfort design requirements.>

C. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Show dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

D. Delegated-Design Submittal: For each HVLS fan.

1. Include design calculations and details for selecting product mounting components and seismic restraints complying with performance requirements, design criteria, and analysis

data signed and sealed by the qualified professional engineer responsible for their preparation.

2. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, and seismic forces required to select mounting components and seismic restraints.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and details, drawn to scale and coordinated with each other, using input from installers of the items involved.

B. Qualification Data:

1. For Installer: Certificate from HVLS fan manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, controls, and accessories indicated and furnished for installation.

C. Seismic-Restraint Details:

1. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
2. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
3. Preapproval and Evaluation Documentation: By [**an evaluation service member of ICC-ES**] [**Office of Statewide Health Planning and Development**] [**an agency acceptable to authorities having jurisdiction**], showing maximum ratings of restraint items and the basis for approval (tests or calculations).

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVLS fans to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Provide certification that manufacturer complies with [**the most recent edition of ISO 9001**] <**Insert requirement**>.

B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by HVLS fan manufacturer.

1. Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, controls, and accessories indicated and furnished for installation.
2. Installer certification shall be valid and current for duration of Project.

3. Retain copies of Installer certificates on-site and make available on request.
4. Each person assigned to Project shall have demonstrated past experience.

    a. Demonstrated past experience with products being installed for period within [**three**] [**five**] <**Insert number**> consecutive years before time of bid.
    b. Demonstrated past experience on [**five**] <**Insert number**> projects of similar complexity, scope, and value.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

E. Replace installed products damaged during construction.

1.9 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of fans that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

    a. For Motor, Including Controls: [**Five**] [**Seven**] [**10**] <**Insert number**> year(s) from date of Substantial Completion.
    b. For Parts, Including Blades and Hub: [**Five**] [**Seven**] [**10**] <**Insert number**> year(s) from date of Substantial Completion.
    c. For Labor: [**One**] [**Two**] <**Insert number**> year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Listed and labeled to UL 507.

C. CSA Compliance: Listed and labeled to CSA C22.2, No. 113.

D. Comply with NFPA 13 requirements for HVLS fans.

E. AMCA Compliance:

1. Test HVLS fans according to AMCA 230.
2. Certify HVLS fan performance according to AMCA 211.

F. Performance Data: Comply with ANSI 230 test procedure standard, based on five rating points: 20-, 40-, 60-, 80-, and 100-percent of maximum speed. Comply with AMCA 211 for publication of performance data.

G. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design HVLS ceiling fans.

H. Seismic Performance: HVLS ceiling fans shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] <**Insert requirement**>.

1. The term "withstand" means "the HVLS fans will remain in place without separation of any parts when subjected to the seismic forces specified[**and the units will be fully operational after the seismic event**]."
2. Component Importance Factor: [**1.5**] [**1.0**].
3. <**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

2.2 CAPACITIES AND CHARACTERISTICS

A. Fan:

1. Type: HVLS [**Upflow**] [**Downflow**] [**Selectable**].
2. Number of Fan Blades: <**Insert number**>.
3. Fan Diameter: <**Insert value**> feet.
4. Maximum Fan Speed: <**Insert rpm**>.
5. Fan Airflow at AMCA Rating Points cfm:

a. Airflow at 20 Percent: <**Insert value**>.
b. Airflow at 40 Percent: <**Insert value**>.
c. Airflow at 60 Percent: <**Insert value**>.
d. Airflow at 80 Percent: <**Insert value**>.
e. Airflow at 100 Percent: <**Insert value**>.

6. Fan Discharge Sound Power at Maximum Speed, dB:

a. 1st Octave: <**Insert value**>.
b. 2nd Octave: <**Insert value**>.
c. 3rd Octave: <**Insert value**>.
d. 4th Octave: <**Insert value**>.
e. 5th Octave: <**Insert value**>.
f. 6th Octave: <**Insert value**>.
g. 7th Octave: <**Insert value**>.
h. 8th Octave: <**Insert value**>.

B. Motor:

1. Size: <**Insert horsepower**>.
2. Speed: <**Insert rpm**>.
3. Volts: [**120**] [**208**] [**230**] [**277**] [**460**] <**Insert value**> V.
4. Phase: [**Single**] [**Three**] <**Insert number**>.
5. Hertz: [**60**] <**Insert number**> Hz.
6. Full-Load Amperes: <**Insert value**> A.
7. Minimum Circuit Ampacity: <**Insert value**> A.
8. Maximum Overcurrent Protection: <**Insert amperage**> A.

2.3 MANUFACTURERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Source Limitations: Obtain HVLS fans from single source from single manufacturer.

2.4 HIGH-VOLUME, LOW-SPEED FANS

A. Description: Factory-assembled and -tested horizontal, non-ducted fan unit, consisting of large-diameter blade set, direct-drive electric motor, with [**speed-reducing gearbox**] [**variable-speed motor controller**].

1. Provide fan designed to circulate large air volume, vertically, at low velocity.
2. Maximum Operating Temperature: [**122**] [**140**] <**Insert value**> deg F.
3. Frame:

   a. Material: [**Aluminum**] [**Galvanized steel**] [**Stainless steel**] <**Insert metal**>.

      1) Finish: [**Paint**] [**Powdercoat**] [**Thermoset, polyester powder paint**] [**Anodized**] <**Insert finish**>.

4. Diameter: [**8**] [**10**] [**12**] [**14**] [**16**] [**18**] [**20**] [**24**] <**Insert diameter**> feet.
5. Blades: Airfoil type.

   a. Quantity: [**3**] <**Insert number**>.
   b. Material: [**Aluminum**] <**Insert material**>.

      1) Blade Finish: [**Anodized**] <**Insert finish**>.

6. Motor: [**Squirrel cage**], [**integral to fan frame**] [**totally enclosed fan cooled**] [**ODP**] [**explosion proof**] <**Insert motor enclosure class**>.
7. Wiring and Controls Enclosure:

   a. NEMA 250, [**Class 1**] [**Class 4**] [**Class 4X**] <**Insert NEMA enclosure class**>.
   b. Material: [**Aluminum**] [**Galvanized steel**] [**Stainless steel**] <**Insert metal**>.

      1) Enclosure Finish: [**Paint**] [**Powdercoat**] [**Thermoset**] [**Polyester powder paint**] [**Anodized**] [**Polished**] <**Insert finish**>.

   c. Grounded.

8. Controls: Provide [**wall-mounted keypad**] <**Insert controlling device**>.

    a. Provide [**fixed**] [**automatic**] [**manual**] [**variable speed motor controller**] [**Insert speed control component here**] **speed control**.

9. Maximum Sound Power Level: <**Insert value**> dBA.
10. Standard Mounting Bracket: Steel beam/steel angle.
11. Mounting Bracket: [**Large beam**] [**Solid beam**] [**Z-purlin**] <**Insert mounting bracket type**>.
12. Accessories:

    a. Mounting extension tube.
    b. <**Insert accessory option here**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with requirements for installation tolerances and other conditions affecting HVLS fan performance, maintenance, and operations.

    1. Fan locations indicated on Drawings are approximate. Determine exact locations before roughing-in for mounting, control, and electrical connections.

B. Examine roughing-in for mounting location, anchor-bolt sizes, and locations, to verify actual locations for mounting connections before installation of fan.

C. Examine areas for suitable conditions where fan will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF HIGH-VOLUME LOW-SPEED FANS

A. Install fan according to manufacturer's published instructions.

B. Comply with NECA 1 and NFPA 70.

C. Comply with NFPA 13 for installation of HVLS fans and maximum allowable fan diameter. Center HVLS fans between four adjacent sprinklers. Minimum vertical clearance from HVLS fan to sprinkler deflector is 3 feet.

D. Comply with NFPA 72 and interlock HVLS fans to shut down upon receiving an alarm from fire alarm system.

E. Equipment Mounting:

    1. Anchor fan to building structure [**with manufacturer's recommended mounting bracket**] [**as shown in approved delegated design**] for installed condition.
    2. Consult a licensed professional structural engineer for mounting methods and approval for mounting to the structure. Structure must be able to withstand the torque and forces generated by the fan.

3. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
4. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
5. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

F. Install unit to permit access for maintenance.

G. Install parts and accessories shipped loose.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

E. Install power wiring to field-mounted electrical devices, furnished by fan manufacturer, but not factory mounted.

3.4 CONTROL CONNECTIONS

A. Connect control wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

C. Connect control interlock wiring between HVLS fan and other equipment to provide a complete and functioning system.

D. Connect control wiring between fan unit control interface and control system to provide remote control and monitoring.

E. Install control devices furnished by manufacturer, but not factory mounted.

F. Install control wiring to field-mounted control devices, furnished by fan manufacturer, but not factory mounted.

G. Protect installed units from damage caused by other work.

3.5 FIELD QUALITY CONTROL

A. Testing Agency, Owner Engaged: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency, Contractor Engaged: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform the following tests and inspections[**with the assistance of a factory-authorized service representative**]:

1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Fan or components will be considered defective if fan or components do not pass tests and inspections.

F. Prepare and submit test and inspection reports.

3.6 STARTUP SERVICE

A. [**Engage a factory-authorized service representative to perform**] [**Perform**] startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that fan is secure on mountings and supporting devices and that connections to electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers and switches.
3. Verify proper motor rotation direction and free fan rotation.
4. Check bearing [**and gearbox**] lubrication.
5. Verify proper fan rotation. [**Set rotation selector to blow vertically downward during heating season, and vertically upward during cooling season.**]

3.7 ADJUSTING

A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.8 CLEANING

A. Clean equipment externally; remove coatings applied for protection during shipping and storage, foreign material, and oily residue according to manufacturer's written instructions. Following manufacturer's cleaning procedures, and clean with manufacturer-recommended cleaning products.

3.9 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**] [**Train**] Owner's maintenance personnel to adjust, operate, and maintain HVLS fans.

B. Video training sessions, and provide electronic copy of video to Owner.

END OF SECTION 233439

SECTION 233713.13 - AIR DIFFUSERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ceiling diffusers - rectangular and square face.

B. Related Requirements:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers.
2. Section 233713.23 "Air Registers and Grilles" for adjustable-bar register and grilles, fixed-face registers and grilles, and linear bar grilles.
3. Section 233713.43 "Security Registers and Grilles" for security registers and security grilles.
4. Section 233716 "Fabric Air-Diffusion Devices" for continuous tubular diffusers.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
b. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples: For each exposed product and for each color and texture specified. Actual size of smallest diffuser indicated.

C. Samples for Initial Selection: For diffusers with factory-applied color finishes. Actual size of smallest diffuser indicated.

D. Samples for Verification: For diffusers, in manufacturer's standard sizes to verify color selected. Actual size of smallest diffuser indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.

4. Ceiling-mounted items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS - RECTANGULAR AND SQUARE FACE

A. Ceiling Diffuser - Rectangular and Square <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: [**Square**] [**Rectangular**] ceiling diffuser with round or rectangular duct collar and a series of curved louvers to provide discharge parallel to ceiling surface.
3. Source Limitations: Obtain from single source from single manufacturer.
4. Material: [**Steel**] [**Aluminum**] [**Stainless steel**].
5. Finish: [**Baked enamel, white**] [**Baked enamel, color selected by Architect**] [**Anodized aluminum**] <**Insert finish**>.
6. Face Size: [**24 by 24 inches**] [**20 by 20 inches**] [**12 by 12 inches**] <**Insert dimensions**>.
7. Face Style: [**Three cone**] [**Four cone**] [**Plaque**].
8. Mounting: [**Surface**] [**T-bar**] [**Snap in**] [**Spline**] [**Mounting panel**].
9. Pattern: [**Fixed**] [**Two position**] [**Adjustable**].
10. Dampers: [**Radial opposed blade**] [**Butterfly**] [**Combination damper and grid**].
11. Accessories:

    a. Equalizing grid.
    b. Plaster ring.
    c. Safety chain.
    d. Wire guard.
    e. Sectorizing baffles.
    f. Manual remote balancing damper operator.
    g. UL 5555C fire-rated assembly, including fire damper and insulating blanket.

PART 3 - EXECUTION

3.1 INSTALLATION OF AIR DIFFUSERS

A. Install diffusers level and plumb.

B. Ceiling-Mounted Outlets and Inlets: For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.13

SECTION 233713.23 - REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grilles - fixed-blade face.

B. Related Requirements:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to registers and grilles.
2. Section 233713.13 "Air Diffusers" for various types of air diffusers.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
b. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples: For each exposed product and for each color and texture specified. Smallest size register and grille indicated.

C. Samples for Initial Selection: For registers and grilles with factory-applied color finishes. Actual size of smallest register and grille indicated.

D. Samples for Verification: For registers and grilles, in manufacturer's standard sizes to verify color selected. Actual size of smallest size register and grille indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 GRILLES

A. Grilles - Fixed-Blade Face <**Insert drawing designation**>:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Material: [**Steel**] [**Aluminum**] [**Stainless steel**].
3. Finish: [**Baked enamel, white**] [**Baked enamel, color selected by Architect**] <**Insert finish**>.
4. Face-Blade Arrangement: Fixed-face blade position, [**horizontally**] [**vertically**] spaced [**3/4 inch**] [**1/2 inch**] <**Insert dimension**> apart.
5. Core Construction: [**Integral**] [**Removable**].
6. Frame: [**1-1/4 inches**] [**1 inch**] <**Insert dimension**> wide.
7. Filter-Mounting Frame: <**Insert frame size and style**>.
8. Mounting: [**Countersunk screw**] [**Concealed**] [**Lay in**].
9. Accessory: Filter.

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate registers and grilles in accordance with ASHRAE 70.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION OF REGISTERS AND GRILLES

A. Install registers and grilles level and plumb.

B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.23

SECTION 238236 - FINNED-TUBE RADIATION HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes [**hydronic**] [**steam**] [**electric**], [**baseboard**] [**and**] [**finned-tube**] radiation heaters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include details and dimensions of custom-fabricated enclosures.
4. Indicate location and size of each field connection.
5. Indicate location and arrangement of piping valves and specialties.
6. Indicate location and arrangement of integral controls.
7. Include enclosure joints, corner pieces, access doors, and other accessories.
8. Include diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

D. Color Samples for Initial Selection: For finned-tube radiation heaters with factory-applied color finishes.

E. Color Samples for Verification: For each type of exposed finish.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members, including wall construction, to which finned-tube radiation heaters will be attached.

2. Method of attaching finned-tube radiation heaters to building structure.
3. Penetrations of fire-rated wall and floor assemblies.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 ELECTRIC BASEBOARD RADIATION HEATERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Factory-packaged units constructed according to UL 499, UL 1030, and UL 2021.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Heating Elements: Nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded to fins, with high-temperature cutout and sensor running the full length of the element. Element supports shall eliminate thermal expansion noise.

1. Volts: <**Insert value**>.
2. Phase: <**Insert value**>.
3. Hertz: <**Insert value**>.
4. Heat Output: <**Insert W/ft.** >.

D. Enclosures: Minimum [**0.0329-inch-**] [**0.0428-inch-**] <**Insert dimension**> thick steel, removable front cover.

1. Full-height back.
2. Full-length damper.
3. End panel.
4. [**Plastic end**] [**End**] caps.
5. Inside and outside corners.
6. Joiner pieces to snap together.
7. Enclosure Height: <**Insert inches**>.
8. Enclosure Depth: <**Insert inches**>.
9. Finish: Baked-enamel finish in manufacturer's [**standard**] [**custom**] color as selected by Architect.
10. Element Brackets: Primed and painted steel to support front panel and element.

E. Rust-Resistant Enclosures: Minimum [**0.040-inch-**] [**0.052-inch-**] <**Insert dimension**> thick ASTM A653/A653M, G60 galvanized-steel, removable front cover.

1. Full-height back.
2. Full-length damper.
3. End panel.
4. [**Plastic end**] [**End**] caps.
5. Inside and outside corners.
6. Joiner pieces to snap together.
7. Enclosure Height: <**Insert inches**>.
8. Enclosure Depth: <**Insert inches**>.

9. Finish: Baked-enamel finish in manufacturer's [**standard**] [**custom**] color as selected by Architect.
10. Element Brackets: Primed and painted steel to support front panel and element.

F. Unit Controls: [**Integral line-voltage thermostat**] [**Integral electronic thermostat**] [**Remote line-voltage thermostat**].

G. Accessories:

1. Filler sections without a heating element matching the adjacent enclosure.
2. Straight-blade-type receptacles complying with DSCC W-C-596G/GEN, NEMA WD 1, NEMA WD 6, and UL 498; in color selected by Architect.

2.2 [**HOT-WATER**] [**STEAM**] BASEBOARD RADIATION HEATERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Performance Ratings: Rate baseboard radiation heaters according to Hydronics Institute's "I=B=R Testing and Rating Standard for Baseboard Radiation."

C. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on polypropylene element glides. One end of tube shall be belled.

1. Tube Diameter: [**NPS 1/2**] [**NPS 3/4**] [**NPS 1**] [**NPS 1-1/4**] <**Insert pipe size**>.
2. Fin Size: [**2-1/2 by 2-1/2 inches**] [**3 by 3 inches**] <**Insert dimensions**>.
3. Fin Spacing: [**40 per foot**] [**50 per foot**] [**58 per foot**] <**Insert value**>.
4. Number of Tiers: <**Insert number**>.
5. Heat Output: <**Insert Btu/h per ft.** >.
6. Entering-Air Temperature: [**65 deg F**] <**Insert temperature**>.
7. Average Water Temperature: [**180 deg F**] <**Insert temperature**>.
8. Minimum Water Velocity: [**1/2 fps**] <**Insert value**>.
9. Entering Steam Pressure: [**1 psig**] <**Insert value**>.

D. Heating Elements: Steel tubing mechanically expanded into flanged collars of evenly spaced steel fins resting on polypropylene element glides. Tube ends shall be threaded.

1. Tube Diameter: [**NPS 1-1/4**] <**Insert pipe size**>.
2. Fin Size: [**3 by 3 inches**] <**Insert dimensions**>.
3. Fin Spacing: [**52 per foot**] <**Insert value**>.
4. Number of Tiers: <**Insert number**>.
5. Heat Output: <**Insert Btu/h per ft.** >.
6. Entering-Air Temperature: [**65 deg F**] <**Insert temperature**>.
7. Average Water Temperature: [**180 deg F**] <**Insert temperature**>.
8. Minimum Water Velocity: [**1/2 fps**] <**Insert value**>.
9. Entering Steam Pressure: [**1 psig**] <**Insert value**>.

E. Enclosures: Minimum [**0.0329-inch-**] [**0.0428-inch-**] <**Insert dimension**> thick steel, removable front cover.

1. Full-height back.
2. Full-length damper.
3. End panel.
4. End caps.

5. Inside and outside corners.
6. Valve access door.
7. Joiner pieces to snap together.
8. Enclosure Height: <**Insert inches**>.
9. Enclosure Depth: <**Insert inches**>.
10. Finish: Baked-enamel finish in manufacturer's [**standard**] [**custom**] color as selected by Architect.
11. Element Brackets: Primed and painted steel to support front panel and element.

F. Rust-Resistant Enclosures: Minimum [**0.040-inch-**] [**0.052-inch-**] <**Insert dimension**> thick ASTM A653/A653M, G60 galvanized-steel, removable front cover.

1. Full-height back.
2. Full-length damper.
3. End panel.
4. End caps.
5. Inside and outside corners.
6. Valve access door.
7. Joiner pieces to snap together.
8. Enclosure Height: <**Insert inches**>.
9. Enclosure Depth: <**Insert inches**>.
10. Finish: Baked-enamel finish in manufacturer's [**standard**] [**custom**] color as selected by Architect.
11. Element Brackets: Primed and painted steel to support front panel and element.

2.3 ELECTRIC FINNED-TUBE RADIATION HEATERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Description: Factory-packaged units constructed according to UL 499, UL 1030, and UL 2021.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Heating Elements: Nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded to fins, with high-temperature cutout and sensor running the full length of the element. Element supports shall eliminate thermal expansion noise.

1. Volts: <**Insert value**>.
2. Phase: <**Insert value**>.
3. Hertz: <**Insert value**>.
4. Heat Output: <**Insert W/ft.** >.

D. Front Panel: Minimum [**0.0428-inch-**] [**0.0528-inch-**] <**Insert dimension**> thick steel.

E. Rust-Resistant Front Panel: Minimum [**0.052-inch-**] [**0.064-inch-**] <**Insert dimension**> thick, ASTM A653/A653M, G60 galvanized steel.

F. Wall-Mounted Back Panel: Minimum 0.0329-inch-thick steel, full height, with full-length channel support for front panel without exposed fasteners.

G. Floor-Mounted Pedestals: Conceal conduit for power and control wiring at maximum 36-inch spacing. Pedestal-mounted back panel shall be solid panel matching front panel.

H. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.

I. Finish: Baked[**-enamel**][**-epoxy**] finish in manufacturer's [**standard**] [**custom**] color as selected by Architect.

J. Damper: Knob-operated internal damper at enclosure outlet.

K. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.

L. Enclosure Style: [**Sloped**] [**Flat**] top.

1. Front Inlet Grille: Punched louver; painted to match enclosure.
2. Front Inlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.

   a. Mill-finish aluminum.
   b. Anodized finish, color as selected by Architect from manufacturer's [**standard**] [**custom**] colors.
   c. Painted to match enclosure.

3. [**Top**] [**Front**] Outlet Grille: Punched louver; painted to match enclosure.
4. [**Top**] [**Front**] Outlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.

   a. Mill-finish aluminum.
   b. Anodized finish, color as selected by Architect from manufacturer's [**standard**] [**custom**] colors.
   c. Painted to match enclosure.

5. Enclosure Height: <**Insert inches**>.
6. Enclosure Depth: <**Insert inches**>.

M. Unit Controls: Integral [**line-voltage thermostat with minimum range of 60 to 90 deg F**] [**low-voltage relay and control transformer for remote thermostat**].

N. Accessories: Integral disconnect switch, filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.

2.4 [**HOT-WATER**] [**STEAM**] FINNED-TUBE RADIATION HEATERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Performance Ratings: Rate finned-tube radiation heaters according to Hydronics Institute's "I=B=R Testing and Rating Standard for Finned-Tube (Commercial) Radiation."

C. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on element supports. One end of tube shall be belled.

1. Tube Diameter: [**NPS 3/4**] [**NPS 1**] [**NPS 1-1/4**] <**Insert pipe size**>.
2. Fin Size: [**3 by 3 inches**] [**4 by 4 inches**] <**Insert dimensions**>.
3. Fin Spacing: [**40 per foot**] [**50 per foot**] [**58 per foot**] <**Insert value**>.

4. Number of Tiers: <**Insert number**>.
5. Heat Output: <**Insert Btu/h per ft.** >.
6. Entering-Air Temperature: [**65 deg F**] <**Insert temperature**>.
7. Average Water Temperature: [**180 deg F**] <**Insert temperature**>.
8. Minimum Water Velocity: [**1/2 fps**] <**Insert value**>.
9. Entering Steam Pressure: [**1 psig**] <**Insert value**>.

D. Heating Elements: Steel tubing mechanically expanded into flanged collars of evenly spaced steel fins resting on element supports. Tube ends shall be threaded.

1. Tube Diameter: [**NPS 1-1/4**] <**Insert pipe size**>.
2. Fin Size: [**4 by 4 inches**] <**Insert dimensions**>.
3. Fin Spacing: [**52 per foot**] <**Insert value**>.
4. Number of Tiers: <**Insert number**>.
5. Heat Output: <**Insert Btu/h per ft.** >.
6. Entering-Air Temperature: [**65 deg F**] <**Insert temperature**>.
7. Average Water Temperature: [**180 deg F**] <**Insert temperature**>.
8. Minimum Water Velocity: [**1/2 fps**] <**Insert value**>.
9. Entering Steam Pressure: [**1 psig**] <**Insert value**>.

E. Element Supports: Ball-bearing cradle type to permit longitudinal movement on enclosure brackets.

F. Front Panel: Minimum [**0.0428-inch-**] [**0.0528-inch-**] <**Insert thickness**> thick steel.

G. Rust-Resistant Front Panel: Minimum [**0.052-inch-**] [**0.064-inch-**] <**Insert thickness**> thick, ASTM A653/A653M, G60 galvanized steel.

H. Wall-Mounted Back Panel: Minimum 0.0329-inch-thick steel, full height, with full-length channel support for front panel without exposed fasteners.

I. Floor-Mounted Pedestals: Conceal insulated piping at maximum 36-inch spacing. Pedestal-mounted back panel shall be solid panel matching front panel. Provide stainless-steel escutcheon for floor openings at pedestals.

J. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.

K. Finish: Baked[**-enamel**][**-epoxy**] finish in manufacturer's [**standard**] [**custom**] color as selected by Architect.

L. Damper: Knob-operated internal damper at enclosure outlet.

M. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.

N. Enclosure Style: [**Sloped**] [**Flat**] top.

1. Front Inlet Grille: Punched louver; painted to match enclosure.
2. Front Inlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.

   a. Mill-finish aluminum.
   b. Anodized finish, color as selected by Architect from manufacturer's [**standard**] [**custom**] colors.
   c. Painted to match enclosure.

3. [**Top**] [**Front**] Outlet Grille: Punched louver; painted to match enclosure.
4. [**Top**] [**Front**] Outlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.

    a. Mill-finish aluminum.
    b. Anodized finish, color as selected by Architect from manufacturer's [**standard**] [**custom**] colors.
    c. Painted to match enclosure.

5. Enclosure Height: <**Insert inches**>.
6. Enclosure Depth: <**Insert inches**>.

O. Accessories: Filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive finned-tube radiation heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for [**hydronic-piping**] [**steam-piping**] [**electrical**] connections to verify actual locations before installation of finned-tube radiation heaters.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BASEBOARD RADIATION HEATER INSTALLATION

A. Install units level and plumb.

B. Install enclosure continuously around corners, using outside and inside corner fittings.

C. Join sections with splice plates and filler pieces to provide continuous enclosure.

D. Install access doors for access to valves.

E. Install enclosure continuously from wall to wall.

F. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

G. Install valves within reach of access door provided in enclosure.

H. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.

I. Install piping within pedestals for freestanding units.

3.3 FINNED-TUBE RADIATION HEATER INSTALLATION

A. Install units level and plumb.

B. Install enclosure continuously around corners, using outside and inside corner fittings.

C. Join sections with splice plates and filler pieces to provide continuous enclosure.

D. Install access doors for access to valves.

E. Install enclosure continuously from wall to wall.

F. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

G. Install valves within reach of access door provided in enclosure.

H. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.

I. Install piping within pedestals for freestanding units.

3.4 CONNECTIONS

A. Piping installation requirements are specified in [**Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."**] [**Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."**] Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot-water finned-tube radiation heaters and components to piping according to Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."

1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.

C. Connect steam finned-tube radiation heaters and components to piping according to Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."

1. Install shutoff valve on inlet; install strainer, steam trap, and shutoff valve on outlet.

D. Install control valves as required by Section 230923.11 "Control Valves."

E. Install piping adjacent to finned-tube radiation heaters to allow service and maintenance.

F. Ground electric finned-tube radiation heaters according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 238236

SECTION 238239.19 - WALL AND CEILING UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Wall and ceiling unit heaters with propeller fans and electric-resistance heating coils.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Sustainable Design Submittals:

1. <Double click to insert sustainable design text for HVAC units.>

C. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include details of anchorages and attachments to structure and to supported equipment.
4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
5. Wiring Diagrams: Power, signal, and control wiring.

D. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 WALL AND CEILING UNIT HEATERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Heaters: Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

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 CABINET

A. Front Panel: [**Stamped-steel louver**] [**Extruded-aluminum bar grille**], with removable panels fastened with tamperproof fasteners.

B. Finish: Baked enamel over baked-on primer with manufacturer's [**standard**] [**custom**] color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

C. Airstream Surfaces: Surfaces in contact with the airstream comply with requirements in ASHRAE 62.1.

D. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

2.3 FAN AND MOTOR

A. Fan: Aluminum propeller directly connected to motor.

B. Motor: Permanently lubricated[**, multispeed**]. Comply with requirements in Section 230500 "Common Work Results for HVAC."

2.4 CONTROLS

A. Controls: Unit-mounted thermostat.[**Low-voltage relay with transformer kit.**]

B. Electrical Connection: Factory wire motors and controls for a single field connection[**with disconnect switch**].

2.5 CAPACITIES AND CHARACTERISTICS

A. Airflow: <**Insert cfm**>.

B. Fan Speed: <**Insert rpm**>.

C. Heating Coil: <**Insert kilowatts**>.

D. Electrical Characteristics for Single-Point Connection:

1. Volts: <**Insert value**>.
2. Phase: <**Insert value**>.
3. Hertz: <**Insert value**>.
4. Full-Load Amperes: <**Insert value**>.
5. Minimum Circuit Ampacity: <**Insert value**>.
6. Maximum Overcurrent Protection: <**Insert amperage**>.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WALL AND CEILING UNIT HEATERS

A. Install wall and ceiling unit heaters to comply with NFPA 90A.

B. Install wall and ceiling unit heaters level and plumb.

C. Install wall-mounted 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.

D. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 238239.19

Table of Contents Generated by MasterWorks: 12/11/2024

Division	Section Title	Pages
	SPECIFICATIONS GROUP	
	Facility Services Subgroup	
DIVISION 26 - ELECTRICAL		
260519	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES	12
260523	CONTROL-VOLTAGE ELECTRICAL POWER CABLES	14
260526	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS	10
260529	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS	8
260533	RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS	16
260536	CABLE TRAYS FOR ELECTRICAL SYSTEMS	10
260543	UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS	12
260544	SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING	4
260548.16	SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS	7
260553	IDENTIFICATION FOR ELECTRICAL SYSTEMS	15
260573.13	SHORT-CIRCUIT STUDIES	6
260573.16	COORDINATION STUDIES	9
260573.19	ARC-FLASH HAZARD ANALYSIS	8
260923	LIGHTING CONTROL DEVICES	12
262213	LOW-VOLTAGE DISTRIBUTION TRANSFORMERS	9
262413	SWITCHBOARDS	18
262416	PANELBOARDS	14
262726	WIRING DEVICES	29
262813	FUSES	4
265119	LED INTERIOR LIGHTING	17
265213	EMERGENCY AND EXIT LIGHTING	10
265619	LED EXTERIOR LIGHTING	11
DIVISION 27 - COMMUNICATIONS		
271100	COMMUNICATIONS EQUIPMENT ROOM FITTINGS	8
271300	COMMUNICATIONS BACKBONE CABLING	11
271500	COMMUNICATIONS HORIZONTAL CABLING	12
DIVISION 28 - ELECTRONIC SAFETY AND SECURITY		
284621.11	ADDRESSABLE FIRE-ALARM SYSTEMS	30

END OF TABLE OF CONTENTS

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. Copper building wire rated 600 V or less.
2. Aluminum building wire rated 600 V or less.
3. Metal-clad cable, Type MC, rated 600 V or less.
4. Armored cable, Type AC, rated 600 V or less.
5. Mineral-insulated cable, Type MI, rated 600 V or less.
6. Tray cable, Type TC, rated 600 V or less.
7. Fire-alarm wire and cable.
8. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35,000 V.
2. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.
3. Section 271313 "Communications Copper Backbone Cabling" for twisted pair cabling used for data circuits.
4. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair cabling used for data circuits.

1.3 DEFINITIONS

A. PV: Photovoltaic.

B. RoHS: Restriction of Hazardous Substances.

C. VFC: Variable-frequency controller.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: Indicate type, use, location, and termination locations.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Owner and Engineer Review/Approval.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member Company of NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alpha Wire Company.
2. American Bare Conductor.
3. Belden Inc.
4. Cerro Wire LLC.
5. Encore Wire Corporation.
6. General Cable Technologies Corporation.
7. Okonite Company (The).
8. Service Wire Co.
9. Southwire Company.
10. WESCO.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

E. Conductor Insulation:

1. Type RHH and Type RHW-2: Comply with UL 44.
2. Type USE-2 and Type SE: Comply with UL 854.
3. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
4. Type THHN and Type THWN-2: Comply with UL 83.

5. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
6. Type XHHW-2: Comply with UL 44.

F. Shield:

1. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.

2.2 ALUMINUM BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn aluminum current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alpha Wire Company.
2. American Bare Conductor.
3. Belden Inc.
4. Cerro Wire LLC.
5. Encore Wire Corporation.
6. General Cable Technologies Corporation.
7. Okonite Company (The).
8. Southwire Company.
9. WESCO.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Aluminum, complying with ASTM B 800 and ASTM B 801.

E. Conductor Insulation:

1. Type RHH and Type RHW-2: Comply with UL 44.
2. Type USE-2 and Type SE: Comply with UL 854.
3. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
4. Type THHN and Type THWN-2: Comply with UL 83.
5. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
6. Type XHHW-2: Comply with UL 44.

2.3 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems; a part of Atkore International.
2. Alpha Wire Company.
3. American Bare Conductor.
4. Belden Inc.
5. Encore Wire Corporation.
6. General Cable Technologies Corporation.
7. Okonite Company (The).
8. Service Wire Co.
9. Southwire Company.
10. WESCO.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. RoHS compliant.
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

1. Single circuit and Multi-circuit with color-coded conductors.
2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors. Aluminum, complying with ASTM B 800 and ASTM B 801.

F. Ground Conductor: Bare or Insulated.

G. Conductor Insulation:

1. Type TFN/THHN/THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

H. Armor: Steel or Aluminum, interlocked.

I. Jacket: PVC applied over armor.

2.4 ARMORED CABLE, TYPE AC

A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in an overall metallic sheath.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems; a part of Atkore International.
2. Alpha Wire Company.
3. American Bare Conductor.

4. Belden Inc.
5. Cerro Wire LLC.
6. Encore Wire Corporation.
7. General Cable Technologies Corporation.
8. Okonite Company (The).
9. Service Wire Co.
10. Southwire Company.
11. WESCO.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Comply with UL 4.
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

1. Single circuit and Multi-circuit with color-coded conductors.
2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors. Aluminum, complying with ASTM B 800 and ASTM B 801.

F. Ground Conductor: Insulated.

G. Conductor Insulation: Type THHN/THWN-2. Comply with UL 83.

H. Armor: Steel or Aluminum, interlocked.

2.5 TRAY CABLE, TYPE TC

A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in a nonmetallic jacket.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alpha Wire Company.
2. Belden Inc.
3. Encore Wire Corporation.
4. General Cable Technologies Corporation.
5. Okonite Company (The).
6. Service Wire Co.
7. Southwire Company.
8. WESCO.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

2. RoHS compliant.
3. Comply with UL 1277.
4. Comply with ICEA S-73-532/NEMA WC 57 for Type TC cables used for control, thermocouple extension, and instrumentation.
5. Comply with ICEA S-95-658/NEMA WC 70 for Type TC cables used for power distribution.
6. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors. Aluminum, complying with ASTM B 800 and ASTM B 801.

E. Ground Conductor: Bare or Insulated.

F. Conductor Insulation: Type XHHW-2. Comply with UL 44.

G. Shield: Metallic.

2.6 FIRE-ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Wire & Cable Inc.
2. CommScope, Inc.
3. Comtran Corporation.
4. Draka Cableteq USA; a Prysmian Group company.
5. Genesis Cable Products; Honeywell International, Inc.
6. Radix Wire.
7. Rockbestos-Suprenant Cable Corp.
8. Superior Essex Inc.
9. West Penn Wire.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

2.7 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. 3M Electrical Products.
2. AFC Cable Systems; a part of Atkore International.
3. Gardner Bender.
4. Hubbell Power Systems, Inc.
5. Ideal Industries, Inc.
6. ILSCO.
7. NSi Industries LLC.
8. O-Z/Gedney; a brand of Emerson Industrial Automation.
9. Service Wire Co.
10. TE Connectivity Ltd.
11. Thomas & Betts Corporation; a Member of the ABB Group.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Material: Copper or Aluminum.
2. Type: One or Two hole with long barrels.
3. Termination: Compression or Crimp.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

D. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

E. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.

F. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway.

B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway, Type XHHW-2, single conductors in raceway Armored cable, Type AC Metal-clad cable, Type MC.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway Armored cable, Type AC Metal-clad cable, Type MC.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway Type XHHW-2, single conductors in raceway.

E. Feeders Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway Armored cable, Type AC Metal-clad cable, Type MC.

F. Feeders in Cable Tray: Type THHN/THWN-2, single conductors in raceway Type XHHW-2, single conductors larger than No. 1/0 AWG Armored cable, Type AC Metal-clad cable, Type MC.

G. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway Armored cable, Type AC Metal-clad cable, Type MC.

H. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway Armored cable, Type AC Metal-clad cable, and Type MC. Type Nonmetallic-sheathed cable, **Type NM, is not permitted in this project.**

I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway Type XHHW-2, single conductors in raceway.

J. Branch Circuits Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway Armored cable, Type AC Metal-clad cable, Type MC.

K. Branch Circuits in Cable Tray: Type THHN/THWN-2, single conductors in raceway Type XHHW-2, single conductors larger than No. 1/0 AWG Armored cable, Type AC Metal-clad cable, Type MC.

L. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, and strain relief device at terminations to suit application.

M. VFC Output Circuits: Type XHHW-2 in metal conduit Type TC-ER cable with braided shield Type TC-ER cable with dual tape shield.

N. PV Circuits: Type USE-2 for PV source circuits rated at 600 V or less.

O. PV Circuits: Type PV for PV source circuits rated at 600 V.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means; including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

3.4 INSTALLATION OF FIRE-ALARM WIRING

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal pathway according to Section 270528.29 "Hangers and Supports for Communications Systems."

1. Install plenum cable in environmental airspaces, including plenum ceilings.
2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system shall be installed in a dedicated pathway system. This system shall not be used for any other wire or cable.

C. Wiring Method:

1. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
2. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is permitted.
3. Signaling Line Circuits: Power-limited fire-alarm cables shall not be installed in the same cable or pathway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-

code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.

G. Risers: Install at least two vertical cable risers to serve the fire-alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.

H. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.

1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

D. Comply with requirements in Section 283111 "Digital, Addressable Fire-Alarm System" for connecting, terminating, and identifying wires and cables.

3.6 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.8 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements:

    a. Generator

    b. Panels

    c. Mechanical

    d. .

3. Perform each of the following visual and electrical tests:

    a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
    b. Test bolted connections for high resistance using one of the following:

        1) A low-resistance ohmmeter.
        2) Calibrated torque wrench.
        3) Thermographic survey.

    c. Inspect compression-applied connectors for correct cable match and indentation.
    d. Inspect for correct identification.
    e. Inspect cable jacket and condition.
    f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
    g. Continuity test on each conductor and cable.
    h. Uniform resistance of parallel conductors.

4. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

    a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

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. Backboards.
2. Category 5e balanced twisted pair cable.
3. Category 6 balanced twisted pair cable.
4. Category 6a balanced twisted pair cable.
5. Balanced twisted pair cabling hardware.
6. RS-485 cabling.
7. Low-voltage control cabling.
8. Control-circuit conductors.
9. Identification products.

B. Section Includes:

1. This project includes the requirements of the Build America Buy America (2CFR Part 184), which requires Made in America products to be preferred above all others.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

D. RCDD: Registered Communications Distribution Designer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency, RCDD, layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: 60 inches (1520 mm) or less.
2. Peak Optical Smoke Density: 0.5 or less.
3. Average Optical Smoke Density: 0.15 or less.

C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

E. RoHS compliant.

2.2 BACKBOARDS

A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels in Section 061000 "Rough Carpentry."

B. Painting: Paint plywood on all sides and edges with flat white paint. Comply with requirements in Section 099123 "Interior Painting."

2.3 CATEGORY 5e BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AMP NETCONNECT; a TE Connectivity Ltd. company.
2. Belden Inc.
3. Berk-Tek Leviton; a Nexans/Leviton alliance.
4. CommScope, Inc.
5. General Cable; General Cable Corporation.
6. Hitachi Cable America Inc.
7. Mohawk; a division of Belden Networking, Inc.
8. SYSTIMAX Solutions; a CommScope Inc. brand.
9. West Penn Wire.

C. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables.

D. Conductors: 100-ohm, 24 AWG solid copper.

E. Shielding/Screening: Shielded twisted pairs (FTP), Screened twisted pairs (F/UTP), or Screened and shielded twisted pairs (F/FTP).

F. Cable Rating: Riser and Plenum.

G. Jacket: White thermoplastic.

2.4 CATEGORY 6 BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. 3M.
2. AMP NETCONNECT; a TE Connectivity Ltd. company.
3. Belden CDT Networking Division/NORDX.
4. Berk-Tek Leviton; a Nexans/Leviton alliance.
5. CommScope, Inc.
6. Draka USA.
7. General Cable; General Cable Corporation.
8. Genesis Cable Products; Honeywell International, Inc.
9. Hitachi Cable America Inc.
10. Mohawk; a division of Belden Networking, Inc.
11. Superior Essex Inc.
12. SYSTIMAX Solutions; a CommScope Inc. brand.

C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

E. Shielding/Screening: Shielded twisted pairs (FTP), Screened twisted pairs (F/UTP), or Screened and shielded twisted pairs (F/FTP).

F. Cable Rating: Riser and Plenum.

G. Jacket: Yellow thermoplastic.

2.5 CATEGORY 6a BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. 3M.
2. AMP NETCONNECT; a TE Connectivity Ltd. company.
3. Belden CDT Networking Division/NORDX.
4. Berk-Tek Leviton; a Nexans/Leviton alliance.
5. CommScope, Inc.
6. Draka USA.
7. General Cable; General Cable Corporation.
8. Genesis Cable Products; Honeywell International, Inc.
9. Hitachi Cable America Inc.
10. Mohawk; a division of Belden Networking, Inc.
11. Superior Essex Inc.
12. SYSTIMAX Solutions; a CommScope Inc. brand.

C. Standard: Comply with TIA-568-C.2 for Category 6a cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

E. Shielding/Screening: Shielded twisted pairs (FTP), Screened twisted pairs (F/UTP), or Screened and shielded twisted pairs (F/FTP).

F. Cable Rating: Riser and Plenum.

G. Jacket: Yellow thermoplastic.

2.6 BALANCED TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. 3M.
2. American Technology Systems Industries, Inc.
3. AMP NETCONNECT; a TE Connectivity Ltd. company.

4. Belden CDT Networking Division/NORDX.
5. Berk-Tek Leviton; a Nexans/Leviton alliance.
6. CommScope, Inc.
7. Draka USA.
8. Dynacom Corporation.
9. General Cable; General Cable Corporation.
10. Genesis Cable Products; Honeywell International, Inc.
11. Hubbell Premise Wiring.
12. KRONE Incorporated.
13. Leviton Manufacturing Co., Inc.
14. Mohawk; a division of Belden Networking, Inc.
15. Molex Premise Networks.
16. Panduit Corp.
17. Siemon Co. (The).
18. Superior Essex Inc.
19. SYSTIMAX Solutions; a CommScope Inc. brand.

C. General Requirements for Balanced Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 6.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

D. Source Limitations: Obtain balanced twisted pair cable hardware from single source from single manufacturer.

E. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

F. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

G. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.
c. Replaceable connectors.
d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on 19-inch (483 mm) equipment racks.
3. Number of Jacks per Field: One for each four-pair cable indicated.

H. Patch Cords: Factory-made, four-pair cables in 36-inch (900-mm)lengths; terminated with an eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.

2. Patch cords shall have color-coded boots for circuit identification.

I. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.
2. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.
3. Marked to indicate transmission performance.

J. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standards:

    a. Category 5e, unshielded balanced twisted pair cable shall comply with IEC 60603-7-2.
    b. Category 5e, shielded balanced twisted pair cable shall comply with IEC 60603-7-3.
    c. Category 6, unshielded balanced twisted pair cable shall comply with IEC 60603-7-4.
    d. Category 6, shielded balanced twisted pair cable shall comply with IEC 60603-7.5.
    e. Category 6a, unshielded balanced twisted pair cable shall comply with IEC 60603-7-41.
    f. Category 6a, shielded balanced twisted pair cable shall comply with IEC 60603-7.51.

4. Marked to indicate transmission performance.

K. Faceplate:

1. Two port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
2. Eight port, vertical double-gang faceplates designed to mount to double-gang wall boxes.
3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
4. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
5. For use with snap-in jacks accommodating any combination of balanced twisted pair, optical fiber, and coaxial work area cords.

    a. Flush mounting jacks, positioning the cord at a 45-degree angle.

L. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.7 TWIN-AXIAL DATA HIGHWAY CABLE

A. Standard Cable: NFPA 70, Type CM.

1. Paired, 4 pairs, No. 20 AWG, stranded (7x28) tinned-copper conductors.
2. Polypropylene insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. PVC jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 4 pairs, No. 20 AWG, stranded (7x28) tinned-copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned-copper drain wire.
6. Flame Resistance: Comply with NFPA 262.
7. <Double click to insert sustainable design text for lead content.>

2.8 RS-232 CABLE

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. PVC-Jacketed, TIA 232-F:

1. Three, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Polypropylene insulation.
3. Aluminum foil-polyester tape shield with 100 percent shield coverage.
4. PVC jacket.
5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. NFPA 70 Type: Type CM.
7. Flame Resistance: Comply with UL 1581.

C. Plenum-Type, TIA 232-F:

1. Three, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. PE insulation.
3. Aluminum foil-polyester tape shield with 100 percent shield coverage.
4. Fluorinated ethylene propylene jacket.
5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.9 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CMG.

1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262.

2.10 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.11 CONTROL-CIRCUIT CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Encore Wire Corporation.
2. General Cable; General Cable Corporation.
3. Service Wire Co.
4. Southwire Company.

B. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway Type XHHW-2, complying with UL 44 in raceway.

C. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway Type XHHW-2, complying with UL 44 in raceway power-limited cable, concealed in building finishes power-limited tray cable, in cable tray.

D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway Type XHHW-2, complying with UL 44 in raceway power-limited cable,

concealed in building finishes power-limited tray cable, in cable tray Type TW or Type TF, complying with UL 83, in raceway.

E. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.

1. Smoke control signaling and control circuits.

2.12 FIRE-ALARM WIRE AND CABLE

A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG size as recommended by system manufacturer.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
3. Multi-conductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

2.13 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test twisted pair cables according to TIA-568-C.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wire ways as supplemented or modified in this Section.

1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.
2. Outlet boxes for cables shall be no smaller than 4 inches (102 mm) square by 2-1/8 inches (53 mm) deep with extension ring sized to bring edge of ring to within 1/8 inch (3.1 mm) of the finished wall surface.
3. Flexible metal conduit shall not be used.

B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering the room from overhead.
4. Extend conduits 3 inches (75 mm) above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. 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.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.

8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before derailing. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
15. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

C. Balanced Twisted Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware as specified in Section 271513 "Communications Copper Horizontal Cabling" unless otherwise indicated.
3. Do not untwist balanced twisted pair cables more than 1/2 inch (12 mm) at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.
3. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wire way or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 30 inches (760 mm) apart.
3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Below each feed point, neatly coil a minimum of 72 inches (1830 mm) of cable in a coil not less than 12 inches (305 mm) in diameter.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches (305 mm).
c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches (600 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches (305 mm).

4. 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 or Circuit Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.5 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.6 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 GROUNDING

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections:

1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

F. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

G. End-to-end cabling will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports.

END OF SECTION 260523

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

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 grounding and bonding systems and equipment.

B. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Ground bonding common with lightning protection system.
3. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

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

B. Sustainable Design Submittals:

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.
3. Ground rings.
4. Grounding arrangements and connections for separately derived systems.

B. Qualification Data: For testing agency and testing agencies field supervisor.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Plans showing as-built, dimensioned locations of system described in "Field Quality Control" Article, including the following:

1) Test wells.
2) Ground rods.
3) Ground rings.
4) Grounding arrangements and connections for separately derived systems.

b. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, and grounding connections for separately derived systems based on NFPA 70B.

1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
2) Include recommended testing intervals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advanced Lightning Technology, Ltd.
2. Burndy; Part of Hubbell Electrical Systems.
3. Dossert; AFL Telecommunications LLC.
4. ERICO; a brand of nVent.
5. Fushi Copperweld Inc.
6. Galvan Industries, Inc.; Electrical Products Division, LLC.
7. Harger Lightning & Grounding.
8. ILSCO.
9. O-Z/Gedney; a brand of Emerson Industrial Automation.
10. Robbins Lightning, Inc.
11. Siemens Industry, Inc., Energy Management Division.
12. Thomas & Betts Corporation; a Member of the ABB Group.

2.3 CONDUCTORS

A. Insulated Conductors: Copper or tinned-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 B3.
2. Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) 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 (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression or exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.

E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

F. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

G. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

H. Conduit Hubs: Mechanical type, terminal with threaded hub.

I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt or socket set screw.

J. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

K. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

L. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.

M. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.

N. Straps: Solid copper, cast-bronze clamp or copper lugs. Rated for 600 A.

O. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal two-piece clamp.

P. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

Q. Water Pipe Clamps:

1. Mechanical type, two pieces with zinc-plated or stainless-steel bolts.

   a. Material: Tin-plated aluminum or Die-cast zinc alloy.
   b. Listed for direct burial.

2. U-bolt type with malleable-iron clamp and copper ground connector rated for direct burial.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad; 3/4 inch by 10 feet (19 mm by 3 m).

B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.

1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
2. Backfill Material: Electrode manufacturers recommended material.

C. Ground Plates: 1/4 inch (6 mm) thick, hot-dip galvanized.

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. Underground Grounding Conductors: Install bare tinned- copper conductor, No. 2/0 AWG minimum.

1. Bury at least 30 inches (750 mm) below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Grounding Conductors: Green-colored insulation with continuous yellow stripe.

D. Isolated Grounding Conductors: Green-colored insulation with more than one 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.

E. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

F. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, no shrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-

copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

3.5 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

G. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

H. Metallic Fences: Comply with requirements of IEEE C2.

1. Grounding Conductor: Bare, tinned copper, not less than No. 8 AWG.
2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.6 FENCE GROUNDING

A. 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.
2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (460 mm) below finished grade.

B. 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.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.

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. 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 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. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. Use exothermic welds for all below-grade connections.
3. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.

1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. 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 bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned **bonding** jumper to bond across flexible duct connections to achieve continuity.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column or indicated item, extending around the perimeter of building.

1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches (600 mm) from building's foundation.

J. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

K. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet (6.0 m) long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.

L. 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.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

F. Grounding system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).
5. Substations and Pad-Mounted Equipment: 5 ohms.
6. Manhole Grounds: 10 ohms.

I. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

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. Steel slotted support systems.
2. Aluminum slotted support systems.
3. Nonmetallic slotted support systems.
4. Conduit and cable support devices.
5. Support for conductors in vertical conduit.
6. Structural steel for fabricated supports and restraints.
7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
8. Fabricated metal equipment support assemblies.

B. Related Requirements:

1. Section 260548.16 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

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 the following:

   a. Slotted support systems, hardware, and accessories.
   b. Clamps.
   c. Hangers.
   d. Sockets.
   e. Eye nuts.
   f. Fasteners.
   g. Anchors.
   h. Saddles.
   i. Brackets.

2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.
2. Slotted support systems.
3. Equipment supports.
4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For hangers and supports for electrical systems.

1. Include design calculations and details of hangers.
2. Include design calculations for seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Ductwork, piping, fittings, and supports.
3. Structural members to which hangers and supports will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

a. Luminaires.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Projectors.

B. Seismic Qualification Data: Certificates, for hangers and supports for electrical equipment and systems, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline 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 and their installation requirements.

C. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M or AWS D1.2/D1.2M.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M.
2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.

B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the supported equipment and systems will be fully operational after the seismic event."
2. Component Importance Factor: 1.5.
3. See ASCE/SEI 7, Coefficients for Architectural Component Table and Seismic Coefficients for Mechanical and Electrical Components Table for requirements to be inserted in subparagraph below.

C. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame Rating: Class 1.
2. Self-extinguishing according to ASTM D 635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-(10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c. in at least one surface.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit; a part of Atkore International.
b. B-line, an Eaton business.
c. CADDY; a brand of nVent.
d. Flex-Strut Inc.
e. Gripple Inc.
f. GS Metals Corp.
g. G-Strut.
h. Haydon Corporation.
i. Metal Ties Innovation.
j. MIRO Industries.
k. Thomas & Betts Corporation; a Member of the ABB Group.
l. Unistrut; Part of Atkore International.
m. Wesanco, Inc.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.

3. Material for Channel, Fittings, and Accessories: Galvanized steel, Plain steel, Stainless steel, Type 304, or Stainless steel, Type 316.
4. Channel Width: Selected for applicable load criteria 1-5/8 inches (41.25 mm).
5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c. in at least one surface.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Cooper Industries, Inc.
   b. Flex-Strut Inc.
   c. Haydon Corporation.
   d. MKT Metal Manufacturing.
   e. Thomas & Betts Corporation; a Member of the ABB Group.
   f. Unistrut; Part of Atkore International.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.

3. Channel Material: 6063-T5 aluminum alloy.
4. Fittings and Accessories Material: 5052-H32 aluminum alloy.
5. Channel Width: Selected for applicable load criteria 1-5/8 inches (41.25 mm).
6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least one surface.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Allied Tube & Conduit; a part of Atkore International.
   b. B-line, an Eaton business.
   c. Fabco Plastics Wholesale Limited.
   d. G-Strut.
   e. Haydon Corporation.
   f. Seasafe, Inc.; AMICO, a Gibraltar Industries Company.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Channel Width: Selected for applicable load criteria 1-5/8 inches (41.25 mm).
4. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.

5. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
6. Rated Strength: Selected to suit applicable load criteria.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

D. Conduit and Cable Support Devices: Steel or Stainless-steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) Hilti, Inc.
      2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co., Inc.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) B-line, an Eaton business.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti, Inc.
      4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F 3125/F 3125M, Grade A325 (Grade A325M).
6. Toggle Bolts: All Stainless-steel springhead type.

7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA 101
3. NECA 102.
4. NECA 105.
5. NECA 111.

B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and IMC may be supported by openings through structure members, according to NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69, or Spring-tension clamps.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete." Section 033053 "Miscellaneous Cast-in-Place Concrete."

C. Anchor equipment to concrete base as follows:

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in Section 099113 "Exterior Painting" Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

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. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Metal wire ways and auxiliary gutters.
4. Nonmetal wire ways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for firestopping at conduit and box entrances.
2. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.
3. Section 270528 "Pathways for Communications Systems" for conduits, wire ways, surface pathways, inner duct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wire ways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Sustainable Design Submittals:

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

D. Samples: For wire ways, nonmetallic wire ways, and surface raceways and for each color and texture specified, 12 inches (300 mm) long.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Seismic Qualification Data: Certificates, for enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline 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 and their installation requirements.
4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AFC Cable Systems; a part of Atkore International.
b. Allied Tube & Conduit; a part of Atkore International.
c. Anamet Electrical, Inc.
d. Calconduit.
e. Electri-Flex Company.
f. FSR Inc.
g. Korkap.
h. NEC, Inc.
i. Opti-Com Manufacturing Network, Inc (OMNI).
j. O-Z/Gedney; a brand of Emerson Industrial Automation.
k. Patriot Aluminum Products, LLC.
l. Perma-Cote.
m. Picoma Industries, Inc.
n. Plasti-Bond.

o. Republic Conduit.
p. Southwire Company.
q. Thomas & Betts Corporation; a Member of the ABB Group.
r. Topaz Electric; a division of Topaz Lighting Corp.
s. Western Tube and Conduit Corporation.
t. Wheatland Tube Company.

2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3. GRC: Comply with ANSI C80.1 and UL 6.
4. ARC: Comply with ANSI C80.5 and UL 6A.
5. IMC: Comply with ANSI C80.6 and UL 1242.
6. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit IMC.

a. Comply with NEMA RN 1.
b. Coating Thickness: 0.040 inch (1 mm), minimum.

7. EMT: Comply with ANSI C80.3 and UL 797.
8. FMC: Comply with UL 1; zinc-coated steel or aluminum.
9. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AFC Cable Systems; a part of Atkore International.
b. Allied Tube & Conduit; a part of Atkore International.
c. Anamet Electrical, Inc.
d. Calconduit.
e. Electri-Flex Company.
f. FSR Inc.
g. Korkap.
h. NEC, Inc.
i. NewBasis.
j. Opti-Com Manufacturing Network, Inc (OMNI).
k. O-Z/Gedney; a brand of Emerson Industrial Automation.
l. Patriot Aluminum Products, LLC.
m. Perma-Cote.
n. Picoma Industries, Inc.
o. Plasti-Bond.
p. Republic Conduit.
q. Southwire Company.
r. Thomas & Betts Corporation; a Member of the ABB Group.
s. Topaz Electric; a division of Topaz Lighting Corp.
t. Western Tube and Conduit Corporation.
u. Wheatland Tube Company.

2. Comply with NEMA FB 1 and UL 514B.

3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Fittings, General: Listed and labeled for type of conduit, location, and use.

5. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
6. Fittings for EMT:

    a. Material: Steel.
    b. Type: Setscrew or compression.

7. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
8. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AFC Cable Systems; a part of Atkore International.
    b. Anamet Electrical, Inc.
    c. Arnco Corporation.
    d. CANTEX INC.
    e. CertainTeed Corporation.
    f. Champion Fiberglass, Inc.
    g. Condux International, Inc.
    h. Electri-Flex Company.
    i. FRE Composites.
    j. Kraloy.
    k. Lamson & Sessions.
    l. Niedax Inc.
    m. RACO; Hubbell.
    n. Thomas & Betts Corporation; a Member of the ABB Group.
    o. Topaz Electric; a division of Topaz Lighting Corp.
    p. United Fiberglass.

2. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Fiberglass:

    a. Comply with NEMA TC 14.
    b. Comply with UL 2515 for aboveground raceways.
    c. Comply with UL 2420 for belowground raceways.

4. ENT: Comply with NEMA TC 13 and UL 1653.
5. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
6. LFNC: Comply with UL 1660.
7. Rigid HDPE: Comply with UL 651A.

8. Continuous HDPE: Comply with UL 651A.
9. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.
10. RTRC: Comply with UL 2515A and NEMA TC 14.

B. Nonmetallic Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AFC Cable Systems; a part of Atkore International.
   b. Anamet Electrical, Inc.
   c. Arnco Corporation.
   d. CANTEX INC.
   e. CertainTeed Corporation.
   f. Champion Fiberglass, Inc.
   g. Condux International, Inc.
   h. Electri-Flex Company.
   i. FRE Composites.
   j. Kraloy.
   k. Lamson & Sessions.
   l. Niedax Inc.
   m. RACO; Hubbell.
   n. Thomas & Betts Corporation; a Member of the ABB Group.
   o. Topaz Electric; a division of Topaz Lighting Corp.
   p. United Fiberglass.

2. Fittings, General: Listed and labeled for type of conduit, location, and use.

3. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

   a. Fittings for LFNC: Comply with UL 514B.

4. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line, an Eaton business.
2. Hoffman; a brand of nVent.
3. MonoSystems, Inc.
4. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 or Type 3R unless otherwise indicated, and sized according to NFPA 70.

1. Metal wire ways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wire ways as required for complete system.

D. Wire way Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Moulded Products, Inc.
2. Hoffman; a brand of nVent.
3. Lamson & Sessions.
4. Niedax Inc.

B. Listing and Labeling: Nonmetallic wire ways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

D. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

E. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wire ways as required for complete system.

F. Solvents and Adhesives: As recommended by conduit manufacturer.

2.5 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hubbell Incorporated; Wiring Device-Kellems.
b. MonoSystems, Inc.
c. Panduit Corp.
d. Wiremold / Legrand.

C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Hubbell Incorporated.
   b. MonoSystems, Inc.
   c. Panduit Corp.
   d. Wiremold / Legrand.

D. Tele-Power Poles:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. MonoSystems, Inc.
   b. Panduit Corp.
   c. Wiremold / Legrand.

2. Material: Galvanized steel with ivory baked-enamel finish.

3. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.6 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Adalet.
2. Crouse-Hinds, an Eaton business.
3. EGS/Appleton Electric.
4. Erickson Electrical Equipment Company.
5. FSR Inc.
6. Hoffman; a brand of nVent.
7. Hubbell Incorporated.
8. Hubbell Incorporated; Wiring Device-Kellems.
9. Kraloy.
10. Milbank Manufacturing Co.
11. MonoSystems, Inc.
12. Oldcastle Enclosure Solutions.
13. O-Z/Gedney; a brand of Emerson Industrial Automation.
14. Plasti-Bond.
15. RACO; Hubbell.
16. Spring City Electrical Manufacturing Company.
17. Stahlin Non-Metallic Enclosures.
18. Thomas & Betts Corporation; a Member of the ABB Group.
19. Topaz Electric; a division of Topaz Lighting Corp.
20. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Metal Floor Boxes:

1. Material: Cast metal or sheet metal.
2. Type: Fully adjustable or Semi-adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Nonmetallic Floor Boxes: Nonadjustable, round or rectangular.

1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

I. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).

1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

J. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

K. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

L. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

M. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).

N. Gangable boxes are allowed.

O. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic or Fiberglass.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

P. Cabinets:

1. NEMA 250, Type 1 or Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armorcast Products Company.
   b. NewBasis.
   c. Oldcastle Enclosure Solutions.
   d. Oldcastle Precast, Inc.
   e. Quazite: Hubbell Power Systems, Inc.

2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC.".
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete or reinforced concrete.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armorcast Products Company.
   b. NewBasis.

c. Nordic Fiberglass, Inc.
d. Oldcastle Enclosure Solutions.
e. Oldcastle Enclosure Solutions.
f. Oldcastle Precast, Inc.
g. Quazite: Hubbell Power Systems, Inc.

2. Standard: Comply with SCTE 77.
3. Color of Frame and Cover: Gray.
4. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
7. Cover Legend: Molded lettering, "ELECTRIC.".
8. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
9. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.8 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC or IMC.
2. Concealed Conduit, Aboveground: GRC, IMC, EMT.
3. Underground Conduit: RNC or Type EPC-40-PVC.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT or RNC identified for such use.
3. Exposed and Subject to Severe Physical Damage: GRC or IMC. Raceway locations include the following:

a. Loading dock.
b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
c. Mechanical rooms.
d. Gymnasiums.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT, ENT, or RNC, Type EPC-40-PVC.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC, or IMC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch (21-mm) 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. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

G. Install surface raceways only where indicated on Drawings.

H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

3.2 INSTALLATION

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

D. Do not fasten conduits onto the bottom side of a metal deck roof.

E. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

F. Complete raceway installation before starting conductor installation.

G. Arrange stub-ups so curved portions of bends are not visible above finished slab.

H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

K. Support conduit within 12 inches (300 mm) of enclosures to which attached.

L. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to RNC, Type EPC-40-PVC, GRC or IMC before rising above floor.

M. Stub-Ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

O. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

P. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

R. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

S. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

T. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

U. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

V. Surface Raceways:

1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

W. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

X. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Conduit extending from interior to exterior of building.
4. Conduit extending into pressurized duct and equipment.
5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
6. Where otherwise required by NFPA 70.

Y. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

Z. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.

d. Attics: 135 deg F (75 deg C) temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

AA. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 36 inches (915 mm) of flexible conduit for recessed and semi recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

BB. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

CC. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a rain tight connection between box and cover plate or supported equipment and box.

DD. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

EE. Locate boxes so that cover or plate will not span different building finishes.

FF. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

GG. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

HH. Set metal floor boxes level and flush with finished floor surface.

II. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install handholes with bottom below frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install 0sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260536 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

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. Ladder cable tray.
2. Wire-mesh cable tray.
3. Single-rail cable tray.
4. Solid-bottom cable tray.
5. Trough cable tray.
6. Channel cable tray.
7. Fiberglass cable tray.
8. Fiberglass channel cable tray.
9. Cable tray accessories.
10. Warning signs.

B. Related Requirements:

1. Section 270536 "Cable Trays for Communications Systems" for cable trays and accessories serving communications systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

   a. Vertical and horizontal offsets and transitions.
   b. Clearances for access above and to sides of cable trays.
   c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
   d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Delegated-Design Submittal: For seismic restraints.

1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer who is licensed in the state where Project is located and who is responsible for their preparation.
2. Design Calculations: Calculate requirements for selecting seismic restraints.
3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
2. Vertical and horizontal offsets and transitions.
3. Clearances for access above and to side of cable trays.
4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

B. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline 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 and their installation requirements.

C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.

B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."
2. Component Importance Factor: 1.5.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAY

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles on individual cable tray types for specific values for the following parameters:

1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 LADDER CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. B-line, an Eaton business.
2. Chalfant Manufacturing Company.
3. Cope Cable Tray; A Part of Atkore International.
4. MonoSystems, Inc.
5. MP Husky USA Cable Tray & Cable Bus.
6. Niedax Inc.
7. Thomas & Betts Corporation; A Member of the ABB Group.

B. Description:

1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
2. Width: 12 inches (300 mm) unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: 4 inches (100 mm) unless otherwise indicated on Drawings.
4. Straight Section Lengths: 10 feet (3.0 m), except where shorter lengths are required to facilitate tray assembly.
5. Rung Spacing: 6 inches (150 mm) o.c.
6. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
7. Minimum Cable-Bearing Surface for Rungs: 7/8-inch (22-mm) width with radius edges.
8. No portion of the rungs shall protrude below the bottom plane of side rails.
9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
10. Fitting Minimum Radius: 12 inches (300 mm).
11. Class Designation: Comply with NEMA VE 1, Class 5AA.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
14. Covers: Solid, Louvered, or Ventilated-hat 2-in-3 pitch type made of same materials and with same finishes as cable tray.

C. Materials and Finishes:

1. Steel:

a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33 or ASTM A 1008/A 1008M, Grade 33, Type 2.
b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
d. Finish: Hot-dipped galvanized after fabrication, complying with ASTM A123/A123 M, Class B2.

1) Hardware: Galvanized, ASTM B 633, Chromium-zinc plated, or ASTM F 1136 Stainless steel, Type 316.

e. Finish: Hot-dipped galvanized after fabrication, complying with ASTM A 653/A 653M, G90 (Z275).

1) Hardware: Galvanized, or ASTM B 633 Chromium-zinc plated, ASTM F 1136.

f. Finish: Electrogalvanized after fabrication, complying with ASTM B 633.

1) Hardware: Galvanized, ASTM B 633.

g. Finish: Epoxy-resin or Powder-coat enamel paint.

1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
2) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
3) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.
4) Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

h. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F 1136.
i. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.

2. Aluminum:

a. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 or Alloy 6061-T6 according to ANSI H35.1/H 35.1M for fabricated parts.
b. Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.
c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

3. Stainless Steel:

a. Materials: Low-carbon, passivated stainless steel, Type 304L or Type 316L, ASTM F 593 and ASTM F 594.
b. Hardware for Stainless-Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.4 TROUGH CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. B-line, an Eaton business.
2. Chalfant Manufacturing Company.
3. Legrand US.
4. MonoSystems, Inc.
5. MP Husky USA Cable Tray & Cable Bus.
6. Niedax Inc.

B. Description:

1. Configuration:

a. A corrugated bearing surface with a ventilated bottom contained within two longitudinal side rails, with both edges welded to the side rails complying with NEMA VE 1.
b. Single, formed sheet with a ventilated bottom, complying with NEMA VE 1.

2. Covers: Louvered, Ventilated-hat 2-in-3 pitch type made of same materials and with same finishes as cable tray.
3. Width: 12 inches (300 mm) unless otherwise indicated on Drawings.
4. Minimum Usable Load Depth: 4 inches (100 mm) unless otherwise indicated on Drawings.
5. Straight Section Lengths: 10 feet (3.0 m), except where shorter lengths are required to facilitate tray assembly.
6. Fitting Minimum Radius: 12 inches (300 mm).
7. Class Designation: Comply with NEMA VE 1, Class 5AA.
8. Splicing Assemblies: Bolted type using serrated flange locknuts.
9. Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
10. Covers: Louvered Ventilated-hat 2-in-3 pitch type made of same materials and with same finishes as cable tray.

C. Materials and Finishes:

1. Steel:

a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33 or ASTM A 1008/A 1008M, Grade 33, Type 2.
b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
d. Finish: Hot-dip galvanized after fabrication complying with ASTM A123/A123 M, Class B2.

1) Hardware: Galvanized, ASTM B 633 or Stainless steel, Type 316.

e. Finish: Hot-dip mill galvanized before fabrication complying with ASTM A 653/A 653M, G90 (Z275).

1) Hardware: Galvanized, ASTM B 633.

f. Finish: Electrogalvanized after fabrication, complying with ASTM B 633.

1) Hardware: Galvanized, ASTM B 633.

g. Finish: Powder-coat enamel paint.

1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
2) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
3) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.
4) Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

h. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F 1136.
i. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.

2. Aluminum:

a. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 or Alloy 6061-T6 according to ANSI H35.1/H 35.1M for fabricated parts.
b. Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.
c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

3. Stainless Steel:

a. Materials: Low-carbon, passivated stainless steel, Type 304L or Type 316L, ASTM F 593 and ASTM F 594.
b. Hardware for Stainless-Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.5 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.6 WARNING SIGNS

A. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background, with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."

B. Comply with Section 260553 "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA FG 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable tray and support systems according to NEMA FG 1.

B. Install cable tray as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable tray, so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Join aluminum cable tray with splice plates; use four square-neck carriage bolts and locknuts.

F. Fasten cable tray supports to building structure and install seismic restraints.

G. Design fasteners and supports to carry cable tray, cables, and a concentrated load of 200 lb (90 kg). Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems." Comply with seismic-restraint details according to Section 260548.16 "Seismic Controls for Electrical Systems."

H. Place supports, so that spans do not exceed maximum spans on schedules, and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of tray rungs.

I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

J. Support assembly to prevent twisting from eccentric loading.

K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

L. Do not install more than one cable tray splice between supports.

M. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

N. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed recommended dimensions. Space connectors and set gaps according to applicable standard.

O. Make changes in direction and elevation using manufacturer's recommended fittings.

P. Make cable tray connections using manufacturer's recommended fittings.

Q. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

R. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

S. Install cable trays with enough workspace to permit access for installing cables.

T. Install barriers to separate cables of different systems, such as power, communications, and data processing, or of different insulation levels, such as 600, 5000, and 15 000 V.

U. Install permanent covers and cover clamps, if used, after installing cable.

V. Clamp covers on cable trays installed outdoors with heavy-duty clamps.

W. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Cable trays with electrical power conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch (1800-mm) intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding-bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables

independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).

E. Tie mineral-insulated cables down every 36 inches (900 mm) where required to provide a two-hour fire rating and every 72 inches (1800 mm) elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items, such as pipes, hangers, or other equipment, in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable

tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.

2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 260536

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

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. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
2. Rigid nonmetallic duct.
3. Flexible nonmetallic duct.
4. Duct accessories.
5. Precast concrete handholes.
6. Polymer concrete handholes and boxes with polymer concrete cover.
7. Fiberglass handholes and boxes with polymer concrete cover.
8. Fiberglass handholes and boxes.
9. High-density plastic boxes.
10. Precast manholes.
11. Cast-in-place manholes.
12. Utility structure accessories.

1.3 DEFINITIONS

A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

C. Duct Bank:

1. Two or more ducts installed in parallel, with or without additional casing materials.
2. Multiple duct banks.

D. GRC: Galvanized rigid (steel) conduit.

E. Traffic ways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include duct-bank materials, including spacers and miscellaneous components.

2. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Include accessories for manholes, handholes, boxes, and other utility structures.
4. Include underground-line warning tape.
5. Include warning planks.

B. Shop Drawings:

1. Precast or Factory-Fabricated Underground Utility Structures:

a. Include plans, elevations, sections, details, attachments to other work, and accessories.
b. Include duct entry provisions, including locations and duct sizes.
c. Include reinforcement details.
d. Include frame and cover design and manhole chimneys.
e. Include ladder and or step details.
f. Include grounding details.
g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
h. Include joint details.

2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:

a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
b. Include duct entry provisions, including locations and duct sizes.
c. Include cover design.
d. Include grounding details.
e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

C. Sustainable Design Submittals:

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For duct and duct bank. Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Drawings shall be signed and sealed by a qualified professional engineer.

B. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.

C. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.

D. Source quality-control reports.

E. Field quality-control reports.

1.6 MAINTENANCE MATERIALS SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.8 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Architect's, Construction Manager's, and Owner's written permission.

B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

C. Ground Water: Assume ground-water level is 36 inches (900 mm) below ground surface unless a higher water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

A. GRC: Comply with ANSI C80.1 and UL 6.

B. Coated Steel Conduit: PVC-coated GRC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch (1 mm), minimum.

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems; a part of Atkore International.
2. Allied Tube & Conduit; a part of Atkore International.
3. Anamet Electrical, Inc.
4. Calconduit.
5. Electri-Flex Company.
6. FSR Inc.
7. Korkap.

8. NEC, Inc.
9. Opti-Com Manufacturing Network, Inc (OMNI).
10. O-Z/Gedney; a brand of Emerson Industrial Automation.
11. Perma-Cote.
12. Picoma Industries, Inc.
13. Plasti-Bond.
14. Republic Conduit.
15. Southwire Company.
16. Thomas & Betts Corporation; A Member of the ABB Group.
17. Topaz Electric; a division of Topaz Lighting Corp.
18. Western Tube and Conduit Corporation.
19. Wheatland Tube Company.

D. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT

A. Underground Plastic Utilities Duct: Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.

B. Underground Plastic Utilities Duct: Type DB-60 PVC and Type DB-120 PVC RNC, complying with NEMA TC 6 & 8 and ASTM F 512 for direct burial, with matching fittings complying with NEMA TC 9 by same manufacturer as duct.

C. Underground Plastic Utilities Duct: Type EB-20 PVC RNC, complying with NEMA TC 6 & 8, ASTM F 512, and UL 651, with matching fittings complying with NEMA TC 9 by same manufacturer as duct.

D. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ARNCO Corp.
2. Beck Manufacturing.
3. CANTEX INC.
4. CertainTeed Corporation.
5. Condux International, Inc.
6. Crown Line Plastics.
7. ElecSys, Inc.
8. Electri-Flex Company.
9. Endot Industries Inc.
10. IPEX USA LLC.
11. Lamson & Sessions.
12. Manhattan/CDT.
13. National Pipe & Plastics.
14. Opti-Com Manufacturing Network, Inc (OMNI).
15. Spiraduct/AFC Cable Systems, Inc.

E. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

F. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 FLEXIBLE NONMETALLIC DUCTS

A. HDPE Duct: Type EPEC-40 HDPE, complying with NEMA TC 7 and UL 651A.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ARNCO Corp.
   b. Carlon; a brand of Thomas & Betts Corporation.
   c. National Pipe & Plastics.
   d. Opti-Com Manufacturing Network, Inc (OMNI).
   e. Premier Conduit.

2. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.4 DUCT ACCESSORIES

A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Allied Tube & Conduit; a part of Atkore International.
   b. CANTEX INC.
   c. Carlon; a brand of Thomas & Betts Corporation.
   d. IPEX USA LLC.
   e. PenCell Plastics.
   f. Underground Devices, Inc.

B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

C. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 75 mm) in size, manufactured from 6000-psi (41-MPa) concrete.

1. Color: Red dye added to concrete during batching.
2. Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.

2.5 PRECAST CONCRETE HANDHOLES AND BOXES

A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Christy Concrete Products.

2. Elmhurst-Chicago Stone Co.
3. Oldcastle Precast, Inc.
4. Rinker Group, Ltd.
5. Riverton Concrete Products.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.
8. Wausau Tile Inc.

C. Comply with ASTM C 858 for design and manufacturing processes.

D. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

E. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

F. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.

1. Cover Hinges: Concealed, with hold-open ratchet assembly.
2. Cover Handle: Recessed.

G. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.

1. Cover Hinges: Concealed, with hold-open ratchet assembly.
2. Cover Handle: Recessed.

H. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

I. Cover Legend: Molded lettering, "ELECTRIC." As indicated for each service.

J. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

K. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.

1. Extension shall provide increased depth of 12 inches (300 mm).
2. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

L. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

M. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.

1. Center window location.
2. Knockout panels shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.

4. Knockout panels shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
5. Knockout panels shall be 1-1/2 to 2 inches (38 to 50 mm) thick.

N. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

1. Type and size shall match fittings to duct to be terminated.
2. Fittings shall align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.

O. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.6 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armorcast Products Company.
2. MacLean Highline.
3. NewBasis.
4. Oldcastle Enclosure Solutions.
5. Quazite: Hubbell Power Systems, Inc.

C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

D. Color: Gray.

E. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

H. Cover Legend: Molded lettering, "ELECTRIC."

I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

K. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.7 FIBERGLASS HANDHOLES AND BOXES WITH POLYMER CONCRETE FRAME AND COVER

A. Description: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Armorcast Products Company.
2. Christy Concrete Products.
3. NewBasis.
4. Oldcastle Enclosure Solutions.
5. Quazite: Hubbell Power Systems, Inc.

C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

D. Color: Gray.

E. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

H. Cover Legend: Molded lettering, "ELECTRIC." As indicated for each service.

I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

K. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.8 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

A. Duct for Electrical Cables More Than 600 V: Type EPC-40-PVC RNC, concrete-encased unless otherwise indicated.

B. Duct for Electrical Feeders 600 V and Less: Type EPC-40-PVC RNC, concrete-encased unless otherwise indicated.

C. Duct for Electrical Feeders 600 V and Less: Type EPC-40-PVC RNC, direct-buried unless otherwise indicated.

D. Duct for Electrical Branch Circuits: Type EPC-40-PVC RNC, direct-buried unless otherwise indicated.

E. Bored Underground Duct: Type EPEC-40-HDPE unless otherwise indicated.

F. Underground Ducts Crossing Paved Paths Walks and Driveways: Type EPC-40 PVC RNC, encased in reinforced concrete.

G. Stub-ups: Concrete-encased GRC.

3.3 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.
2. Knockouts for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches (38 to 50 mm) thick, arranged as indicated.
3. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.

B. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches (375 mm) below finished grade.
2. Manhole Frame: In paved areas and traffic ways, set frames flush with finished grade. Set other manhole frames 1 inch (25 mm) above finished grade.
3. Install handholes with bottom below frost line, Insert depth of frost line below grade at Project site below grade.
4. Handhole Covers: In paved areas and traffic ways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.

F. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Section 071353 "Elastomeric Sheet Waterproofing." Section 071354 "Thermoplastic Sheet Waterproofing." After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

G. Damp proofing: Apply damp proofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Damp proofing materials and installation are specified in Section 071113 "Bituminous Damp proofing." After ducts are connected and grouted, and before backfilling, damp proof joints and connections, and touch up abrasions and scars. Damp proof exterior of manhole chimneys after mortar has cured at least three days.

H. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and **cable** arms, and insulators, **as** required for installation and support of cables and conductors and as indicated.

I. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

J. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (97 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.4 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 duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and traffic ways, set cover flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.

D. Install handholes and boxes with bottom below frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and subject to occasional, non-deliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with a troweled finish.
2. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

3.5 GROUNDING

A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch- (300-mm-) long mandrel equal to duct size minus 1/4 inch (6 mm). If obstructions are indicated, remove obstructions and retest.
3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Prepare test and inspection reports.

3.7 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump.

1. Sweep floor, removing dirt and debris.
2. Remove foreign material.

END OF SECTION 260543

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

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. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM or Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, water stop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber water stop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. HOLDRITE.

2.4 GROUT

A. Description: Non-shrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 260548.16 - SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

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. Restraint channel bracings.
2. Restraint cables.
3. Seismic-restraint accessories.
4. Mechanical anchor bolts.
5. Adhesive anchor bolts.

B. Related Requirements:

1. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

   a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by OSHPD an agency acceptable to authorities having jurisdiction.
   b. Annotate to indicate application of each product submitted and compliance with requirements.

B. Delegated-Design Submittal: For each seismic-restraint device.

1. Include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Design Calculations: Calculate static and dynamic loading caused by equipment weight, operation, and seismic and wind forces required to select seismic and wind restraints and for designing vibration isolation bases.

   a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

3. Seismic- and Wind-Restraint Details:

   a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
   c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
   d. Preapproval and Evaluation Documentation: By OSHPD an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints. Electrical components include:

   1. Control and monitoring panels.
   2. Generators.
   3. Luminaires.
   4. Motor control centers.
   5. Panelboards.
   6. Photovoltaic system components.
   7. Substations.
   8. Switchboards.
   9. Switchgear.
   10. Transformers.
   11. Unit substations.

B. Qualification Data: For professional engineer and testing agency.

C. Welding certificates.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

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

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis. They shall bear anchorage preapproval from OSHPD in addition to preapproval, showing maximum seismic-restraint ratings, by ICC-ES or another agency acceptable to authorities having jurisdiction. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) that support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

E. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Basic Wind Speed: 150.
2. Building Classification Category: IV.
3. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) multiplied by maximum area of component projected on vertical plane normal to wind direction and 45 degrees either side of normal.

B. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: A.
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: I.

   a. Component Importance Factor: 1.5.
   b. Component Response Modification Factor: 1.5.
   c. Component Amplification Factor: 1.0.

3. Design Spectral Response Acceleration at Short Periods (0.2 Second) : 10%.
4. Design Spectral Response Acceleration at 1.0-Second Period: 10%.

2.2 RESTRAINT CHANNEL BRACINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line, an Eaton business.
2. Hilti, Inc.
3. Mason Industries, Inc.
4. Unistrut; Part of Atkore International.

B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end, with other matching components, and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.3 RESTRAINT CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CADDY; a brand of nVent.
2. Gripple Inc.
3. Kinetics Noise Control, Inc.
4. Vibration Mountings & Controls, Inc.

B. Restraint Cables: ASTM A 603 galvanized or ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.4 SEISMIC-RESTRAINT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line, an Eaton business.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.
4. TOLCO; a brand of NIBCO INC.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.5 MECHANICAL ANCHOR BOLTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line, an Eaton business.
2. Hilti, Inc.
3. Kinetics Noise Control, Inc.
4. Mason Industries, Inc.

B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.6 ADHESIVE ANCHOR BOLTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hilti, Inc.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.

B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and **seismic**-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by OSHPD an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and

formwork specified in Section 033000 "Cast-in-Place Concrete." Section 033053 "Miscellaneous Cast-in-Place Concrete."

B. Equipment and Hanger Restraints:

1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
2. Install seismic-restraint devices using methods approved by OSHPD an agency acceptable to authorities having jurisdiction providing required submittals for component.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

F. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wire ways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.

C. Seismic controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 260548.16

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

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. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.
8. Paint for identification.
9. Fasteners for labels and signs.

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 electrical identification products.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

D. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Comply with NFPA 70E and Section 260573.19 "Arc-Flash Hazard Analysis" requirements for arc-flash warning labels.

F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase-and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.

1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
2. Colors for 208/120-V Circuits:

   a. Phase A: Black.
   b. Phase B: Red.
   c. Phase C: Blue.

3. Colors for 240-V Circuits:

   a. Phase A: Black.
   b. Phase B: Red.

4. Colors for 480/277-V Circuits:

   a. Phase A: Brown.
   b. Phase B: Orange.
   c. Phase C: Yellow.

5. Color for Neutral: White.
6. Color for Equipment Grounds: Bare copper Green.
7. Colors for Isolated Grounds: Green with two or more yellow stripes.

C. Raceways and Cables Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

D. Warning Label Colors:

1. Identify system voltage with black letters on an orange background.

E. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

F. Equipment Identification Labels:

1. Black letters on a white field.

2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.
b. Champion America.
c. emedco.
d. Grafoplast Wire Markers.
e. HellermannTyton.
f. LEM Products Inc.
g. Marking Services, Inc.
h. Panduit Corp.
i. Seton Identification Products.

B. Snap-around Labels: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.
b. HellermannTyton.
c. Marking Services, Inc.
d. Panduit Corp.
e. Seton Identification Products.

C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- (0.08-mm-) thick, polyester or vinyl flexible label with acrylic pressure-sensitive adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. A'n D Cable Products.

b. Brady Corporation.
c. Brother International Corporation.
d. emedco.
e. Grafoplast Wire Markers.
f. Ideal Industries, Inc.
g. LEM Products Inc.
h. Marking Services, Inc.
i. Panduit Corp.
j. Seton Identification Products.

2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
3. Marker for Labels: Permanent, waterproof, black ink marker recommended by tag manufacturer.
4. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Polyester or Vinyl, thermal, transfer-printed, 3-mil- (0.08-mm-) thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. A'n D Cable Products.
b. Brady Corporation.
c. Brother International Corporation.
d. emedco.
e. Grafoplast Wire Markers.
f. HellermannTyton.
g. Ideal Industries, Inc.
h. LEM Products Inc.
i. Marking Services, Inc.
j. Panduit Corp.
k. Seton Identification Products.

2. Minimum Nominal Size:

a. 1-1/2 by 6 inches (37 by 150 mm) for raceway and conductors.
b. 3-1/2 by 5 inches (76 by 127 mm) for equipment.
c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

A. Snap-around, Color-Coding Bands: Slit, pre-tensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) long, with diameters sized to suit diameters and that stay in place by gripping action.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.
b. HellermannTyton.

c. Marking Services, Inc.
d. Panduit Corp.

B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F (93 deg C). Comply with UL 224.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.
b. Panduit Corp.

2.5 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Carlton Industries, LP.
b. Champion America.
c. HellermannTyton.
d. Ideal Industries, Inc.
e. Marking Services, Inc.
f. Panduit Corp.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide; compounded for outdoor use.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.
b. Carlton Industries, LP.
c. emedco.
d. Marking Services, Inc.

C. Tape and Stencil: 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers placed diagonally over orange background and are 12 inches (300 mm) wide. Stop stripes at legends.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. HellermannTyton.
b. LEM Products Inc.
c. Marking Services, Inc.
d. Seton Identification Products.

D. Floor Marking Tape: 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Carlton Industries, LP.
    b. Seton Identification Products.

E. Underground-Line Warning Tape:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Brady Corporation.
    b. Ideal Industries, Inc.
    c. LEM Products Inc.
    d. Marking Services, Inc.
    e. Reef Industries, Inc.
    f. Seton Identification Products.

2. Tape:

    a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications **utility** lines.
    b. Printing on tape shall be permanent and shall not be damaged by burial operations.
    c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

3. Color and Printing:

    a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
    b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
    c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".

4. Tag: Type I:

    a. Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, **compounded** for direct-burial service.
    b. Width: 3 inches (75 mm).
    c. Thickness: 4 mils (0.1 mm).
    d. Weight: 18.5 lb/1000 sq. ft. (9.0 kg/100 sq. m).
    e. Tensile according to ASTM D882: 30 lbf (133.4 N) and 2500 psi (17.2 MPa).

5. Tag: Type II:

    a. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, continuous-printed on one side with the inscription of the utility, **compounded** for direct-burial service.
    b. Width: 3 inches (75 mm).
    c. Thickness: 12 mils (0.3 mm).
    d. Weight: 36.1 lb/1000 sq. ft. (17.6 kg/100 sq. m).
    e. Tensile according to ASTM D882: 400 lbf (1780 N) and 11,500 psi (79.2 MPa).

6. Tag: Type ID:

   a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
   b. Width: 3 inches (75 mm).
   c. Overall Thickness: 5 mils (0.125 mm).
   d. Foil Core Thickness: 0.35 mil (0.00889 mm).
   e. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m).
   f. Tensile according to ASTM D882: 70 lbf (311.3 N) and 4600 psi (31.7 MPa).

7. Tag: Type IID:

   a. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
   b. Width: 3 inches (75 mm).
   c. Overall Thickness: 8 mils (0.2 mm).
   d. Foil Core Thickness: 0.35 mil (0.00889 mm).
   e. Weight: 34 lb/1000 sq. ft. (16.6 kg/100 sq. m).
   f. Tensile according to ASTM D882: 300 lbf (1334 N) and 12,500 psi (86.1 MPa).

F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm).

2.6 TAGS

A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Brady Corporation.
      b. Carlton Industries, LP.
      c. emedco.
      d. Marking Services, Inc.
      e. Seton Identification Products.

B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.023 inch (0.58 mm) thick, color-coded for phase and voltage level, with factory screened permanent designations; punched for use with self-locking cable tie fastener.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Brady Corporation.
      b. Carlton Industries, LP.
      c. emedco.
      d. Grafoplast Wire Markers.

e. LEM Products Inc.
f. Marking Services, Inc.
g. Panduit Corp.
h. Seton Identification Products.

C. Write-on Tags:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Carlton Industries, LP.
   b. LEM Products Inc.
   c. Seton Identification Products.

2. Polyester Tags: 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment.
3. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
4. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.7 SIGNS

A. Baked-Enamel Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Carlton Industries, LP.
   b. Champion America.
   c. emedco.
   d. Marking Services, Inc.

2. Preprinted aluminum signs, high-intensity reflective, **punched** or drilled for fasteners, with colors, legend, and size required for application.

3. 1/4-inch (6.4-mm) grommets in corners for mounting.
4. Nominal Size: 7 by 10 inches (180 by 250 mm).

B. Metal-Backed Butyrate Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Brady Corporation.
   b. Champion America.
   c. emedco.
   d. Marking Services, Inc.

2. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch (1-mm) galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.

3. 1/4-inch (6.4-mm) grommets in corners for mounting.
4. Nominal Size: 10 by 14 inches (250 by 360 mm).

C. Laminated Acrylic or Melamine Plastic Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Brady Corporation.
   b. Carlton Industries, LP.
   c. emedco.
   d. Marking Services, Inc.

2. Engraved legend.

3. Thickness:

   a. For signs up to 20 sq. in. (129 sq. cm), minimum 1/16 inch (1.6 mm) thick.
   b. For signs larger than 20 sq. in. (129 sq. cm), 1/8 inch (3.2 mm) thick.
   c. Engraved legend with black letters on white face.
   d. Punched or drilled for mechanical fasteners with 1/4-inch (6.4-mm) grommets in corners for mounting or Self-adhesive.
   e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 CABLE TIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. HellermannTyton.
2. Ideal Industries, Inc.
3. Marking Services, Inc.
4. Panduit Corp.

B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 Deg F (23 Deg C) according to ASTM D638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black, except where used for color-coding.

C. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 Deg F (23 Deg C) according to ASTM D638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black.

D. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 Deg F (23 Deg C) according to ASTM D638: 7000 psi (48.2 MPa).
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer load shedding.

K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

M. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

N. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.

O. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.

P. Self-Adhesive Labels:

1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.

Q. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

R. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.

S. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.

T. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

U. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

V. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.

W. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope **exceeds** 16 inches (400 mm) overall.
2. Limit use of underground-line warning tape to direct-buried cables.
3. Install underground-line warning tape for direct-buried cables and cables in raceways.

X. Metal Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using general-purpose cable ties.

Y. Nonmetallic Preprinted Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using general-purpose cable ties.

Z. Write-on Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using general-purpose cable ties.

AA. Baked-Enamel Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on minimum 1-1/2-inch- (38-mm-) high sign; where two lines of text are required, use signs minimum 2 inches (50 mm) high.

BB. Metal-Backed Butyrate Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high sign; where two lines of text are required, use labels 2 inches (50 mm) high.

CC. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

2. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high sign; where two lines of text are required, use labels 2 inches (50 mm) high.

DD. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals pull points, and locations of high visibility. Identify by system and circuit designation.

C. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3-inch- (75-mm-) high, black letters on 20-inch (500-mm) centers.

1. Locate identification at changes in direction, at penetrations of walls and floors, and at 30-foot (10-m) maximum intervals.

D. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Vinyl wraparound labels.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

E. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels vinyl tape applied in bands.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

F. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

G. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels self-adhesive vinyl tape to identify the phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

H. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase and a separate tag with the circuit designation.

I. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.

J. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes or self-adhesive labels with the conductor designation.

K. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

L. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

M. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

N. Concealed Raceways and Duct Banks, More Than 600 V, within Buildings: Apply floor marking tape to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within 12 inches (300 mm) of a floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to raceways concealed within wall.
3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

O. Workspace Indication: Apply floor marking tape or tape and stencil to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

P. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

Q. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.

1. Apply to exterior of door, cover, or other access.
2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

a. Power-transfer switches.
b. Controls with external control power connections.

R. Arc Flash Warning Labeling: Self-adhesive labels.

S. Operating Instruction Signs: Self-adhesive labels.

T. Emergency Operating Instruction Signs: Self-adhesive labels with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.

U. Equipment Identification Labels:

1. Indoor Equipment: Self-adhesive label.
2. Outdoor Equipment: Laminated acrylic or melamine sign.
3. Equipment to Be Labeled:

    a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a engraved, laminated acrylic or melamine label.
    b. Enclosures and electrical cabinets.
    c. Access doors and panels for concealed electrical items.
    d. Switchgear.
    e. Switchboards.
    f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
    g. Substations.
    h. Emergency system boxes and enclosures.
    i. Motor-control centers.
    j. Enclosed switches.
    k. Enclosed circuit breakers.
    l. Enclosed controllers.
    m. Variable-speed controllers.
    n. Push-button stations.
    o. Power-transfer equipment.
    p. Contactors.
    q. Remote-controlled switches, dimmer modules, and control devices.
    r. Battery-inverter units.
    s. Battery racks.
    t. Power-generating units.
    u. Monitoring and control equipment.
    v. UPS equipment.

END OF SECTION 260553

SECTION 260573.13 - SHORT-CIRCUIT STUDIES

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 a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.

B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

E. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.

G. SCCR: Short-circuit current rating.

H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

I. Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

A. Product Data:

1. For computer software program to be used for studies.
2. Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

    a. Short-circuit study input data, including completed computer program input data sheets.
    b. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.

        1) Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
        2) Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Power Systems Analysis Software Developer.
2. For Power System Analysis Specialist.
3. For Field Adjusting Agency.

B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. For overcurrent protective devices to include in emergency, operation, and maintenance manuals.
2. The following are from the Short-Circuit Study Report:

    a. Final one-line diagram.
    b. Final Short-Circuit Study Report.
    c. Short-circuit study data files.
    d. Power system data.

1.7 QUALITY ASSURANCE

A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

1. Power System Analysis Software Qualifications: Computer program shall be designed to perform short-circuit studies or have a function, component, or add-on module designed to perform short-circuit studies.
2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

D. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

E. Short-Circuit Study Certification: Short-Circuit Study Report shall be signed and sealed by Power Systems Analysis Specialist.

F. Field Adjusting Agency Qualifications:

1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
2. A member company of NETA.
3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CGI CYME.
2. EDSA Micro Corporation.
3. ESA Inc.
4. Operation Technology, Inc.
5. Power Analytics, Corporation.
6. SKM Systems Analysis, Inc.

B. Comply with IEEE 399 and IEEE 551.

1. Analytical features of power systems analysis software program shall have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
6. Derating factors and environmental conditions.
7. Any revisions to electrical equipment required by the study.

D. Comments and recommendations for system improvements or revisions in a written document, separate from one-line diagram.

E. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

F. Short-Circuit Study Input Data:

1. One-line diagram of system being studied.
2. Power sources available.
3. Manufacturer, model, and interrupting rating of protective devices.
4. Conductors.
5. Transformer data.

G. Short-Circuit Study Output Reports:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. Equivalent impedance.

2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated symmetrical fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. Calculated asymmetrical fault currents:

        1) Based on fault-point X/R ratio.
        2) Based on calculated symmetrical value multiplied by 1.6.

3) Based on calculated symmetrical value multiplied by 2.7.

3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

   a. Voltage.
   b. Calculated symmetrical fault-current magnitude and angle.
   c. Fault-point X/R ratio.
   d. No AC Decrement (NACD) ratio.
   e. Equivalent impedance.
   f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
   g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 - EXECUTION

3.1 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the study.

1. Verify completeness of data supplied on one-line diagram. Call any discrepancies to Architect's attention.
2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
3. For equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.

B. Gather and tabulate the required input data to support the short-circuit study. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on a Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at the service.
3. Power sources and ties.
4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.

9. Motor horsepower and NEMA MG 1 code letter designation.
10. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
11. Derating factors.

3.2 SHORT-CIRCUIT STUDY

A. Perform study following the general study procedures contained in IEEE 399.

B. Calculate short-circuit currents according to IEEE 551.

C. Base study on device characteristics supplied by device manufacturer.

D. Extent of electrical power system to be studied is indicated on Drawings.

E. Begin short-circuit current analysis at the service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 10 kA or less.
2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for the fault-current dc decrement to address asymmetrical requirements of interrupting equipment.

H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

I. Include in the report identification of any protective device applied outside its capacity.

END OF SECTION 260573.13

SECTION 260573.16 - COORDINATION STUDIES

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 computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

1. Study results shall be used to determine coordination of series-rated devices.

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.

B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

E. Power System Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.

G. SCCR: Short-circuit current rating.

H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

I. Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

A. Product Data:

1. For computer software program to be used for studies.
2. Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

   a. Coordination-study input data, including completed computer program input data sheets.
   b. Study and equipment evaluation reports.

3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.

   a. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Power System Analysis Software Developer.
2. For Power Systems Analysis Specialist.
3. For Field Adjusting Agency.

B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For overcurrent protective devices to include in emergency, operation, and maintenance manuals.

1. The following are from the Coordination Study Report:

   a. Final one-line diagram.
   b. Final protective device coordination study.
   c. Coordination study data files.
   d. List of all protective device settings.
   e. Time-current coordination curves.
   f. Power system data.

1.7 QUALITY ASSURANCE

A. Studies shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

D. Power System Analysis Software Qualifications:

1. Computer program shall be designed to perform coordination studies or have a function, component, or add-on module designed to perform coordination studies.
2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

E. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

F. Field Adjusting Agency Qualifications:

1. Employer of a NETA ETT-Certified Technician Level III responsible for all field adjusting of the Work.
2. A member company of NETA.
3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Comply with IEEE 242 and IEEE 399.

C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:

a. Arcing faults.
b. Simultaneous faults.
c. Explicit negative sequence.
d. Mutual coupling in zero sequence.

2.2 COORDINATION STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations.
6. Any revisions to electrical equipment required by the study.
7. Study Input Data: As described in "Power System Data" Article.

   a. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

D. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.

   a. Phase and Ground Relays:

      1) Device tag.
      2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
      3) Recommendations on improved relaying systems, if applicable.

   b. Circuit Breakers:

      1) Adjustable pickups and time delays (long time, short time, and ground).
      2) Adjustable time-current characteristic.
      3) Adjustable instantaneous pickup.
      4) Recommendations on improved trip systems, if applicable.

   c. Fuses: Show current rating, voltage, and class.

E. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:

   a. Power utility's overcurrent protective device.

b. Medium-voltage equipment overcurrent relays.
c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
f. Cables and conductors damage curves.
g. Ground-fault protective devices.
h. Motor-starting characteristics and motor damage points.
i. Generator short-circuit decrement curve and generator damage point.
j. The largest feeder circuit breaker in each motor-control center and panelboard.

5. Maintain selectivity for tripping currents caused by overloads.
6. Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.
7. Provide adequate time margins between device characteristics such that selective operation is achieved.
8. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the overcurrent protective device study.

1. Verify completeness of data supplied in one-line diagram on Drawings. Call any discrepancies to Architect's attention.
2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
3. For equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.

B. Gather and tabulate all required input data to support the coordination study. List below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Electrical power utility impedance at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Maximum demands from service meters.
13. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
14. Motor horsepower and NEMA MG 1 code letter designation.
15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
16. Medium-voltage cable sizes, lengths, conductor material, cable construction, metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).
17. Data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Generator thermal-damage curve.
    e. Ratings, types, and settings of utility company's overcurrent protective devices.
    f. Special overcurrent protective device settings or types stipulated by utility company.
    g. Time-current-characteristic curves of devices indicated to be coordinated.
    h. Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
    j. Switchgear, switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.
    k. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.3 COORDINATION STUDY

A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

B. Comply with IEEE 399 for general study procedures.

C. Base study on device characteristics supplied by device manufacturer.

D. Extent of electrical power system to be studied is indicated on Drawings.

E. Begin analysis at the service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 10 kA or less.
2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

H. Motor Protection:

1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
2. Select protection for motors served at voltages more than 600 V according to IEEE 620.

I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

J. Generator Protection: Select protection according to manufacturer's written instructions and to IEEE 242.

K. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.

L. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

M. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.
4. Include in the report identification of any protective device applied outside its capacity.

3.4 LOAD-FLOW AND VOLTAGE-DROP STUDY

A. Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:

1. Determine load flow and voltage drop based on full-load currents obtained in "Power System Data" Article.
2. Determine load flow and voltage drop based on 80 percent of the design capacity of load buses.
3. Prepare load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.5 MOTOR-STARTING STUDY

A. Perform a motor-starting study to analyze the transient effect of system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze the effects of motor starting on the power system stability.

B. Prepare the motor-starting study report, noting light flicker for limits proposed by IEEE 141, and, and voltage sags so as not to affect operation of other utilization equipment on system supplying the motor.

3.6 FIELD ADJUSTING

A. Adjust relay and protective device settings according to recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of equipment manufacturer under the "Startup and Acceptance Testing" contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

3.7 DEMONSTRATION

A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in the following:

1. Acquaint personnel in fundamentals of operating the power system in normal and emergency modes.
2. Hand-out and explain the coordination study objectives, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting time-current coordination curves.
3. For Owner's maintenance staff certified as NETA ETT-Certified Technicians Level III or NICET Electrical Power Testing Level III Technicians, teach how to adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION 260573.16

SECTION 260573.19 - ARC-FLASH HAZARD ANALYSIS

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 a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

E. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

G. SCCR: Short-circuit current rating.

H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

I. Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form:

1. Arc-flash study input data, including completed computer program input data sheets.
2. Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.
3. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Power Systems Analysis Software Developer.
2. For Power System Analysis Specialist.
3. For Field Adjusting Agency.

B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Provide maintenance procedures in equipment manuals according to requirements in NFPA 70E.
2. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

D. Power System Analysis Software Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Computer program shall be designed to perform arc-flash analysis or have a function, component, or add-on module designed to perform arc-flash analysis.
2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

E. Power Systems Analysis Specialist Qualifications: Professional engineer in charge of performing the arc-flash study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

F. Arc-Flash Study Certification: Arc-Flash Study Report shall be signed and sealed by Power Systems Analysis Specialist.

G. Field Adjusting Agency Qualifications:

1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
2. A member company of NETA.
3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

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. CGI CYME.
2. EDSA Micro Corporation.
3. ESA Inc.
4. Operation Technology, Inc.
5. Power Analytics, Corporation.
6. SKM Systems Analysis, Inc.

B. Comply with IEEE 1584 and NFPA 70E.

C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

F. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."

G. Arc-Flash Study Output Reports:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:

    a. Voltage.
    b. Calculated symmetrical fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. No AC Decrement (NACD) ratio.
    e. Equivalent impedance.
    f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
    g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

H. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Restricted approach boundary.
6. Limited approach boundary.
7. Working distance.
8. Incident energy.
9. Hazard risk category.
10. Recommendations for arc-flash energy reduction.

I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of computer printout.

2.3 ARC-FLASH WARNING LABELS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch (76-by-127-mm) self-adhesive equipment label for each work location included in the analysis.

B. Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

1. Location designation.
2. Nominal voltage.
3. Protection boundaries.

    a. Arc-flash boundary.
    b. Restricted approach boundary.

c. Limited approach boundary.

4. Arc flash PPE category.
5. Required minimum arc rating of PPE in Cal/cm squared.
6. Available incident energy.
7. Working distance.
8. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Preparatory Studies: Perform the Short-Circuit and Protective Device Coordination studies prior to starting the Arc-Flash Hazard Analysis or obtain results from another source.

1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."

C. Calculate maximum and minimum contributions of fault-current size.

1. Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
2. Calculate arc-flash energy at 85 percent of maximum short-circuit current according to IEEE 1584 recommendations.
3. Calculate arc-flash energy at 38 percent of maximum short-circuit current according to NFPA 70E recommendations.
4. Calculate arc-flash energy with the utility contribution at a minimum and assume no motor contribution.

D. Calculate the arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.

E. Include medium- and low-voltage equipment locations, except equipment rated 240 V ac or less fed from transformers less than 125 kVA.

F. Calculate the limited, restricted, and prohibited approach boundaries for each location.

G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

1. Fault contribution from induction motors shall not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

H. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.
2. When the line terminals of the circuit breaker are separate from the work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the arc-flash hazard analysis.

1. Verify completeness of data supplied on one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to Architect's attention.
2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers.

B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance or available short circuit current at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.

8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

3.4 LABELING

A. Apply one **arc**-flash label on the front cover of each section of the equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in the study. Base arc-flash label data on highest values calculated at each location.

B. Each piece of equipment listed below shall have an arc-flash label applied to it:

1. Motor-control center.
2. Low-voltage switchboard.
3. Switchgear.
4. Medium-voltage switch.
5. Medium voltage transformers
6. Low voltage transformers.
7. Panelboard and safety switch over 250 V.
8. Applicable panelboard and safety switch under 250 V.
9. Control panel.

C. Note on record Drawings the location of equipment where the personnel could be exposed to arc-flash hazard during their work.

1. Indicate arc-flash energy.
2. Indicate protection level required.

3.5 APPLICATION OF WARNING LABELS

A. Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

3.6 DEMONSTRATION

A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels.

END OF SECTION 260573.19

SECTION 260923 - LIGHTING CONTROL DEVICES

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. Time switches.
2. Photoelectric switches.
3. Standalone daylight-harvesting switching and dimming controls.
4. Indoor occupancy and vacancy sensors.
5. Switchbox-mounted occupancy sensors.
6. Digital timer light switches.
7. High-bay occupancy sensors.
8. Extreme temperature occupancy sensors.
9. Outdoor motion sensors.
10. Lighting contactors.
11. Emergency shunt relays.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show installation details for the following:

   a. Occupancy sensors.
   b. Vacancy sensors.

2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and elevations, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which equipment will be attached.
3. Items penetrating finished ceiling, including the following:

a. Luminaires.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Control modules.

B. Field quality-control reports.

C. Sample Warranty: For manufacturer's warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media. Provide names, versions, and website addresses for locations of installed software.
3. Device address list.
4. Printout of software application and graphic screens.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of lighting control software.
b. Faulty operation of lighting control devices.

2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. Invensys Controls.
4. Leviton Manufacturing Co., Inc.
5. NSi Industries LLC.
6. TE Connectivity Ltd.

B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.

1. Listed and labeled as defined in NFPA 70 and marked for intended location and application.
2. Programs: Eight on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
3. Programs: Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.
4. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
5. Astronomic Time: Selected channels.
6. Automatic daylight savings time changeover.
7. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

C. Electromechanical-Dial Time Switches: Comply with UL 917.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.
3. Astronomic time dial.
4. Eight-Day Program: Uniquely programmable for each weekday and holidays.
5. Skip-a-day mode.
6. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. Leviton Manufacturing Co., Inc.
4. NSi Industries LLC.
5. TE Connectivity Ltd.

B. Description: Solid state, with SPST or DPST dry contacts rated for 1000 W incandescent, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with ballasts and LED lamps.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
3. Time Delay: Fifteen-second minimum, to prevent false operation.
4. Surge Protection: Metal-oxide varistor.
5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
6. Failure Mode: Luminaire stays ON.

7. Power Pack: Digital controller capable of accepting four Insert number RJ45 inputs with two outputs rated for 20-A incandescent or LED load at 120- and 277-V ac, for 16-A LED at 120- and 277-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.

   a. With integral current monitoring
   b. Compatible with digital addressable lighting interface.
   c. Plenum rated.

2.3 DAYLIGHT-HARVESTING SWITCHING CONTROLS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Cooper Industries, Inc.
2. Eaton.
3. Hubbell Building Automation, Inc.
4. Leviton Manufacturing Co., Inc.
5. Lithonia Lighting; Acuity Brands Lighting, Inc.
6. NSi Industries LLC.
7. Sensor Switch, Inc.
8. TE Connectivity Ltd.
9. WattStopper; a Legrand® Group brand.

B. Description: System operates indoor lighting.

C. Sequence of Operation: As daylight increases, the lights are turned off at a predetermined level. As daylight decreases, the lights are turned on at a predetermined level.

1. Lighting control set point is based on two lighting conditions:

   a. When no daylight is present.
   b. When significant daylight is present (target level).
   c. System programming is done with two hand-held, remote-control tools.

D. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with integrated power pack, that detects changes in indoor lighting levels that are perceived by the eye.

E. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with separate power pack mounted on luminaire, that detects changes in indoor lighting levels that are perceived by the eye.

F. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
3. Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. Sensor shall be powered by the power pack.
4. Sensor Output: Digital signal compatible with power pack.
5. Sensor type: Open loop.
6. Zone: Multi.
7. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

    a. LED status lights to indicate load status.
    b. Plenum rated.

8. Power Pack: Digital controller capable of accepting 4 RJ45 inputs with two outputs rated for 20-A incandescent LED load at 120- and 277-V ac, for 16-A or LEDat 120- and 277-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc Class 2 power source, as defined by NFPA 70.

    a. With integral current monitoring
    b. Compatible with digital addressable lighting interface.
    c. Plenum rated.

9. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lux), with an adjustment for turn-on and turn-off levels within that range.
10. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc (1080 to 10 800 lux), with an adjustment for turn-on and turn-off levels within that range.
11. Skylight Sensors Light-Level Monitoring Range: 1000 to 10,000 fc (10 800 to 108 000 lux), with an adjustment for turn-on and turn-off levels within that range.
12. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
13. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
14. Test Mode: User selectable, overriding programmed time delay to allow settings check.
15. Control Load Status: User selectable to confirm that load wiring is correct.
16. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.4 DAYLIGHT-HARVESTING DIMMING CONTROLS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Cooper Industries, Inc.
2. Deep Roof Lighting.
3. Hubbell Building Automation, Inc.
4. Leviton Manufacturing Co., Inc.
5. Lithonia Lighting; Acuity Brands Lighting, Inc.
6. WattStopper; a Legrand® Group brand.

B. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.

1. Lighting control set point is based on two lighting conditions:

   a. When no daylight is present (target level).
   b. When significant daylight is present.

2. System programming is done with two hand-held, remote-control tools.

   a. Initial setup tool.
   b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with integrated power pack mounted on luminaire, to detect changes in indoor lighting levels that are perceived by the eye.

D. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Sensor Output: 0- to 10-V dc to operate luminaires. Sensor is powered by controller unit.
3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc (120 to 640 lux).

E. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

1. LED status lights to indicate load status.
2. Plenum rated.

F. Power Pack: Digital controller capable of accepting 4 RJ45 inputs with two outputs rated for 20-A incandescent LED load at 120- and 277-V ac, for 16-A LED at 120- and 277-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc Class 2 power source, as defined by NFPA 70.

1. With integral current monitoring

   a. Compatible with digital addressable lighting interface.

      1) Plenum rated.

2.5 INDOOR OCCUPANCY AND VACANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Bryant Electric.
2. Cooper Industries, Inc.
3. Hubbell Building Automation, Inc.
4. Intermatic, Inc.
5. Leviton Manufacturing Co., Inc.
6. Lithonia Lighting; Acuity Brands Lighting, Inc.
7. Lutron Electronics Co., Inc.

8. NSi Industries LLC.
9. Philips Lighting Controls.
10. RAB Lighting.
11. Sensor Switch, Inc.
12. Square D.
13. WattStopper; a Legrand® Group brand.

B. General Requirements for Sensors:

1. Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
2. Dual technology.
3. Integrated power pack.
4. Hardwired connection to switch and BAS.
5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Operation:

    a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
    b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
    c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

7. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A Sensor is powered from the power pack.
8. Power: Line voltage.
9. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
10. Mounting:

    a. Sensor: Suitable for mounting in any position on a standard outlet box.
    b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
12. Bypass Switch: Override the "on" function in case of sensor failure.
13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.

C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm),

and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 square feet (110 square meters) when mounted48 inches (1200 mm) above finished floor.

2.6 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Bryant Electric.
2. Cooper Industries, Inc.
3. Hubbell Building Automation, Inc.
4. Intermatic, Inc.
5. Leviton Manufacturing Co., Inc.
6. Lithonia Lighting; Acuity Brands Lighting, Inc.
7. Lutron Electronics Co., Inc.
8. NSi Industries LLC.
9. Philips Lighting Controls.
10. RAB Lighting.
11. Sensor Switch, Inc.
12. Square D.
13. WattStopper; a Legrand® Group brand.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
4. Switch Rating: Not less than 800-VA LED load at 120 V, 1200-VA LED load at 277 V, and 800-W incandescent.

2.7 DIGITAL TIMER LIGHT SWITCH

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. Invensys Controls.
4. Leviton Manufacturing Co., Inc.
5. NSi Industries LLC.
6. TE Connectivity Ltd.

B. Description: Combination digital timer and conventional switch lighting control unit. Switchbox-mounted, backlit LCD display, with selectable time interval in 10 minute increments.

1. Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 amps at 277-V ac for LED, and 1/4 horsepower at 120-V ac.
2. Integral relay for connection to BAS.
3. Voltage: Match the circuit voltage Dual voltage - 120 and 277 V.
4. Color: White.
5. Faceplate: Color matched to switch.

2.8 HIGH-BAY OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Hubbell Building Automation, Inc.

B. Description: Solid-state unit. The unit is designed to operate with the lamp and ballasts indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.
3. Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.
4. Power: Line voltage.
5. Operating Ambient Conditions: 32 to 149 deg F (0 to 65 deg C).
6. Mounting: Threaded pipe.
7. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
8. Detector Technology: PIR.
9. Power and dimming control from the luminaire ballast that has been modified to include the dimming capacitor and MyzerPORT option.

C. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet (3.7 to 15.2 m).

D. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

2.9 EMERGENCY SHUNT RELAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lighting Control and Design.
2. WattStopper; a Legrand® Group brand.

B. Description: NC, electrically held relay, arranged for wiring in parallel with manual or automatic **switching** contacts; complying with UL 924.

1. Coil Rating: 120 V.

2.10 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multi-conductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multi-conductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SENSOR INSTALLATION

A. Comply with NECA 1.

B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

C. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 CONTACTOR INSTALLATION

A. Comply with NECA 1.

B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).

C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and non-power-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.

3.5 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Lighting control devices will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.8 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 260943.16 "Addressable-Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls."

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 260923

SECTION 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

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 distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

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 and size of transformer.
2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Seismic Qualification Data: Certificates, for transformers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline 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 and their installation requirements.
4. Certification: Indicate that equipment meets Project equipment seismic requirements.

C. Source quality-control reports.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.

1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.

C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

D. Handling: Follow manufacturer's instructions for lifting and transporting 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.
2. Controlled Power Company; an Emerson company.
3. Dongan Electric Manufacturing Company.
4. Eaton.
5. Federal Pacific.
6. General Electric Company.
7. Hammond Power Solutions Inc.
8. Jefferson Electric, Inc.
9. Lincoln Electric Products Co., Inc.
10. Mag-Tran; a division of Quality Transformer & Electronics.
11. Marcus Transformer LTD.
12. MGM Transformer Company.

13. Micron Industries Corporation.
14. Mirus International Inc.
15. Powersmiths International Corp.
16. Rex Power Magnetics.
17. Siemens Industry, Inc., Energy Management Division.
18. Sola/Hevi-Duty; a brand of Emerson Electric Co.
19. Square D; by Schneider Electric.
20. TEMCo Transformers.

B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Transformers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the transformer will remain in place without separation of any parts when subjected to the seismic forces specified and the transformer will be fully operational after the seismic event."

2.3 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Comply with NFPA 70.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Transformers Rated 15 kVA and Larger:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.

D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.4 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

1. One leg per phase.
2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
3. Grounded to enclosure.

D. Coils: Continuous windings without splices except for taps.

1. Coil Material: Aluminum.
2. Internal Coil Connections: Brazed or pressure type.
3. Terminal Connections: Welded or Bolted.

E. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

F. Enclosure: Ventilated.

1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
3. Wiring Compartment: Sized for conduit entry and wiring installation.
4. Finish: Comply with NEMA 250.

    a. Finish Color: Gray weather-resistant enamel.

G. Taps for Transformers 3 kVA and Smaller: One 5 percent tap above normal full capacity.

H. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

I. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

J. Insulation Class, Smaller than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

K. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

L. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.

M. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for non-sinusoidal 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, without exceeding the indicated insulation class in a 40 deg C maximum ambient and a 24-hour average ambient of 30 deg C.
2. Indicate value of K-factor on transformer nameplate.
3. Unit shall comply with requirements of DOE 2016 efficiency levels when tested according to NEMA TP 2 with a K-factor equal to one.

N. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.

O. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.

P. Wall Brackets: Manufacturer's standard brackets or Wall brackets fabricated from design drawings signed and sealed by a licensed structural engineer.

Q. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:

1. 9.00 kVA and Less: 40 dBA.
2. 9.01 to 30.00 kVA: 45 dBA.
3. 30.01 to 50.00 kVA: 45 dBA for K-factors of 1, 4, and 9.
4. 50.01 to 150.00 kVA: 50 dBA for K-factors of 1, 4, and 9
5. 150.01 to 300.00 kVA: 55 dBA for K-factors of 1, 4, and 9.
6. 300.01 to 500.00 kVA: 60 dBA for K-factors of 1, 4, and 9.
7. 500.01 to 700.00: 62 dBA for K-factors of 1, 4, and 9.
8. 700.01 to 1000.00: 64 dBA for K-factors of 1, 4, and 9.

2.5 IDENTIFICATION

A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

B. Nameplates: Self-adhesive label for each distribution transformer. Self-adhesive labels are specified in Section 260553 "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.

1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
2. Ratio tests at rated voltage connections and at all tap connections.
3. Phase relation and polarity tests at rated voltage connections.
4. No load losses, and excitation current and rated voltage at rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
6. Applied and induced tensile tests.
7. Regulation and efficiency at rated load and voltage.
8. Insulation-Resistance Tests:

    a. High-voltage to ground.
    b. Low-voltage to ground.
    c. High-voltage to low-voltage.

9. Temperature tests.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer or from design drawings signed and sealed by a licensed structural engineer.

1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
2. Brace wall-mounted transformers as specified in Section 260548.16 "Seismic Controls for Electrical Systems."

B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

C. Construct concrete bases according to Section 033000 "Cast-in-Place Concrete" or Section 033053 "Miscellaneous Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

D. Secure transformer to concrete base according to manufacturer's written instructions.

E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:

1. Visual and Mechanical Inspection.

   a. Inspect physical and mechanical condition.
   b. Inspect anchorage, alignment, and grounding.
   c. Verify that resilient mounts are free and that any shipping brackets have been removed.
   d. Verify the unit is clean.
   e. Perform specific inspections and mechanical tests recommended by manufacturer.
   f. Verify that as-left tap connections are as specified.
   g. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

   a. Measure resistance at each winding, tap, and bolted connection.
   b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
   c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
   d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

F. Large (Larger Than 167-kVA Single Phase or 500-kVA Three Phase) Dry-Type Transformer Field Tests:

1. Visual and Mechanical Inspection:

   a. Inspect physical and mechanical condition.
   b. Inspect anchorage, alignment, and grounding.
   c. Verify that resilient mounts are free and that any shipping brackets have been removed.
   d. Verify the unit is clean.
   e. Perform specific inspections and mechanical tests recommended by manufacturer.
   f. Verify that as-left tap connections are as specified.
   g. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

   a. Measure resistance at each winding, tap, and bolted connection.
   b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
   c. Perform power-factor or dissipation-factor tests on all windings.
   d. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
   e. Perform an excitation-current test on each phase.
   f. Perform an applied voltage test on all high- and low-voltage windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.
   g. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

G. Remove and replace units that do not pass tests or inspections and retest as specified above.

H. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

I. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262213

SECTION 262413 - SWITCHBOARDS

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. Service and distribution switchboards rated 600 V and less.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.
8. Mimic bus.

B. Related Requirements

1. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash analysis and arc-flash label requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.

1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.
7. Include evidence of NRTL listing for series rating of installed devices.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
10. Include diagram and details of proposed mimic bus.
11. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Samples: Representative portion of mimic bus with specified material and finish, for color selection.

D. Delegated Design Submittal:

1. For arc-flash hazard analysis.
2. For arc-flash labels.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Data: Certificates, for switchboards, overcurrent protective devices, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline 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 and their installation requirements.

C. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Routine maintenance requirements for switchboards and all installed components.
b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and connect factory-installed space heaters to temporary electrical service to prevent condensation.

C. Handle and prepare switchboards for installation according to NECA 400.

1.9 FIELD CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
b. Altitude: Not exceeding 6600 feet (2000 m).

C. Unusual Service Conditions: NEMA PB 2, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).

D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect Construction Manager Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Architect's Construction Manager's Owner's written permission.
4. Comply with NFPA 70E.

1.10 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.

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

B. Manufacturer's Warranty: Manufacturer's agrees to repair or replace surge protection devices that fail in materials or workmanship within specified warranty period.

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
2. 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."

2.2 SWITCHBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. General Electric Company.
3. Siemens Industry, Inc., Energy Management Division.
4. Square D; by Schneider Electric.

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 2.

F. Comply with NFPA 70.

G. Comply with UL 891.

H. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Panel mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

I. Front- and Side-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.
3. Section Alignment: Front aligned.

J. Front- and Rear-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel and fixed, individually mounted.
3. Sections front and rear aligned.

K. Nominal System Voltage: 208Y/120 V.

L. Main-Bus Continuous: 2000 A.

M. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.

   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."
   b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

N. Indoor Enclosures: Steel, NEMA 250, Type 1.

O. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

P. Outdoor Enclosures: Type 3R.

1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
2. Enclosure: Flat roof; bolt-on rear covers for each section, with provisions for padlocking.
3. Doors: Personnel door at each end of aisle, minimum width of 30 inches (762 mm); opening outwards; with panic hardware and provisions for pad locking. At least one door shall be sized to permit the largest single switchboard section to pass through without disassembling doors, hinges, or switchboard section.
4. Accessories: LED luminaires, ceiling mounted; wired to a three-way light switch at each end of aisle; ground-fault circuit interrupter (GFCI) duplex receptacle; emergency battery pack luminaire installed on wall of aisle midway between personnel doors.
5. Walk-in Aisle Heating and Ventilating:

   a. Factory-installed electric unit heater(s), wall or ceiling mounted, with integral thermostat and disconnect and with capacities to maintain switchboard interior temperature of 40 deg F (5 deg C) with outside design temperature of 0 deg F (minus 18 deg C).
   b. Factory-installed exhaust fan with capacities to maintain switchboard interior temperature of 100 deg F (38 deg C) with outside design temperature of 90 deg F (32 deg C).
   c. Ventilating openings complete with replaceable fiberglass air filters.
   d. Thermostat: Single stage; wired to control heat and exhaust fan.

6. Power for Space Heaters, Ventilation, Lighting, and Receptacle: Include a control-power transformer, with spare capacity of 25 percent, within the switchboard. Supply voltage shall be 120/208 V ac.
7. Power for space heaters, ventilation, lighting, and receptacle provided by a remote source.

Q. Barriers: Between adjacent switchboard sections.

R. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

S. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.

1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.
2. Space-Heater Power Source: Transformer, factory installed in switchboard.

T. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

U. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

V. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.

W. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

X. Removable, Hinged Rear Doors and Compartment Covers: Secured by captive thumb screws, for access to rear interior of switchboard.

Y. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

Z. Pull Box on Top of Switchboard:

1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
2. Set back from front to clear circuit-breaker removal mechanism.
3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

AA. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated.
3. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.
4. Copper feeder circuit-breaker line connections.
5. Tin-plated aluminum feeder circuit-breaker line connections.
6. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical or compression connectors for outgoing circuit

conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.

7. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-) or Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical or compression connectors for feeder and branch-circuit ground conductors.
8. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
9. Disconnect Links:

    a. Isolate neutral bus from incoming neutral conductors.
    b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.

10. Neutral Buses: 50 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical or compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
11. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical or compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
12. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

BB. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

CC. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

DD. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.

2.3 SURGE PROTECTION DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advanced Protection Technologies Inc. (APT).
2. Eaton.
3. General Electric Company.
4. Siemens Industry, Inc., Energy Management Division.
5. Square D; by Schneider Electric.

B. SPDs: Comply with UL 1449, Type 1.

C. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1.

D. Features and Accessories:

1. Integral disconnect switch.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Indicator light display for protection status.

4. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
5. Surge counter.

E. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

F. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V for 208Y/120 V.
2. Line to Ground: 1200 V for 208Y/120 V.
3. Line to Line: 1000 V for 208Y/120 V.

G. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: 1000 V.
3. Line to Line: 1000 V.

H. SCCR: Equal or exceed 200 kA.

I. Nominal Rating: 20 kA.

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.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

   a. Instantaneous trip.
   b. Long- and short-time pickup levels.
   c. Long and short time adjustments.
   d. Ground-fault pickup level, time delay, and I squared t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
6. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).

7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
8. MCCB Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical or Compression style, suitable for number, size, trip ratings, and conductor material.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
    f. Communication Capability: Circuit-breaker-mounted Integral communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
    g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
    h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
    i. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
    j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

B. Insulated-Case Circuit Breaker (ICCB): 80 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

1. Fixed circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Time adjustments for long- and short-time pickup.
    c. Ground-fault pickup level, time delay, and I squared t response.

4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
5. Remote trip indication and control.
6. Communication Capability: Web enabled integral Ethernet communication module and embedded Web server with factory-configured Web pages (HTML file format). Provide functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
8. Control Voltage: 120-V ac.

C. Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Boltswitch, Inc.
b. Eaton.
c. Siemens Industry, Inc., Energy Management Division.
d. Square D.

2. Main-Contact Interrupting Capability: Minimum of 12 times the switch current rating.

3. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.

   a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
   b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.

4. Auxiliary Switches: Factory installed, SPDT, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
5. Service-Rated Switches: Labeled for use as service equipment.
6. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.

   a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   b. Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.
   c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
   d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).

7. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.

D. High-Pressure, Butt-Type Contact Switch: Operating mechanism uses butt-type contacts and a spring-charged mechanism to produce and maintain high-pressure contact when switch is closed.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. General Electric Company.

2. Main-Contact Interrupting Capability: Minimum of 12 times the switch current rating.

3. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.

   a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
   b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.

4. Auxiliary Switches: Factory installed, SPDT, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
5. Service-Rated Switches: Labeled for use as service equipment.

6. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.

    a. Configuration: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    b. Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.
    c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
    d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).

7. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.

E. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

F. Fuses are specified in Section 262813 "Fuses."

2.5 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, and the following:

1. Potential Transformers: NEMA EI 21.1; 120 V, 60 Hz, tapped secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
2. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

    a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
    b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
    c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
    d. Megawatts: Plus or minus 1 percent.
    e. Megavars: Plus or minus 1 percent.
    f. Power Factor: Plus or minus 1 percent.
    g. Frequency: Plus or minus 0.1 percent.
    h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
    i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
    j. Contact devices to operate remote impulse-totalizing demand meter.

2. Mounting: Display and control unit flush or semi flush mounted in instrument compartment door.

C. Analog Meters:

1. Meters: 4-inch (100-mm) diameter or 6 inches (150 mm) square flush or semi flush, with anti-parallax 250-degree scales and external zero adjustment.

D. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.

E. Instrument Switches: Rotary type with off position.

1. Voltmeter Switches: Permit reading of all phase-to-phase voltages and, where a neutral is indicated, phase-to-neutral voltages.
2. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in a closed-circuit condition at all times.

F. Ammeters: 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale. Meter and transfer device with off position, located on overcurrent device door for indicated feeder circuits only.

G. Watt-Hour Meters and Wattmeters:

1. Comply with ANSI C12.1.
2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
3. Suitable for connection to three- and four-wire circuits.
4. Potential indicating lamps.
5. Adjustments for light and full load, phase balance, and power factor.
6. Four-dial clock register.
7. Integral demand indicator.
8. Contact devices to operate remote impulse-totalizing demand meter.
9. Ratchets to prevent reverse rotation.
10. Removable meter with drawout test plug.
11. Semi flush mounted case with matching cover.
12. Appropriate multiplier tag.

H. Impulse-Totalizing Demand Meter:

1. Comply with ANSI C12.1.
2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.
3. Cyclometer.
4. Four-dial, totalizing kilowatt-hour register.
5. Positive chart drive mechanism.
6. Capillary pen holding a minimum of one month's ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
8. Capable of indicating and recording five-minute integrated demand of totalized system.

2.6 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Control Circuits: 120-V ac, supplied from remote branch circuit.

C. Control Circuits: 24-V dc.

D. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to the primary side of each control-power transformer at the line side of the associated main circuit breaker. 120-V secondaries connected through automatic transfer relays to ensure a fail-safe automatic transfer scheme.

E. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

F. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

C. Portable Circuit-Breaker Lifting Device: Floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.

D. Overhead Circuit-Breaker Lifting Device: Mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.

E. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

F. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

2.8 IDENTIFICATION

A. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on a photoengraved nameplate.

1. Nameplate: At least 0.032-inch- (0.813-mm-) thick anodized aluminum, located at eye level on front cover of the switchboard incoming service section.

B. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on an engraved laminated-plastic (Gravoply) nameplate.

1. Nameplate: At least 0.0625-inch- (1.588 mm-) thick laminated plastic (Gravoply), located at eye level on front cover of the switchboard incoming service section.

C. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram.

D. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.

E. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components complete with lettered designations.

F. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NECA 400.

1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
3. Protect from moisture, dust, dirt, and debris during storage and installation.
4. Install temporary heating during storage per manufacturer's instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NECA 400.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete." Section 033053 "Miscellaneous Cast-in-Place Concrete."

1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches (50-mm) above concrete base after switchboard is anchored in place.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to switchboards.
6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, surge protection devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

H. Install spare-fuse cabinet.

I. Comply with NECA 1.

3.3 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.

B. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

C. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.

D. Support and secure conductors within the switchboard according to NFPA 70.

E. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections:

1. Acceptance Testing:

a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
b. Test continuity of each circuit.

2. Test ground-fault protection of equipment for service equipment per NFPA 70.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
5. Perform the following infrared scan tests and inspections, and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Switchboard will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated. As specified in Section 260573.16 "Coordination Studies."

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

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. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Load centers.
4. Electronic-grade panelboards.

1.3 DEFINITIONS

A. ATS: Acceptance testing specification.

B. GFCI: Ground-fault circuit interrupter.

C. GFEP: Ground-fault equipment protection.

D. HID: High-intensity discharge.

E. MCCB: Molded-case circuit breaker.

F. SPD: Surge protective device.

G. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of panelboard.

1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.

3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of NRTL listing for series rating of installed devices.
7. Include evidence of NRTL listing for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 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. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407.

1.10 FIELD CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

   a. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) to plus 104 deg F (plus 40 deg C).
   b. Altitude: Not exceeding 6600 feet (2000 m).

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect Construction Manager Owner no fewer than two days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Architect's Construction Manager's Owner's written permission.
3. Comply with NFPA 70E.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.

1. SPD Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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. Comply with NEMA PB 1.

E. Comply with NFPA 70.

F. Enclosures: Flush and Surface-mounted, dead-front cabinets.

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,.
d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2. Height: 84 inches (2.13 m) maximum.
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
7. Finishes:

a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

b. Load Centers: Shall be provided with white factory finish.
c. Back Boxes: Galvanized steel.
d. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

G. Incoming Mains:

1. Location: Convertible between top and bottom.

2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

H. Phase, Neutral, and Ground Buses:

1. Material: Tin-plated aluminum.

   a. Plating shall run entire length of bus.
   b. Bus shall be fully rated the entire length.

2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.
7. Split Bus: Vertical buses divided into individual vertical sections.

I. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Tin-plated aluminum.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Compression or Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Compression or Mechanical type, with a lug on the bar for each pole in the panelboard.
6. Feed-Through Lugs: Compression or Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
7. Subfeed (Double) Lugs: Compression or Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
8. Gutter-Tap Lugs: Compression or Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
9. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

J. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

K. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Percentage of Future Space Capacity: 20 percent.

L. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.

1. Panelboards rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
2. Panelboards rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

M. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. 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."

B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.3 POWER PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Eaton.
2. Siemens Industry, Inc., Energy Management Division.
3. Square D; by Schneider Electric.

B. Panelboards: NEMA PB 1, distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

D. Mains: Circuit breaker.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

G. Branch Overcurrent Protective Devices: Fused switches.

H. Contactors in Main Bus: NEMA ICS 2, Class A, electrically or mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
2. External Control-Power Source: 24-V control circuit.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Eaton.
2. Siemens Industry, Inc., Energy Management Division.
3. Square D; by Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Contactors in Main Bus: NEMA ICS 2, Class A, electrically or mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
2. External Control-Power Source: 24-V control circuit.

F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

G. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

H. Column-Type Panelboards: Single row of overcurrent devices with narrow gutter extension and overhead junction box equipped with ground and neutral terminal buses.

1. Doors: Concealed hinges secured with multipoint latch with tumbler lock; keyed alike.

2.5 LOAD CENTERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Eaton.
2. Siemens Industry, Inc., Energy Management Division.

3. Square D; by Schneider Electric.

B. Mains: Circuit breaker.

C. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

D. Doors: Concealed hinges secured with flush latch with tumbler lock; keyed alike.

E. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.6 ELECTRONIC-GRADE PANELBOARDS

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Panelboards: NEMA PB 1; with factory-installed, integral SPD; labeled by an NRTL for compliance with UL 67 and UL 1449 after installing SPD.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

D. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.

E. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.

F. SPD.

1. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
2. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

   a. Line to Neutral: 700 V for 208Y/120 V.
   b. Line to Ground: 700 V for 208Y/120 V.
   c. Neutral to Ground: 700 V for 208Y/120 V.
   d. Line to Line: 1200 V for 208Y/120 V.

3. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:

   a. Line to Neutral: 700 V.
   b. Line to Ground: 700 V.
   c. Neutral to Ground: 700 V.
   d. Line to Line: 1200 V.

4. SCCR: Equal to the SCCR of the panelboard in which installed or exceed 100 kA.
5. Inominal Rating: 20 kA.

G. Buses:

1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
2. Copper equipment and isolated ground buses.

2.7 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Eaton.
2. Siemens Industry, Inc., Energy Management Division.
3. Square D; by Schneider Electric.

B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:

   a. Inverse time-current element for low-level overloads.
   b. Instantaneous magnetic trip element for short circuits.
   c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Circuit Breakers:

   a. RMS sensing.
   b. Field-replaceable rating plug or electronic trip.
   c. Digital display of settings, trip targets, and indicated metering displays.
   d. Multi-button keypad to access programmable functions and monitored data.
   e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
   f. Integral test jack for connection to portable test set or laptop computer.
   g. Field-Adjustable Settings:

      1) Instantaneous trip.
      2) Long- and short-time pickup levels.
      3) Long and short time adjustments.
      4) Ground-fault pickup level, time delay, and I squared T response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Subfeed Circuit Breakers: Vertically mounted.
9. MCCB Features and Accessories:

   a. Standard frame sizes, trip ratings, and number of poles.
   b. Breaker handle indicates tripped status.
   c. UL listed for reverse connection without restrictive line or load ratings.
   d. Lugs: Compression or Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
   f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

g. Communication Capability: Circuit-breaker-mounted Integral communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
h. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
i. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
j. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
k. Auxiliary Contacts: One, SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
l. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
m. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
n. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
o. Multipole units enclosed in a single housing with a single handle or factory assembled to operate as a single unit.
p. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
q. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."
2. Fused Switch Features and Accessories:

a. Standard ampere ratings and number of poles.
b. Mechanical cover interlock with a manual interlock override, to prevent the opening of the cover when the switch is in the on position. The interlock shall prevent the switch from being turned on with the cover open. The operating handle shall have lock-off means with provisions for three padlocks.
c. Auxiliary Contacts: One normally open and normally closed contact(s) that operate with switch handle operation.

2.8 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.9 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NECA 407.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NECA 407.

D. Equipment Mounting:

1. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete." Section 033053 "Miscellaneous Cast-in-Place Concrete."
2. Attach panelboard to the vertical finished or structural surface behind the panelboard.
3. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

G. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.

H. Mount panelboard cabinet plumb and rigid without distortion of box.

I. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

J. Mount surface-mounted panelboards to steel slotted supports 1 1/4 inch (32 mm) in depth. Orient steel slotted supports vertically.

K. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.
2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

L. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

M. Install filler plates in unused spaces.

N. Stub four 1-inch (25 mm) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (25 mm) empty conduits into raised floor space or below slab not on grade.

O. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

P. Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Perform optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated and as specified in Section 260573.16 "Coordination Studies."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

1. Measure loads during period of normal facility operations.
2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

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-grade receptacles, 125 V, 20 A.
2. USB receptacles.
3. GFCI receptacles, 125 V, 20 A.
4. SPD receptacles, 125 V, 20 A.
5. Hospital-grade receptacles, 125 V, 20 A.
6. Hazardous (classified) location receptacles.
7. Twist-locking receptacles.
8. Pendant cord-connector devices.
9. Cord and plug sets.
10. Toggle switches, 120/277 V, 20 A.
11. Decorator-style devices, 20 A.
12. Occupancy sensors.
13. Digital timer light switches.
14. Residential devices.
15. Wall-box dimmers.
16. Wall plates.
17. Floor service fittings.
18. Poke-through assemblies.
19. Prefabricated multi-outlet assemblies.
20. Service poles.

1.3 DEFINITIONS

A. AFCI: Arc-fault circuit interrupter.

B. BAS: Building automation system.

C. EMI: Electromagnetic interference.

D. GFCI: Ground-fault circuit interrupter.

E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

F. RFI: Radio-frequency interference.

G. SPD: Surge protective device.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.7 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. Service/Power Poles: One for every 10, but no less than one.
2. Floor Service-Outlet Assemblies: One for every 10, but no less than one.
3. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.
4. SPD Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Comply with NFPA 70.

C. RoHS compliant.

D. Comply with NEMA WD 1.

E. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with requirements in this Section.

F. Devices for Owner-Furnished Equipment:

1. Receptacles: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

G. Device Color:

1. Wiring Devices Connected to Normal Power System: White or As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Essential Electrical System: Red.
3. SPD Devices: Blue.
4. Isolated-Ground Receptacles: As specified above, with orange triangle on face.

H. Wall Plate Color: For plastic covers, match device color.

I. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

A. Duplex Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498 and FS W-C-596.

B. Isolated-Ground Duplex Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Straight blade; equipment grounding contacts shall be connected only to green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts. Two pole, three wire, and self-grounding.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498 and FS W-C-596.

C. Tamper-Resistant Duplex Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498 and FS W-C-596.
5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

D. Weather-Resistant Duplex Receptacle, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498.
5. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

E. Tamper- and Weather-Resistant Duplex Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498.
5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

2.3 STANDARD-GRADE RECEPTACLES, 125 V, 15 A

A. Duplex Receptacles, 125 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding.
3. Configuration: NEMA WD 6, Configuration 5-15R.
4. Standards: Comply with UL 498 and FS W-C-596.

B. Isolated-Ground Duplex Receptacles, 125 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Straight blade; equipment grounding contacts shall be connected only to green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts. Two pole, three wire, and self-grounding.
3. Configuration: NEMA WD 6, Configuration 5-15R.
4. Standards: Comply with UL 498 and FS W-C-596.

C. Tamper-Resistant Duplex Receptacles, 125 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
3. Configuration: NEMA WD 6, Configuration 5-15R.
4. Standards: Comply with UL 498 and FS W-C-596.
5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

D. Weather-Resistant Duplex Receptacle, 125 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.

d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
3. Configuration: NEMA WD 6, Configuration 5-15R.
4. Standards: Comply with UL 498.
5. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

E. Tamper- and Weather-Resistant Duplex Receptacles, 125 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
3. Configuration: NEMA WD 6, Configuration 5-15R.
4. Standards: Comply with UL 498.
5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

2.4 USB RECEPTACLES

A. USB Charging Receptacles:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Single-piece, rivet-less, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
3. USB Receptacles: Dual and quad, USB Type A, 5 V dc, and 2.1 A per receptacle (minimum).
4. Standards: Comply with UL 1310 and USB 3.0 devices.

B. Tamper-Resistant Duplex and USB Charging Receptacles:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Single-piece, rivet-less, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap. Integral shutters that operate only when a plug is inserted in the line voltage receptacle.
3. Line Voltage Receptacles: Two pole, three wire, and self-grounding; NEMA WD 6, Configuration 5-20R.
4. USB Receptacles: Dual USB Type A, 5 V dc, and 2.1 A per receptacle (minimum).
5. Standards: Comply with UL 498, UL 1310, USB 3.0 devices, and FS W-C-596.
6. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

2.5 GFCI RECEPTACLES, 125 V, 20 A

A. Duplex GFCI Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.

3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Type: Feed through.
5. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

B. Tamper-Resistant Duplex GFCI Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Hubbell Incorporated; Wiring Device-Kellems.
   b. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.

3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Type: Feed through.
5. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.
6. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

C. Tamper- and Weather-Resistant, GFCI Duplex Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).

b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.

3. Configuration: NEMA WD 6, Configuration 5-15R.
4. Type: Feed through.
5. Standards: Comply with UL 498 and UL 943 Class A.
6. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

2.6 SPD RECEPTACLES, 125 V, 20 A

A. Duplex SPD Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral SPD in line to ground, line to neutral, and neutral to ground. LED indicator light.
3. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
4. Active SPD Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
5. Configuration: NEMA WD 6, Configuration 5-20R.
6. Standards: Comply with NEMA WD 1, UL 498, UL 1449, and FS W-C-596.

B. Isolated-Ground Duplex SPD Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral SPD in line to ground, line to neutral, and neutral to ground. LED indicator light.
3. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
4. Active SPD Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."

5. Grounding: Equipment grounding contacts shall be connected only to green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
6. Configuration: NEMA WD 6, Configuration 5-20R.
7. Standards: Comply with UL 498, UL 1449, and FS W-C-596.

2.7 HOSPITAL-GRADE RECEPTACLES, 125 V, 20 A

A. Hospital-Grade, Single Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Single-piece, rivet-less, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap. Two pole, three wire, and self-grounding.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498 Supplement sd and FS W-C-596.
5. Marking: Listed and labeled as complying with NFPA 70, "Health Care Facilities" Article.

B. Hospital-Grade, Duplex Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Single-piece, rivet-less, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap. Two pole, three wire, and self-grounding.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498 Supplement sd and FS W-C-596.
5. Marking: Listed and labeled as complying with NFPA 70, "Health Care Facilities" Article.

C. Hospital-Grade, Isolated-Ground, Duplex Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Premise Wiring.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Straight blade; equipment grounding contacts shall be connected only to green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts. Two pole, three wire, and self-grounding.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498 Supplement sd and FS W-C-596.
5. Marking: Listed and labeled as complying with NFPA 70, "Health Care Facilities" Article.

D. Hospital-Grade, Tamper-Resistant, Duplex Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Premise Wiring.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with NEMA WD 1, UL 498 Supplement sd, and FS W-C-596.
5. Marking: Listed and labeled as complying with NFPA 70, "Health Care Facilities" Article.

E. Hospital-Grade, Tamper-Resistant, Duplex (125 V, 20 A) and USB Charging Receptacles:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Single-piece, rivet-less, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap. Integral shutters that operate only when a plug is inserted in the line voltage receptacle.
3. Line Voltage Receptacles: Two pole, three wire, and self-grounding, NEMA Configuration 5-20R.
4. USB Receptacles: Dual, USB Type A, 5 V dc, and 2.1 A per receptacle (minimum).
5. Standards: Comply with NEMA WD 1, UL 498 Supplement sd, UL 1310, and FS W-C-596.
6. Marking: Listed and labeled as complying with NFPA 70, "Health Care Facilities" Article.

2.8 TWIST-LOCKING RECEPTACLES

A. Twist-Lock, Single Receptacles, 120 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.

c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Configuration: NEMA WD 6, Configuration L5-20R.

3. Standards: Comply with UL 498.

B. Twist-Lock, Single Receptacles, 250 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Eaton (Arrow Hart).
b. Hubbell Premise Wiring.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Configuration: NEMA WD 6, Configuration L6-20R.

3. Standards: Comply with UL 498.

C. Twist-Lock, Single Receptacles, 277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Eaton (Arrow Hart).
b. Hubbell Premise Wiring.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Configuration: NEMA WD 6, Configuration L7-20R.

3. Standards: Comply with UL 498.

D. Twist-Lock, Isolated-Ground, Single Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Eaton (Arrow Hart).
b. Hubbell Premise Wiring.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Grounding: Equipment grounding contacts shall be connected only to green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

3. Configuration: NEMA WD 6, Configuration L5-20R.
4. Standards: Comply with UL 498.

2.9 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector, heavy-duty grade.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton (Arrow Hart).
2. Ericson.
3. Hubbell Premise Wiring.
4. Leviton Manufacturing Co., Inc.
5. Pass & Seymour/Legrand (Pass & Seymour).

C. Configuration: NEMA WD 6, Configurations L5-20P and L5-20R.

D. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.

E. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

F. Standards: Comply with FS W-C-596.

2.10 CORD AND PLUG SETS

A. Match voltage and current ratings and number of conductors to requirements of equipment being connected.

B. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.

C. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.11 TOGGLE SWITCHES, 120/277 V, 15 A

A. Single-Pole Switches, 120/277 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Standards: Comply with UL 20 and FS W-S-896.

B. Two-Pole Switches, 120/277 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Comply with UL 20 and FS W-S-896.

3. Description: Contact surfaces treated with a coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.
4. Standards: Comply with UL 20 and FS W-S-896.

C. Three-Way Switches, 120/277 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Comply with UL 20 and FS W-S-896.

D. Four-Way Switches, 120/277 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Standards: Comply with UL 20 and FS W-S-896.

E. Pilot-Light, Single-Pole Switches: 120/277 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Illuminated when switch is on.

3. Standards: Comply with UL 20 and FS W-S-896.

F. Lighted Single-Pole Switches, 120/277 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Handle illuminated when switch is on.

3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

G. Key-Operated, Single-Pole Switches, 120/277 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Factory-supplied key in lieu of switch handle.

3. Standards: Comply with UL 20 and FS W-S-896.

H. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches, 120/277 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: For use with mechanically held lighting contactors.

3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

I. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches, 120/277 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Leviton Manufacturing Co., Inc.
   c. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: For use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.12 TOGGLE SWITCHES, 120/277 V, 20 A

A. Single-Pole Switches, 120/277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Standards: Comply with UL 20 and FS W-S-896.

B. Antimicrobial, Single-Pole Switches, 120/277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Contact surfaces treated with a coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.
3. Standards: Comply with UL 20 and FS W-S-896.

C. Two-Pole Switches, 120/277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Comply with UL 20 and FS W-S-896.

D. Antimicrobial, Double-Pole Switches, 120/277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Contact surfaces treated with a coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.
3. Standards: Comply with UL 20 and FS W-S-896.

E. Three-Way Switches, 120/277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Comply with UL 20 and FS W-S-896.

F. Antimicrobial, Three-Way Switches, 120/277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Contact surfaces treated with a coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.
3. Standards: Comply with UL 20 and FS W-S-896.

G. Four-Way Switches, 120/277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Standards: Comply with UL 20 and FS W-S-896.

H. Pilot-Light, Single-Pole Switches: 120/277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Illuminated when switch is on.
3. Standards: Comply with UL 20 and FS W-S-896.

I. Lighted Single-Pole Switches, 120/277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Handle illuminated when switch is on.
3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

J. Key-Operated, Single-Pole Switches, 120/277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Factory-supplied key in lieu of switch handle.
3. Standards: Comply with UL 20 and FS W-S-896.

K. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches, 120/277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: For use with mechanically held lighting contactors.
3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

L. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches, 120/277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: For use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.13 DECORATOR-STYLE DEVICES, 15 A

A. Decorator Duplex Receptacles, 125 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Square face.
3. Configuration: NEMA WD 6, Configuration 5-15R.
4. Standards: Comply with UL 498.

B. Decorator, Tamper-Resistant, Duplex Receptacles, 125 V, 15 A,:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
3. Configuration: NEMA WD 6, Configuration 5-15R.
4. Standards: Comply with UL 498.
5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

C. Decorator, Tamper- and Weather-Resistant, Duplex Receptacles, 125 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
3. Configuration: NEMA WD 6, Configuration 5-15R.
4. Standards: Comply with UL 498.
5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

D. Decorator Single-Pole Switches, 120/277 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Comply with UL 20.

E. Decorator Single-Pole Lighted Switches,120/277 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Square face illuminated when circuit is switched off.
3. Standards: Comply with UL 20.

F. Decorator, Antimicrobial, Single-Pole Switches, 120/277 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Contact surfaces treated with a coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.
3. Standards: Comply with UL 20 and FS W-S-896.

2.14 DECORATOR-STYLE DEVICES, 20 A

A. Decorator Duplex Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Square face.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498.

B. Decorator Tamper-Resistant Duplex Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498.
5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

C. Decorator, Tamper- and Weather-Resistant, Duplex Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498.
5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

D. Decorator Single-Pole Switches, 120/277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Comply with UL 20.

E. Decorator Single-Pole Lighted Switches,120/277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Eaton (Arrow Hart).
    b. Hubbell Incorporated; Wiring Device-Kellems.
    c. Leviton Manufacturing Co., Inc.
    d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Square face illuminated when circuit is switched off.
3. Standards: Comply with UL 20.

F. Decorator, Antimicrobial, Single-Pole Switches, 120/277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Contact surfaces treated with a coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.
3. Standards: Comply with UL 20 and FS W-S-896.

2.15 OCCUPANCY SENSORS

A. Wall Switch Sensor Light Switch, Dual Technology:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Switchbox-mounted, combination lighting-control sensor and conventional switch lighting-control unit using dual (ultrasonic and passive infrared) technology.
3. Standards: Comply with UL 20.
4. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.
5. Adjustable time delay of 10 minutes.
6. Able to be locked to Automatic and Manual-On mode.
7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux).
8. Connections: Provisions for connection to BAS.
9. Connections: RJ-45 communications outlet.
10. Connections: Integral wireless networking.

B. Wall Sensor Light Switch, Passive Infrared:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Switchbox-mounted, combination, lighting-control sensor and conventional switch lighting-control unit using passive infrared technology.

3. Standards: Comply with UL 20.
4. Connections: Provisions for connection to BAS.
5. Connections: Hard wired.
6. Connections: Wireless.
7. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.
8. Integral relay for connection to BAS.
9. Adjustable time delay of 10 minutes.
10. Able to be locked to Automatic and Manual-On mode.
11. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux).

C. Wall Sensor Light Switch, Ultrasonic:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Switchbox-mounted, combination, lighting-control sensor and conventional switch lighting-control unit using ultrasonic technology.
3. Standards: Comply with UL 20.
4. Connections: Provisions for connection to BAS.
5. Connections: RJ-45 communications outlet.
6. Connections: Integral wireless networking.
7. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.
8. Integral relay for connection to BAS.
9. Adjustable time delay of 10 minutes.
10. Able to be locked to Automatic and Manual-On mode.
11. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux).

2.16 TIMER LIGHT SWITCH

A. Digital Timer Light Switch:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Switchbox-mounted, combination digital timer and conventional switch lighting-control unit, with backlit digital display, with selectable time interval in 10-minute increments.
3. Standards: Comply with UL 20.
4. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.
5. Integral relay for connection to BAS.

2.17 RESIDENTIAL DEVICES

A. Residential-Grade, Tamper-Resistant, GFCI Receptacles, 125 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Configuration: NEMA WD 6, Configuration 5-15R.
3. Feed-through connectors.
4. Standards: Comply with UL 943 and UL 1699.

B. Residential-Grade, Tamper-Resistant, AFCI Receptacles, 125 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Configuration: NEMA WD 6, Configuration 5-15R.
3. Feed-through connectors.
4. Standards: Comply with UL 943 and UL 1699.

C. Residential-Grade, Tamper-Resistant Receptacles, 125 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Configuration: NEMA WD 6, Configuration 5-15R.
3. Feed-through connectors.
4. Standards: Comply with UL 498.

D. Weather- and Tamper-Resistant Receptacles, 125 V, 15 A:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Configuration: NEMA WD 6, Configuration 5-15R.
3. Feed-through connectors.
4. Standards: Comply with UL 498.
5. Marked as "Weather Resistant."

E. Fan-Speed Controls:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Modular, 120-V ac, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters.
3. Standards: Comply with UL 1917.
4. Continuously adjustable slider, 5 A.
5. Three-speed adjustable slider, 1.5 A.

F. Telephone Outlet:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Single RJ-11 jack for terminating Category 3, balanced twisted pair cable complying with Section 260523 "Control-Voltage Electrical Power Cables."
3. Description: Single RJ-11 jack for terminating Category 3, balanced twisted pair cable complying with Section 271513 "Communications Copper Horizontal Cabling."
4. Standards: Comply with UL 1863.

G. Combination Telephone and Coaxial Outlet:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Single RJ-11 jack for terminating Category 3, twisted pair cable complying with Section 260523 "Control-Voltage Electrical Power Cables" and a single BNC connector for terminating coaxial cable.
3. Description: Single RJ-11 jack for terminating Category 3, twisted pair cable complying with Section 271513 "Communications Copper Horizontal Cabling" and a single BNC connector for terminating coaxial cable complying with Section 271533 "Communications Coaxial Horizontal Cabling."
4. Standards: Comply with UL 1863.

2.18 DIMMERS

A. Wall-Box Dimmers:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Modular, full-wave, solid-state dimmer switch with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
3. Control: Continuously adjustable slider; with single-pole or three-way switching.
4. Standards: Comply with UL 1472.
5. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

   a. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when "off."
   b. .

6. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.
7. LED Lamp Dimmer Switches: Modular; compatible with LED lamps; trim potentiometer to adjust low-end dimming; capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.19 WALL PLATES

A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

B. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting 0.035-inch- (1-mm-) thick, satin-finished, Type 302 stainless steel.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

D. Antimicrobial Cover Plates:

1. Contact surfaces treated with a coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.
2. Tarnish resistant.

2.20 FLOOR SERVICE FITTINGS

A. Flush-Type Floor Service Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Type: Modular, flush-type, dual-service units suitable for wiring method used, with cover flush with finished floor.
3. Compartments: Barrier separates power from voice and data communication cabling.
4. Service Plate and Cover: Rectangular, die-cast aluminum with satin finish.
5. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
6. Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 jacks for twisted pair cable, complying with requirements in Section 271513 "Communications Copper Horizontal Cabling."

2.21 POKE-THROUGH ASSEMBLIES

A. Description: Factory-fabricated and -wired assembly of below-floor junction box with multi-channeled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.

B. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. See drawings.

C. Standards: Comply with scrub water exclusion requirements in UL 514.

D. Service-Outlet Assembly: Flush type with two simplex receptacles and space for two RJ-45 jacks, complying with requirements in Section 271513 "Communications Copper Horizontal Cabling."

E. Size: Selected to fit nominal 4-inch (100-mm) cored holes in floor and matched to floor thickness.

F. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.

G. Closure Plug: Arranged to close unused 4-inch (100-mm) cored openings and reestablish fire rating of floor.

H. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of two, four-pair cables that comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

2.22 PREFABRICATED MULTI-OUTLET ASSEMBLIES

A. Description: Two-piece surface metal raceway, with factory-wired multi-outlet harness.

B. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. See drawings.

C. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

D. Raceway Material: Metal, with manufacturer's standard finish.

E. Multi-outlet Harness:

1. Receptacles: 15-A, 125-V, NEMA WD 6 Configuration 5-15R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
2. Receptacle Spacing: 6 inches (150 mm).
3. Wiring: No. 12 AWG solid, Type THHN copper, single circuit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

a. Cut back and pigtail, or replace all damaged conductors.
b. Straighten conductors that remain and remove corrosion and foreign matter.
c. Pig tailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan-speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device, listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

C. Essential Electrical System: Mark receptacles supplied from the essential electrical system to allow easy identification using a self-adhesive label.

3.4 FIELD QUALITY CONTROL

A. Test Instruments: Use instruments that comply with UL 1436.

B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. In healthcare facilities, prepare reports that comply with NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

D. Tests for Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

E. Test straight-blade convenience outlets in patient-care areas for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115 g).

F. Wiring device will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262813 - FUSES

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. Cartridge fuses rated 600 V ac and less for use in the following:

    a. Control circuits.
    b. Motor-control centers.
    c. Panelboards.
    d. Switchboards.
    e. Enclosed controllers.
    f. Enclosed switches.

2. Spare-fuse cabinets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

    a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in electronic format suitable for use in coordination software and in PDF format.
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700 "Closeout Procedures," Section 017823 "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in electronic format suitable for use in coordination software and in PDF format.
4. Coordination charts and tables and related data.

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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bussmann, an Eaton business.
2. Edison; a brand of Bussmann by Eaton.
3. Littelfuse, Inc.
4. Mersen USA.

B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

1. Type RK-1: 250-V, zero- to 600-A rating, 200 kAIC, time delay.

2. Type RK-5: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting.
4. Type CD: 600-V, 31- to 60-A rating, 200 kAIC, fast acting.
5. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
6. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
7. Type T: 600-V, zero- to 800-A rating, 200 kAIC, very fast acting.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Service Entrance: Class L, fast acting.
2. Feeders: Class L, time delay.
3. Motor Branch Circuits: Class RK5, time delay.
4. Large Motor Branch (601-4000 A): Class L, time delay.
5. Power Electronics Circuits: Class J, high speed.
6. Other Branch Circuits: Class RK5, time delay.
7. Control Transformer Circuits: Class CC, time delay, and control transformer duty.
8. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Architect Construction Manager Owner.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 265119 - LED INTERIOR LIGHTING

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 the following types of LED luminaires:

1. Cylinder.
2. Downlight.
3. Highbay, linear.
4. Highbay, nonlinear.
5. Linear industrial.
6. Lowbay.
7. Parking garage.
8. Recessed, linear.
9. Strip light.
10. Surface mount, linear.
11. Surface mount, nonlinear.
12. Suspended, linear.
13. Suspended, nonlinear.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Section 260926 "Lighting Control Panelboards" for panelboards used for lighting control.
3. Section 260933 "Central Dimming Controls" or Section 260936 "Modular Dimming Controls" for architectural dimming systems and for fluorescent dimming controls with dimming ballasts specified in interior lighting Sections.
4. Section 260943.16 "Addressable-Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
6. Photometric data and adjustment factors based on laboratory tests, complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project IES LM-79 and IES LM-80.

   a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
   b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Sustainable Design Submittals:

D. Samples: For each luminaire and for each color and texture with standard factory-applied finish.

E. Samples for Initial Selection: For each type of luminaire with custom factory-applied finishes.

1. Include Samples of luminaires and accessories involving color and finish selection.

F. Samples for Verification: For each type of luminaire.

1. Include Samples of luminaires and accessories to verify finish selection.

G. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Luminaires.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches (300 mm) of the plane of the luminaires.
4. Structural members to which equipment and or luminaires will be attached.
5. Initial access modules for acoustical tile, including size and locations.
6. Items penetrating finished ceiling, including the following:

   a. Other luminaires.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
   f. Ceiling-mounted projectors.

7. Moldings.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline 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 and their installation requirements.

D. Product Certificates: For each type of luminaire.

E. Product Test Reports: For each type of luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

F. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

E. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of luminaires in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

C. Ambient Temperature: 5 to 104 deg F (Minus 15 to plus 40 deg C).

1. Relative Humidity: Zero to 95 percent.

D. Altitude: Sea level to 5000 feet (300 m).

2.2 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRI.

C. Recessed luminaires shall comply with NEMA LE 4.

D. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

E. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

F. California Title 24 compliant.

2.3 CYLINDER.

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: see drawings

B. Nominal Operating Voltage: 120/277 V ac.

C. Lamp:

1. Minimum 1000 lm.
2. Minimum allowable efficacy of 80 lm/W.
3. CRI of minimum 80. CCT of 3000 K.
4. Rated lamp life of 50,000 hours to L70.
5. Dimmable from 100 percent to 0 percent of maximum light output.
6. Internal driver.
7. User-Replaceable Lamps:

   a. Bulb shape complying with ANSI C78.79.
   b. Lamp base complying with ANSI C81.61 or IEC 60061-1.

8. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear powder-coat finish.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:

1. Clear, UV-stabilized acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

G. With integral mounting provisions.

H. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.4 DOWNLIGHT.

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: see drawings

B. Nominal Operating Voltage: 120/277 V ac.

C. Lamp:

1. Minimum 1000 lm.
2. Minimum allowable efficacy of 80 lm/W.
3. CRI of minimum 80. CCT of 4100 K.

4. Rated lamp life of 50,000 hours to L70.
5. Dimmable from 100 percent to 0 percent of maximum light output.
6. Internal driver.
7. User-Replaceable Lamps:

    a. Bulb shape complying with ANSI C78.79.
    b. Lamp base complying with ANSI C81.61 or IEC 60061-1.

8. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear finish.
3. Universal mounting bracket.
4. Integral junction box with conduit fittings.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:

1. Fixed lens.
2. Medium light distribution.
3. Clear, UV-stabilized acrylic.
4. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
5. Glass: Annealed crystal glass unless otherwise indicated.
6. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.
4. Recessed luminaires shall comply with NEMA LE 4.

2.5 PARKING GARAGE.

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: see drawings

B. Nominal Operating Voltage: 120/277 V ac.

C. Lamp:

1. Minimum 4,000 lm.
2. Minimum allowable efficacy of 75 lm/W.
3. CRI of minimum 80. CCT of 4100 K.
4. Rated lamp life of 50,000 hours to L70.
5. Dimmable from 100 percent to 0 percent of maximum light output.

6. Internal driver.
7. User-Replaceable Lamps:

   a. Bulb shape complying with ANSI C78.79.
   b. Lamp base complying with ANSI C81.61 or IEC 60061-1.

8. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear powder-coat finish.
3. Low-profile housing and heat sink.
4. Fully gasketed and sealed. IP 65 rated.
5. Stainless-steel latches.
6. Integral pressure equalizer.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:

1. Clear, UV-stabilized acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

G. With integral mounting provisions.

H. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.6 RECESSED, LINEAR.

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: see drawings

B. Nominal Operating Voltage: 120/277 V ac.

C. Lamp:

1. Minimum 1,500 lm.
2. Minimum allowable efficacy of 85 lm/W.
3. CRI of minimum 80. CCT of 4100 K.
4. Rated lamp life of 50,000 hours to L70.
5. Dimmable from 100 percent to 0 percent of maximum light output.
6. Internal driver.

7. User-Replaceable Lamps:

    a. Bulb shape complying with ANSI C78.79.
    b. Lamp base complying with ANSI C81.61 or IEC 60061-1.

8. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear powder-coat finish.
3. With integral mounting provisions.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:

1. Cear, UV-stabilized acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.
4. NEMA LE 4.

2.7 STRIP LIGHT.

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: see drawings

B. Nominal Operating Voltage: 120/277 V ac.

C. Lamp:

1. Minimum 3000 lm.
2. Minimum allowable efficacy of 80 lm/W.
3. CRI of minimum 80. CCT of 4100 K.
4. Rated lamp life of 50,000 hours to L70.
5. Dimmable from 100 percent to 0 percent of maximum light output.
6. Internal driver.
7. User-Replaceable Lamps:

    a. Bulb shape complying with ANSI C78.79.
    b. Lamp base complying with ANSI C81.61 or IEC 60061-1.

8. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear powder-coat finish.
3. With integral mounting provisions.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping of luminaire without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:

1. Clear, UV-stabilized acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.8 SURFACE MOUNT, LINEAR.

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Nominal Operating Voltage: 120/277 V ac.

C. Lamp:

1. Minimum 3000 lm.
2. Minimum allowable efficacy of 80 lm/W.
3. CRI of minimum 80. CCT of 4100 K.
4. Rated lamp life of 50,000 hours to L70.
5. Dimmable from 100 percent to 0 percent of maximum light output.
6. Internal driver.
7. User-Replaceable Lamps:

   a. Bulb shape complying with ANSI C78.79.
   b. Lamp base complying with ANSI C81.61 or IEC 60061-1.

8. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear powder-coat finish.

3. With integral mounting provisions.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.9 SURFACE MOUNT, NONLINEAR

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: see specifications

B. Nominal Operating Voltage: 120/277 V ac.

C. Lamp:

1. Minimum 1000 lm.
2. Minimum allowable efficacy of 80 lm/W.
3. CRI of minimum 80. CCT of 4100 K.
4. Rated lamp life of 50,000 hours to L70.
5. Dimmable from 100 percent to 0 percent of maximum light output.
6. Internal driver.
7. User-Replaceable Lamps:

   a. Bulb shape complying with ANSI C78.79.
   b. Lamp base complying with ANSI C81.61 or IEC 60061-1.

8. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear powder-coat finish.
3. With integral mounting provisions.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.10 SUSPENDED, LINEAR

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: see drawings

B. Nominal Operating Voltage: 120/277 V ac.

C. Lamp:

1. Minimum 1,000 lm/ft.
2. Minimum allowable efficacy of 85 lm/W.
3. CRI of minimum 80. CCT of 4100 K.
4. Rated lamp life of 50,000 hours to L70.
5. Dimmable from 100 percent to 0 percent of maximum light output.
6. Internal driver.
7. User-Replaceable Lamps:

   a. Bulb shape complying with ANSI C78.79.
   b. Lamp base complying with ANSI C81.61 or IEC 60061-1.

8. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear powder-coat finish.
3. With integral mounting provisions.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:

1. Tempered Fresnel glass or Clear, UV-stabilized acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.11 SUSPENDED, NONLINEAR

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: see drawings

B. Nominal Operating Voltage: 120/277 V ac.

C. Lamp:

1. Minimum 2,000 3,000 lm.
2. Minimum allowable efficacy of 85 lm/W.
3. CRI of minimum 80. CCT of 4100 K.
4. Rated lamp life of 50,000 hours to L70.
5. Dimmable from 100 percent to 0 percent of maximum light output.
6. Internal driver.
7. User-Replaceable Lamps:

   a. Bulb shape complying with ANSI C78.79.
   b. Lamp base complying with ANSI C81.61 or IEC 60061-1.

8. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear powder-coat finish.
3. Universal mounting bracket.
4. Integral junction box with conduit fittings.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:

1. Tempered Fresnel glass Clear, UV-stabilized acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.12 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Steel:

1. ASTM A 36/A 36M for carbon structural steel.
2. ASTM A 568/A 568M for sheet steel.

C. Stainless Steel:

1. 1. Manufacturer's standard grade.
2. 2. Manufacturer's standard type, ASTM A 240/240 M.

D. Galvanized Steel: ASTM A 653/A 653M.

E. Aluminum: ASTM B 209.

2.13 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.14 LUMINAIRE SUPPORT

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaires:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaires:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

G. Suspended Luminaires:

1. Ceiling Mount:

   a. Two 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 10 feet (3 m) in length.
   b. Pendant mount with 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 10 feet (3 m) in length.
   c. Hook mount.

2. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
3. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
4. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
5. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

H. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

I. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Comply with requirements for startup specified in Section 260943.16 "Addressable-Luminaire Lighting Controls."

B. Comply with requirements for startup specified in Section 260943.23 "Relay-Based Lighting Controls."

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265119

SECTION 265213 - EMERGENCY AND EXIT LIGHTING

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. Emergency lighting units.
2. Exit signs.
3. Luminaire supports.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.

D. Fixture: See "Luminaire" Paragraph.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.

1. Include data on features, accessories, and finishes.
2. Include physical description of the unit and dimensions.
3. Battery and charger for light units.
4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.

    a. Testing Agency Certified Data: For indicated luminaires and signs, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires and signs shall be certified by manufacturer.

b. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Sustainable Design Submittals:

D. Samples: For each product and for each color and texture specified.

E. Samples for Initial Selection: For each type of luminaire with factory-applied finishes.

F. Samples for Verification: For each type of luminaire.

1. Include Samples of luminaires and accessories to verify finish selection.

G. Product Schedule:

1. For emergency lighting units. Use same designations indicated on Drawings.
2. For exit signs. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Luminaires.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches (300 mm) of the plane of the luminaires.
4. Structural members to which equipment will be attached.
5. Size and location of initial access modules for acoustical tile.
6. Items penetrating finished ceiling including the following:

a. Other luminaires.
b. Air outlets and inlets.
c. Speakers.
d. Ceiling-mounted projectors.
e. Sprinklers.
f. Access panels.
g. <**Insert item**>.

7. Moldings.
8. <**Insert feature**>.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Product Certificates: For each type of luminaire.

D. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline 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 and their installation requirements.
4. Provide seismic qualification certificate for each piece of equipment.

E. Product Test Reports: For each luminaire for tests performed by [**manufacturer and witnessed by a qualified testing agency**] [**a qualified testing agency**].

F. Sample Warranty: For manufacturer's [**special**] warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: [**10 for every 100**] of each type and rating installed. Furnish at least one of each type.
2. Luminaire-mounted, emergency battery pack: One for every [**20**] [**50**] emergency lighting units. Furnish at least one of each type.
3. Diffusers and Lenses: [**One for every 100**] of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: [**One for every 20**] of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of luminaires and signs in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: [**Two**] year(s) from date of Substantial Completion.

B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Power Unit Batteries: [**Five**] years from date of Substantial Completion. Full warranty shall apply for [**first year and prorated warranty for the remaining four years**] [**the entire warranty period**].
2. Warranty Period for Self-Powered Exit Sign Batteries: [**Two**] [**Five**] years from date of Substantial Completion. Full warranty shall apply for [**first year and prorated warranty for the remaining six years**] [**the entire warranty period**].

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**]. [**Luminaires and lamps shall be labeled vibration and shock resistant.**]

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

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. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.

C. Comply with NFPA 70 and NFPA 101.

D. Comply with NEMA LE 4 for recessed luminaires.

E. Comply with UL 1598 for fluorescent luminaires.

F. Lamp Base: Comply with ANSI C81.61 or IEC 60061-1.

G. Bulb Shape: Complying with ANSI C79.1.

H. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with ballast.

1. Emergency Connection: Operate [**one**] lamp(s) continuously at an output of [**1100**] lumens each upon loss of normal power. Connect un-switched circuit to battery-inverter unit and switched circuit to luminaire ballast.
2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

   a. Ambient Temperature: Less than 0 deg F (minus 18 deg C) or exceeding 104 deg F (40 deg C), with an average value exceeding 95 deg F (35 deg C) over a 24-hour period.
   b. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C).
   c. Humidity: More than 95 percent (condensing).
   d. Altitude: Exceeding 3300 feet (1000 m).

4. Nightlight Connection: Operate lamp continuously at 40 percent of rated light output.
5. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire 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.

6. Battery: Sealed, maintenance-free, nickel-cadmium type.
7. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
8. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

I. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.

1. Emergency Connection: Operate one LED lamp continuously. Connect un-switched circuit to battery-inverter unit and switched circuit to luminaire [**ballast**].
2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
3. Nightlight Connection: Operate lamp in a remote luminaire continuously.
4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type.
6. Housing: NEMA 250, Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly shall be located no less than half the distance recommended by the emergency power unit manufacturer, whichever is less.
7. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
8. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
9. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
10. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.3 EMERGENCY LIGHTING

A. General Requirements for Emergency Lighting Units: Self-contained units.

B. Emergency Luminaires:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: see drawings

2. Emergency Luminaires: as indicated on Interior Luminaire Schedule Drawings, with the following additional features:

a. Operating at nominal voltage of 120/277 V ac.
b. Internal External emergency power unit.

c. Rated for installation in damp locations, and for sealed and gasketed luminaires in wet locations.
d. UL 94 5VA flame rating.

C. Emergency Lighting Unit:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: see drawings

2. Emergency Lighting Unit: as indicated on Interior Luminaire Schedule Drawings.
3. Operating at nominal voltage of 120/277 V ac.
4. Wall with universal junction box adaptor.
5. UV stable thermoplastic housing, rated for damp locations.
6. Two LED lamp heads.
7. Internal External emergency power unit.

D. Remote Emergency Lighting Units:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: see drawings

2. Emergency Lighting Unit: as indicated on Interior Luminaire Schedule Drawings.
3. Operating at nominal voltage of 120/277 V ac.
4. Wall with universal junction box adaptor.
5. UV stable thermoplastic housing, rated for damp locations.
6. Two LED lamp heads.
7. External emergency power unit.

2.4 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: see drawings

2. Operating at nominal voltage of 120/277 V ac.
3. Lamps for AC Operation: Fluorescent, two for each luminaire; 20,000 hours of rated lamp life.
4. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
5. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.
6. Master/Remote Sign Configurations:

a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply battery for power connection to remote unit.
b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.5 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Clear, UV-stabilized acrylic.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
4. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded aluminum housing and heat sink.
2. Clear powder coat finish.

E. Conduit: Electrical metallic tubing, minimum 3/4 inch (21 mm) in diameter.

2.6 METAL FINISHES

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire and emergency power unit weight.
2. Able to maintain luminaire position when testing emergency power unit.
3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.

E. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

F. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Ceiling Grid Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service:

1. Charge emergency power units and batteries minimum of one hour and depress switch to conduct short-duration test.
2. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

3.6 ADJUSTING

A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:

1. Inspect all luminaires. Replace lamps, emergency power units, batteries, signs, or luminaires that are defective.

   a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

2. Conduct short-duration tests on all emergency lighting.

END OF SECTION 265213

SECTION 265619 – LED EXTERIOR LIGHTING

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. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
2. Luminaire supports.
3. Luminaire-mounted photoelectric relays.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Section 260926 "Lighting Control Panelboards" for panelboard-based lighting control.
3. Section 260933 "Central Dimming Controls" or Section 260936 "Modular Dimming Controls" for architectural dimming systems specified in Section 265100.
4. Section 260943.16 "Addressable-Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.
5. Section 265613 "Lighting Poles and Standards" for poles and standards used to support exterior lighting equipment.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.
4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project IES LM-79 IES LM-80.

    a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
    b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

6. Wiring diagrams for power, control, and signal wiring.
7. Photoelectric relays.
8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Sustainable Design Submittals

D. Samples: For each luminaire and for each color and texture indicated with factory-applied finish.

E. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

F. Delegated-Design Submittal: For luminaire supports.

1. Include design calculations for luminaire supports and seismic restraints.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Luminaires.
2. Structural members to which equipment and luminaires will be attached.
3. Underground utilities and structures.
4. Existing underground utilities and structures.
5. Above-grade utilities and structures.

6. Existing above-grade utilities and structures.
7. Building features.
8. Vertical and horizontal information.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline 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 and their installation requirements.

D. Product Certificates: For each type of the following:

1. Luminaire.
2. Photoelectric relay.

E. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

F. Source quality-control reports.

G. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and photoelectric relays to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Diffusers and Lenses: One for every 100of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: One for every 20of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

E. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

F. Mockups: For exterior luminaires, complete with power and control connections.

1. Obtain Architect's approval of luminaires in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.10 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.11 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including luminaire support components.
b. Faulty operation of luminaires and accessories.

c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: 2 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. UL Compliance: Comply with UL 1598 and listed for wet location.

E. Lamp base complying with ANSI C81.61 or IEC 60061-1.

F. Bulb shape complying with ANSI C79.1.

G. CRI of minimum 80. CCT of 4100 K.

H. L70 lamp life of 50,000 hours.

I. Lamps dimmable from 100 percent to 0 percent of maximum light output.

J. Internal driver.

K. Nominal Operating Voltage: 120/277 V ac.

L. In-line Fusing: Separate in-line fuse for each luminaire.

M. Lamp Rating: Lamp marked for outdoor use and in enclosed locations.

N. Source Limitations: Obtain luminaires from single source from a single manufacturer.

O. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Atlas Lighting Products.
2. Cooper Lighting, an Eaton business.
3. Deco Lighting.
4. Eaton.
5. GE Lighting Solutions.
6. Intelligent Illuminations, Inc.
7. Intermatic, Inc.
8. Lithonia Lighting; Acuity Brands Lighting, Inc.
9. Philips Lighting Company.
10. Schneider Electric USA, Inc.
11. Siemens Industry, Inc., Building Technologies Division.

B. Comply with UL 773 or UL 773A.

C. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc (16 to 32 lx) and off at 4.5 to 10 fc (48 to 108 lx) with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.

1. Relay with locking-type receptacle shall comply with ANSI C136.10.
2. Adjustable window slide for adjusting on-off set points.

2.4 LUMINAIRE TYPES

A. Area and Site:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: see drawings

2. Luminaire Shape: see drawings.

3. Mounting: Pole or Building with extruded-aluminum arm, 11 inches (280 mm) in length.
4. Luminaire-Mounting Height: see drawings.
5. Distribution: see drawings.
6. Diffusers and Globes: Clear, UV-stabilized acrylic.
7. Housings:

   a. Extruded-aluminum housing and heat sink.
   b. Clear powder-coat finish.

B. Bollard:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: see drawings

2. Shape: see drawings.

2.5 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Stainless steel. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

D. Diffusers and Globes:

1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

G. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage and coating.
c. CCT and CRI for all luminaires.

2.6 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. 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.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.

    a. Color: as selected by Architect/Owner.

D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

    a. Color: As selected from manufacturer's standard catalog of colors.
    b. Color: Match Architect's sample of manufacturer's standard color.
    c. Color: As selected by Architect from manufacturer's full range.

2.7 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine walls, roofs, and canopy ceilings and overhang ceilings for suitable conditions where luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Install lamps in each luminaire.

D. Fasten luminaire to structural support.

E. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.

G. Wiring Method: Install cables in raceways. Conceal raceways and cables.

H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.

I. Coordinate layout and installation of luminaires with other construction.

J. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 BOLLARD LUMINAIRE INSTALLATION:

A. Align units for optimum directional alignment of light distribution.

1. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.5 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

A. Aim as indicated on Drawings.

B. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.6 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):

   a. IES LM-5.
   b. IES LM-50.
   c. IES LM-52.
   d. IES LM-64.
   e. IES LM-72.

2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

D. Luminaire will be considered defective if it does not pass tests and inspections.

E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

3.10 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265619

SECTION 271100 - COMMUNICATIONS PATHWAYS AND SPACES

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. Telecommunications vertical and horizontal pathways.
2. Backboards and mounting elements.
3. Telecommunications equipment racks and cabinets.
4. Telecommunications service entrance pathways.
5. Grounding.

B. Related Sections:
1. Division 27 Section "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. LAN: Local area network.

C. RCDD: Registered Communications Distribution Designer.

.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Floor-mounted cabinets and cable pathways shall withstand the effects of earthquake motions determined according to SEI/ASCE 7, (Zone 4).

1. 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.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

C. Qualification Data: For each qualified layout technician, installation supervisor, and field inspector.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician (BICSI), who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as an RCDD to perform the on-site inspection.
4. Contractor: Must be certified with the manufacturer of the proposed solution prior to bid, and must be able to provide a 20 year system warranty from the manufacturer after completion of the project.

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. Telecommunications Pathways and Spaces: Comply with ANSI/TIA/EIA-569-B.

D. Grounding: Comply with ANSI-J-STD-607-A.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weathertight, wet work in spaces is complete and dry,

and associated construction work on the subfloor and raised floor supports is substantially complete.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with ANSI/TIA/EIA-569-B.

B. Cable Support (J-Hook): Cable installation shall require support of cables with J-Hooks. J-Hook pathway support will be spaced no more than 60" between supports.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Erico Caddy
      b. B-Line
      c. CTS
      d. Stiffy
      e. Panduit
      f. Or Approved Equal

   2. Cable Support Materials (J-Hook) shall meet or exceed the below characteristics of construction and features.
      a. Provide broad based support for cabling to aid in maintaining overall system performance.
      b. Be available in 50.8mm (2") and 101.6mm (4") options
      c. Come equipped with a cable retention clip
      d. Offers a full line of mounting accessories.

C. Ladder Rack:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2.
      a. Chatsworth
      b. RXL

   3. Description:
      a. Size: 1.5 inches high by 0.4 inches wide high tubular steel with 0.065 inch wall thickness.
      b. Stringers: 9 feet 11-1/2 inches long.
      c. Cross Members: Welded in between stringers on 12 inch intervals/centers beginning 5-3/4 inches with 10 cross members per ladder rack. Open space of 10-1/2 inches between each cross member.
      d. Finish and Color: Powder coat paint in black.
      e. Provide cable tray widths as noted, 12" – 24" wide.

D. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems".

E. Conduit Sleeves: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems".

F. Conduit and Boxes (Wireless Access Points): Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems". Provide a 1" conduit and two gang box, coordinated with the finished height of a hard lid ceiling for outlet mounting, and extend the conduit to the nearest established j-hook pathway.

2.2 BACKBOARDS

A. Backboards: Provide plywood, fire-retardant treated, 3/4 by 48 by 96 inches, on at least two of the full non-door walls of each telecommunications room, or as noted. Comply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry."

2.3 EQUIPMENT FRAMES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Panduit
2. Chatsworth
3. RXL
4. Or Prior Approved Equal

B. General Frame Requirements:

1. Distribution Frames: Freestanding, modular-metal units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Module Dimension: Width compatible with EIA 310 standard, 19-inch panel mounting.
3. Finish: Manufacturer's standard, baked-polyester powder coat.

C. Floor-Mounted Racks (Horizontal Termination): Modular-type, steel or aluminum construction.

1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
2. Baked-polyester powder coat finish.

D. Cable Management for Equipment Frames:
1. Panduit
2. Chatsworth
3. CommScope
4. Or Prior Approved Equal

2.4 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Rack mounting.

2. Ten, 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
3. LED indicator lights for power and protection status.
4. LED indicator lights for reverse polarity and open outlet ground.
5. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
6. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
7. 10' input cord connected with L5-20P.
8. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all 3 modes shall be not more than 330 V.

B. Manufacturers

1. APC
2. Panduit
3. Leviton
4. Tripp Lite
5. Raritan
6. Or Prior Approved Equal

2.5 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Telecommunications Main Ground Bus Bar:

1. Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

C. Comply with ANSI-J-STD-607-A.

2.6 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Install underground pathways complying with recommendations in TIA/EIA-569-B, "Entrance Facilities" Article.

3.2 INSTALLATION

A. Install underground entrance pathway complying with Division 26 Section "Raceway and Boxes for Electrical Systems." Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Raceway Application
   1. Accessible Ceiling: concealed J-hook pathway.
   2. Exposed Ceiling: Surface mount EMT tight to structure, painted to match ceiling.
      a. Conduits shall be consolidated wherever possible.
      b. Conduits shall be run parallel and perpendicular to structure.
   3. Non-accessible Ceiling: EMT
   4. Walls: concealed EMT
   5. Outdoor undergound: RNC, Type EPC-40-PVC:
   6. Outdoors exposed: EMT

D. Cable Trays: Provide overhead cable runway (ladder rack) as noted. Comply with NEMA VE 2 and TIA/EIA-569-B.

E. J-Hook Pathway Installation:

   1. Shall comply with TIA-C.9.7
   2. Shall comply with TIA-C.9.4.2.2
   3. Shall comply with NEC300.11
   4. All low voltage cable shall all be placed in j-hook tree assemblies. Fire alarm and access control cabling shall be separated from all backbone and horizontal cable and should use the upper tier of the j-hook tree.
   5. J-hooks shall not be spaced further than 5 feet apart, with a maximum sag of 12" on the cable. If the sag becomes greater than 12 inches the contractor shall place additional j-hook supports to reduce the cable sag.
   6. Cable fill ratio for j-hook pathway should not exceed 40% fill ratio.
   7. All cable shall run parallel or perpendicular to the structural lines of the building.
   8. The use of zip ties is not allowed for the use of bundling, supporting, or training conductors in cable tray, ladder racks, non-continuous pathways, or any other communications pathway. The use of hook and loop is required for all bundling of cables.

F. Conduit Pathway Installation:
   1. Refer to 260533 for general raceway requirements.
   2. Minimum conduit size shall be 1" or larger as required to meet cable fill requirements.

3. Conduit shall have no more than a 40% fill.

G. Unacceptable J-Hook Installations:

1. Free flight of cables
2. Resting or attaching of cables on pipes, conduits, HVAC duct work.
3. Resting on or attached to fire sprinkler systems.
4. Resting on ceiling tile grid in ceiling space.
5. Running cables at anything other than right angles.

H. Bundle, wrap, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install management bars and distribution spools.

3.3 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping." Comply with TIA/EIA-569-B, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. See Section 271500 "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion of TIA/EIA standard as it applies to this Section.

D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for

E. Class 4 level of administration, including optional identification requirements of this standard.

F. Labels shall be preprinted or computer-printed type.

END OF SECTION 271100

SECTION 271300 - COMMUNICATIONS BACKBONE CABLING

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. Pathways.
2. Optical fiber cabling Multi-Mode 0M3.
3. Cable connecting hardware, termination panels, and cross-connects.
4. Cabling identification products.

B. Related Sections:

1. Division 27 Section "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. RCDD: Registered Communications Distribution Designer.

G. UTP: Unshielded twisted pair.

1.4 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone

cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects shall be located in termination rooms (telecom) and at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-C.1, when tested according to test procedures of this standard.

1.6 SUBMITTALS

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

1. For all cable, include the following installation data for each type used:

a. Nominal OD.
b. Minimum bending radius.
c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics including the following:

a. Cross-connects.
b. Patch panels.
c. Patch cords.

5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
6. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

a. Vertical and horizontal offsets and transitions.
b. Clearances for access above and to side of cable trays.
c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Qualification Data: For all qualified layout technicians, installation supervisors, and field inspectors.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For splices and connectors to include in maintenance manuals.

G. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician (BICSI), who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
4. Contractor must be a Certified Contractor with the manufacturer that is bid prior to time of bid, and must be able to provide the appropriate system warranty

B. Testing Agency Qualifications:

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

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. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-B.

E. Grounding: Comply with ANSI-J-STD-607-A.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.

2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
3. Test each pair of UTP cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers..

1.11 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Furnish five percent of total quantity provided for each component, minimum of one, if less than one.

PART 2 - PRODUCTS

2.1 PATHWAYS

2.2 OPTICAL FIBER CABLE RISER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Corning
   2. Or approved equal

B. Description: Multi-Mode 0M3 fiber optic cable 12 strand fiber interlocking armored.

   1. Comply with ICEA S-83-596 for mechanical properties.
   2. Comply with TIA/EIA-568-C.3 for performance specifications.
   3. 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. OFCP, Nonconductive: Type Plenum, complying with NFPA 262.

C. Jacket:

1. Jacket Color: Black
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-C.

D. Imprinted with fiber count, fiber type, and aggregate length at regular intervals

2.3 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Corning
2. Or approved eual

B. Cross-Connects and Termination Panels: Splice cassette with modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

2. Pigtails shall be 2 meter in length.

C. Jumper Cords: See EE003 for lengths

D. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-C.3.
2. Type LC connectors. Insertion loss not more than 0.75 dB.

2.4 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.5 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.6 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA/EIA-568-C.1.

C. Factory test UTP cables according to TIA/EIA-568-C.2.

D. Factory test singlemode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-C.3.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within cabinets. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in all spaces.
2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-B.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Section 271100 "Telecommunications Pathways and Spaces." Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wire ways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Termination Rooms (Telecom):

1. Position vertical conduit ends adjacent to a corner where plywood backboard is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Secure conduits to backboard when entering room from overhead.
3. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-C.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. For UTP backbone cable, install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 60 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. 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. Use lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, leave a minimum 3 foot and no more than a 10 foot service loop on the station end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
12. All cable should be protected from direct paint, or incidental overspray.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-C.2.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-C.3.
2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wire way or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60" apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

3.5 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping. "Comply with TIA/EIA-569-B, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Administration Class: 2
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion about TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration.

D. Comply with requirements in Section 271500 "Communications Horizontal Cabling" for cable and asset management software.

E. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

G. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical Fiber Cable Tests:

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and multimode backbone link measurements: Test at 1310 and 1500 nm in both directions according to ANSI/TIA/EIA 568-C standards

2) Attenuation test results for backbone links shall be less than 2.0 dB.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION 271300

SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

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. UTP cabling.
2. Cable connecting hardware, patch panels, and cross-connects.
3. Telecommunications outlet/connectors.
4. Cabling system identification products.
5. Cable management system.

B. Related Sections:

1. Section 27 "Telecommunications Pathways and Spaces" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. EMI: Electromagnetic interference.

C. LAN: Local area network.

D. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

E. RCDD: Registered Communications Distribution Designer.

F. UTP: Unshielded twisted pair.

1.4 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications termination room (Telecom). This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.

1. TIA/EIA-568-C.2 requires that a minimum of two telecommunications outlet/connectors be installed for each work area, however, some locations designated by the owner shall have a single data outlet/connector.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.
4. Splitters shall not be installed as part of the optical fiber cabling.

B. A work area is approximately 100 sq. ft. and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet in the horizontal cross-connect.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-C.1, when tested according to test procedures of this standard.

1.6 SUBMITTALS

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

1. For all cable, include the following installation data for each type used:

   a. Nominal OD.
   b. Minimum bending radius.
   c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics, including the following:

   a. Cross-connects.
   b. Patch panels.
   c. Patch cords.

5. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.

6. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

    a. Vertical and horizontal offsets and transitions.
    b. Clearances for access above and to side of cable trays.
    c. Vertical elevation of cable trays above the subfloor.

C. Samples: For workstation outlets, jacks, jack assemblies, in specified finish, one for each size and outlet configuration.

D. Qualification Data: For all qualified layout technicians, installation supervisors, and field inspectors.

E. Source quality-control reports.

F. Field quality-control reports.

G. Maintenance Data: For splices and connectors to include in maintenance manuals.

H. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field-testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician (BICSI), who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
4. Contractor must be certified with the manufacturer prior to time of bid and must be able to provide a full system warranty to the owner at the completion of the project.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

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. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-B.

E. Grounding: Comply with ANSI-J-STD-607-A.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of UTP cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area. This coordination will generally involve the placement of the raised floor floorboxes and the outlet arrangements therein.

PART 2 - PRODUCTS

2.1 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Panduit
2. General Cable
3. CommScope
4. Berk-Tek

B. Colors:
1. White – Data
2. Yellow – Wireless
3. Orange– Security

Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following typ.

C. Description: 100-ohm, 4-pair UTP.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-C.1 for performance specifications.
3. Comply with TIA/EIA-568-C.2, Category 6, U/UTP.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

   a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

2.2 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CommScope
2. Panduit
3. Leviton

B. Colors:
1. White – Data
2. Yellow – Wireless
3. Orange – Security

C. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated.

E. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

F. Patch Cords: Factory-made, four-pair cables in lengths determined by shop drawings of rack elevations (minimum length of 6 feet); terminated with eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.

2.3 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-C.1.

B. Workstation Outlets: Provide with the number of ports as noted – 1, 2, or 4, ports - connector assemblies mounted in single faceplate.

1. Floorbox Faceplate: Provide adapter plates to mount in the provided floorboxes for the appropriate cable solution being provided, i.e. CommScope adapter plate for CommScope outlet connectors.
2. Legend: Machine printed, in the field, using adhesive-tape label or snap-in, clear-label covers and machine-printed paper inserts.

2.4 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.5 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP cables on reels according to TIA/EIA-568-C.1.

C. Factory test UTP cables according to TIA/EIA-568-C.2.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within cabinets. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in all spaces.

2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-B.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Section 271100 "Telecommunications Pathways and Spaces." Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Termination Rooms (Telecom):

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install basket cable trays to route cables from underfloor up into the floor mounted racks.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-C.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches, not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train 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. Install lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
9. In the termination room (Telecom), install a 6-foot-long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-C.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 48 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
4. Cable shall follow j-hook pathways that run parallel or perpendicular to the building structure. All cable and pathways should run at right angles.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

    1. Administration Class: 1
    2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

C. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 1 level of administration.

E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications rooms, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

G. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA/EIA-568-C.1.
2. Visually confirm Category 6 marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. UTP Performance Tests:

    a. Test for each outlet. Perform the following tests according to TIA/EIA-568-C.1 and TIA/EIA-568-C.2:

        1) Wire map.
        2) Length (physical vs. electrical, and length requirements).
        3) Insertion loss.
        4) Near-end crosstalk (NEXT) loss.
        5) Power sum near-end crosstalk (PSNEXT) loss.
        6) Equal-level far-end crosstalk (ELFEXT).
        7) Power sum equal-level far-end crosstalk (PSELFEXT).
        8) Return loss.
        9) Propagation delay.
        10) Delay skew.

6. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.

    a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
    b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

D. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets. Include training in cabling administration software.

END OF SECTION 271500

SECTION 284621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS

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. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Air-sampling smoke detectors.
5. Non-system smoke detectors.
6. Heat detectors.
7. Notification appliances.
8. Device guards.
9. Firefighters' two-way telephone communication service.
10. Firefighters' smoke-control station.
11. Magnetic door holders.
12. Remote annunciator.
13. Graphic annunciator.
14. Addressable interface device.
15. Digital alarm communicator transmitter.
16. Radio alarm transmitter.
17. Network communications.
18. System printer.

B. Related Requirements:

1. Section 271513 "Communications Copper Horizontal Cabling" for cables and conductors for fire-alarm systems.

1.3 DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. FACP: Fire Alarm Control Panel.

C. HLI: High Level Interface.

D. NICET: National Institute for Certification in Engineering Technologies.

E. PC: Personal computer.

F. VESDA: Very Early Smoke-Detection Apparatus.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.

1. Include construction details, material descriptions, dimensions, profiles, and finishes.
2. Include rated capacities, operating characteristics, and electrical characteristics.

B. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, details, and attachments to other work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
11. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.
12. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.

    a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
    b. Show field wiring required for HVAC unit shutdown on alarm.
    c. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' control system.
    d. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' smoke-evacuation system.
    e. Locate detectors according to manufacturer's written recommendations.
    f. Show air-sampling detector pipe routing.

13. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
14. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:

    a. Trained and certified by manufacturer in fire-alarm system design.

b. NICET-certified, fire-alarm technician; Level IV minimum.
c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Data: Certificates, for fire-alarm control unit, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline 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 and their installation requirements.

C. Field quality-control reports.

1.6 Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:

a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
d. Riser diagram.

e. Device addresses.
f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
g. Record copy of site-specific software.
h. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

1) Equipment tested.
2) Frequency of testing of installed components.
3) Frequency of inspection of installed components.
4) Requirements and recommendations related to results of maintenance.
5) Manufacturer's user training manuals.

i. Manufacturer's required maintenance related to system warranty requirements.
j. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
3. Smoke Detectors, Fire Detectors, and Flame Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
5. Keys and Tools: One extra set for access to locked or tamper proofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.
8. Filters for Air-Sampling Detectors: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
9. Air-Sampling Fan: Quantity equal to one for every five detectors, but no fewer than one unit of each type.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level IV technician.

C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

D. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

E. NFPA Certification: Obtain certification according to NFPA 72 in the form of a placard by an FM Global-approved alarm company.

F. NFPA Certification: Obtain certification according to NFPA 72 by qualified agent.

1.10 PROJECT CONDITIONS

A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.

B. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify Architect Construction Manager Owner no fewer than seven days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with interruption of fire-alarm service without Architect's Construction Manager's Owner's written permission.

C. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.11 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.12 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Non-coded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.

C. Automatic sensitivity control of certain smoke detectors.

D. All components provided shall be listed for use with the selected system.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual stations.
2. Heat detectors.
3. Flame detectors.
4. Smoke detectors.
5. Duct smoke detectors.
6. Air-sampling smoke-detection system (VESDA).
7. Carbon monoxide detectors.
8. Combustible gas detectors.
9. Automatic sprinkler system water flow.
10. Pre-action system.
11. Fire-extinguishing system operation.
12. Fire standpipe system.
13. Dry system pressure flow switch.
14. Fire pump running.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances, including voice evacuation notices.
2. Identify alarm and specific initiating device at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Activate voice/alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
8. Activate smoke-control system (smoke management) at firefighters' smoke-control system panel.
9. Activate stairwell and elevator-shaft pressurization systems.
10. Close smoke dampers in air ducts of designated air-conditioning duct systems.
11. Activate pre-action system.

12. Recall elevators to primary or alternate recall floors.
13. Activate elevator power shunt trip.
14. Activate emergency lighting control.
15. Activate emergency shutoffs for gas and fuel supplies.
16. Record events in the system memory.
17. Record events by the system printer.
18. Indicate device in alarm on the graphic annunciator.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. High- or low-air-pressure switch of a dry-pipe or pre-action sprinkler system.
3. Alert and Action signals of air-sampling detector system.
4. Elevator shunt-trip supervision.
5. Fire pump running.
6. Fire-pump loss of power.
7. Fire-pump power phase reversal.
8. Independent fire-detection and -suppression systems.
9. User disabling of zones or individual devices.
10. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.
10. Voice signal amplifier failure.
11. Hose cabinet door open.

E. System Supervisory Signal Actions:

1. Initiate notification appliances.
2. Identify specific device initiating the event at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
3. Record the event on system printer.
4. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
5. Transmit system status to building management system.
6. Display system status on graphic annunciator.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. 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."

2.4 FIRE-ALARM CONTROL UNIT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bosch Security Systems, Inc.
2. Faraday.
3. Fike Corporation.
4. Fire-Lite Alarms, Inc.; a Honeywell International company.
5. Gamewell - FCI by Honeywell.
6. GE UTC Fire & Security; A United Technologies Company.
7. Keltron Corporation.
8. Mircom Technologies, Ltd.
9. Notifier.
10. Potter Electric Signal Company, LLC.
11. Siemens Industry, Inc.; Fire Safety Division.
12. Silent Knight.
13. SimplexGrinnell LP.

B. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.

   a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
   b. Include a real-time clock for time annotation of events on the event recorder and printer.
   c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
   d. The FACP shall be listed for connection to a central-station signaling system service.
   e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.

2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.

2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

D. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

E. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Pathway Class Designations: NFPA 72, Class A.
2. Pathway Survivability: Level 1.
3. Install no more than 50 addressable devices on each signaling-line circuit.
4. Serial Interfaces:

a. One dedicated RS 485 port for central-station or remote station operation using point ID DACT.
b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
c. One USB port for PC configuration.
d. One RS 232 port for VESDA HLI connection.
e. One RS 232 port for voice evacuation interface.

F. Stairwell and Elevator Shaft **Pressurization**: Provide an output signal using an addressable relay to start the stairwell and elevator shaft pressurization system. Signal shall remain on until alarm conditions are cleared and fire-alarm system is reset. Signal shall not stop in response to alarm acknowledge or signal silence commands.

1. Pressurization starts when any alarm is received at fire-alarm control unit.
2. Alarm signals from smoke detectors at pressurization air supplies have a higher priority than other alarm signals that start the system.

G. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

H. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

I. Elevator Recall:

1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:

   a. Elevator lobby detectors except the lobby detector on the designated floor.
   b. Smoke detector in elevator machine room.
   c. Smoke detectors in elevator hoist way.

2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.

   a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

J. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

K. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

L. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

M. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided in a separate cabinet located in the fire command center.

1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.

   a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
   b. Programmable tone and message sequence selection.
   c. Standard digitally recorded messages for "Evacuation" and "All Clear."
   d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control unit.

2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

N. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also, print

system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

O. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters and digital alarm radio transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

P. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead calcium.

Q. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.5 PRE-ACTION SYSTEM

A. Initiate Pre-signal Alarm: This function shall cause an audible and visual alarm and indication to be provided at the FACP. Activation of an initiation device connected as part of a pre-action system shall be annunciated at the FACP only, without activation of the general evacuation alarm.

2.6 MANUAL FIRE-ALARM BOXES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AMSECO - A Potter Brand.
2. Bosch Security Systems, Inc.
3. Faraday.
4. Federal Signal Corporation.
5. Fike Corporation.
6. Fire-Lite Alarms, Inc.; a Honeywell International company.
7. Gamewell - FCI by Honeywell.
8. GE UTC Fire & Security; A United Technologies Company.
9. Keltron Corporation.
10. Mircom Technologies, Ltd.
11. Notifier.
12. Potter Electric Signal Company, LLC.
13. Siemens Industry, Inc.; Fire Safety Division.
14. Silent Knight.
15. SimplexGrinnell LP.
16. System Sensor.
17. Wheelock; a brand of Eaton.

B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
3. Station Reset: Key- or wrench-operated switch.
4. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
5. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.7 SYSTEM SMOKE DETECTORS

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. Bosch Security Systems, Inc.
2. Faraday.
3. Fenwal Protection Systems; A UTC Fire & Security Company.
4. Fire-Lite Alarms, Inc.; a Honeywell International company.
5. Gamewell - FCI by Honeywell.
6. GE UTC Fire & Security; A United Technologies Company.
7. Gentex Corporation.
8. Harrington Signal, Inc.
9. Keltron Corporation.
10. Mircom Technologies, Ltd.
11. Notifier.
12. Potter Electric Signal Company, LLC.
13. Siemens Industry, Inc.; Fire Safety Division.
14. Silent Knight.
15. SimplexGrinnell LP.
16. System Sensor.

B. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be four-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.

7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.

    a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.
    b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).
    c. Multiple levels of detection sensitivity for each sensor.
    d. Sensitivity levels based on time of day.

C. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

D. Ionization Smoke Detector:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

E. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.

5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.8 PROJECTED BEAM SMOKE DETECTORS

A. Projected Beam Light Source and Receiver: Designed to accommodate small angular movements and continue to operate and not cause nuisance alarms.

B. Detector Address: Accessible from fire-alarm control unit and able to identify the detector's location within the system and its sensitivity setting.

C. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

1. Primary status.
2. Device type.
3. Present average value.
4. Present sensitivity selected.
5. Sensor range (normal, dirty, etc.).

2.9 CARBON MONOXIDE DETECTORS

A. General: Carbon monoxide detector listed for connection to fire-alarm system.

1. Mounting: Adapter plate for outlet box mounting.
2. Testable by introducing test carbon monoxide into the sensing cell.
3. Detector shall provide alarm contacts and trouble contacts.
4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
5. Comply with UL 2075.
6. Locate, mount, and wire according to manufacturer's written instructions.
7. Provide means for addressable connection to fire-alarm system.
8. Test button simulates an alarm condition.

2.10 MULTI-CRITERIA DETECTORS

A. Mounting: Adapter plate for outlet box mounting.

B. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

C. Automatically adjusts its sensitivity by means of drift compensation and smoothing algorithms. The detector shall send trouble alarm if it is incapable of compensating for existing conditions.

D. Test button tests all sensors in the detector.

E. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

1. Primary status.
2. Device type.
3. Present sensitivity selected.
4. Sensor range (normal, dirty, etc.).

F. Sensors: The detector shall be comprised of four sensing elements including a smoke sensor, a carbon monoxide sensor, an infrared sensor, and a heat sensor.

1. Smoke sensor shall be photoelectric type as described in "System Smoke Detectors" Article.
2. Carbon monoxide sensor shall be as described in "Carbon Monoxide Detectors" Article.
3. Heat sensor shall be as described in "Heat Detectors" Article.
4. Each sensor shall be separately listed according to requirements for its detector type.

2.11 NON-SYSTEM SMOKE DETECTORS

A. General Requirements for Non-system Smoke Detectors:

1. Non-system smoke detectors shall be listed as compatible with the fire-alarm equipment installed or shall have a contact closure interface listed for the connected load.
2. Non-system smoke detectors shall meet the monitoring for integrity requirements in NFPA 72.

B. Single-Station Smoke Detectors:

1. Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac with 9-V dc battery as the secondary power source. Provide with "low" or "missing" battery chirping-sound device.
2. Auxiliary Relays: One Form A and one Form C, both rated at 0.5 A.
3. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet (3 m) according to UL 464.
4. Visible Notification Appliance: 177-cd strobe.
5. Heat sensor, 135 deg F (57 deg C) combination rate-of-rise and **fixed** temperature.
6. Test Switch: Push to test; simulates smoke at rated obscuration.
7. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
8. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
9. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
10. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.

C. Single-Station Duct Smoke Detectors:

1. Comply with UL 268A; operating at 120-V ac.
2. Sensor: LED or infrared light source with matching silicon-cell receiver.

   a. Detector Sensitivity: Smoke obscuration between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) when tested according to UL 268A.

3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. The fixed base shall be designed for mounting directly to air duct. Provide terminals in the fixed base for connection to building wiring.

    a. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; listed for use with the supplied detector.

4. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
5. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.12 HEAT DETECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bosch Security Systems, Inc.
2. Faraday.
3. Fire-Lite Alarms, Inc.; a Honeywell International company.
4. Gamewell - FCI by Honeywell.
5. GE UTC Fire & Security; A United Technologies Company.
6. Gentex Corporation.
7. Harrington Signal, Inc.
8. Keltron Corporation.
9. Mircom Technologies, Ltd.
10. Notifier.
11. Potter Electric Signal Company, LLC.
12. Siemens Industry, Inc.; Fire Safety Division.
13. Silent Knight.
14. SimplexGrinnell LP.
15. System Sensor.

B. General Requirements for Heat Detectors: Comply with UL 521.

1. Temperature sensors shall test for and communicate the sensitivity range of the device.

C. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.

1. Mounting: Adapter plate for outlet box mounting.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

D. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C).

1. Mounting: Adapter plate for outlet box mounting.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

E. Continuous Linear Heat-Detector System:

1. Detector Cable: Rated detection temperature 155 deg F (68 deg C). Listed for "regular" service and a standard environment. Cable includes two steel actuator wires twisted together with spring pressure, wrapped with protective tape, and finished with PVC outer sheath. Each actuator wire is insulated with heat-sensitive material that reacts with heat to allow the cable twist pressure to short circuit wires at the location of elevated temperature.
2. Control Unit: Two-zone or multi-zone unit as indicated. Provide same system power supply, supervision, and alarm features as specified for fire-alarm control unit.
3. Signals to Fire-Alarm Control Unit: Any type of local system trouble shall be reported to fire-alarm control unit as a composite "trouble" signal. Alarms on each detection zone shall be individually reported to central fire-alarm control unit as separately identified zones.
4. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.13 AIR-SAMPLING SMOKE DETECTOR

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ansul; Tyco Fire Protection Products.
2. Fenwal Protection Systems; A UTC Fire & Security Company.
3. Fike Corporation.
4. Notifier.
5. Xtralis Pty Ltd.

B. General Description:

1. Air-sampling smoke detector shall be laser based using a piping system and a fan to transport the particles of combustion to the detector.
2. Provide two levels of alarm from each zone covered by the detector and two supervisory levels of alarm from each detector.
3. The air being sampled shall pass through filters to remove dust particulates greater than 20 microns before entering the detection chamber.
4. Detectors shall have the capability via RS 485 to connect up to 100 detectors in a network.
5. Detectors shall communicate with the fire-alarm control unit via addressable, monitored dry contact closures, RS 485, and interface modules. Provide a minimum of six relays, individually programmable remotely for any function.
6. Pipe airflow balancing calculations shall be performed using approved calculation software.

C. Detector:

1. Detector, Filter, Aspirator, and Relays: Housed in a mounting box and arranged in such a way that air is drawn from the detection area and a sample passed through the dual-stage filter and detector by the aspirator.
2. Obscuration Sensitivity Range: 0.005 - 6 percent obs/ft..
3. Four independent, field-programmable, smoke-alarm thresholds per sensor pipe and a programmable scan time delay. The threshold set points shall be programmable.

   a. The four alarm thresholds may be used as follows:

      1) Alarm Level 1 (Alert): Activate a visual and an audible supervisory alarm.

2) Alarm Level 2 (Action): Activate shutdown of electrical/HVAC equipment and activate a visual and an audible supervisory alarm.
3) Alarm Level 3 (Fire 1): Activate building alarm systems and initiate call to fire response unit.
4) Alarm Level 4 (Fire 2): Activate suppression system or other countermeasures.

b. Final Detection System Settings: Approved by Architect.
c. Initial Detection Alarm Settings:

1) Alarm Level 1 (Alert): 0.08 percent obs/ft..
2) Alarm Level 2 (Action): 1.0 percent obs/ft..
3) Alarm Level 3 (Fire 1): 2.0 percent obs/ft..
4) Alarm Level 4 (Fire 2): 4.0 percent obs/ft..

4. Power Supply:

a. Regulated 24-V dc, monitored by the fire-alarm control unit, with battery backup.
b. Battery backup shall provide 24 hours' standby, followed by 30 minutes at maximum connected load.

5. Detector shall also transmit the following faults:

a. Detector.
b. Airflow.
c. Filter.
d. System.
e. Zone.
f. Network.
g. Power.

6. Provide four in-line sample pipe inlets that shall contain a flow sensor for each pipe inlet. The detector shall be capable of identifying the pipe from which smoke was detected.
7. Aspirator: Air pump capable of allowing for multiple sampling pipe runs up to 650 feet (200 m) in total, (four pipe runs per detector) with a transport time of less than 120 seconds from the farthest sample port.
8. Air-Sampling Flow Rates Outside Manufacturer's Specified Range: Result in a trouble alarm.
9. Provide software-programmable relays rated at 2 A at 30-V dc for alarm and fault conditions.
10. Provide built-in event and smoke logging; store smoke levels, alarm conditions, operator actions, and faults with date and time of each event. Each detector (zone) shall be capable of storing up to 18,000 events.
11. Urgent and Minor Faults. Minor faults shall be designated as trouble alarms. Urgent faults, which indicate the unit may not be able to detect smoke, shall be designated as supervisory alarms.

D. Displays:

1. Include display module within each detector.
2. Each display shall provide the following features at a minimum:

a. A bar-graph display.
b. Four independent, high-intensity alarm indicators (Alert, Action, Fire 1, and Fire 2), corresponding to the four alarm thresholds of the indicated sector.

c. Alarm threshold indicators for Alert, Action, and Fire 1.
d. LED indication that the first alarm sector is established.
e. Detector fault and airflow fault indicators.
f. LED indicators shall be provided for faults originating in the particular zone (Zone Fault), faults produced by the overall smoke-detection system, and faults resulting from network wiring errors (Network Fault).
g. Minor and urgent LED fault indicators.

E. Sampling Tubes:

1. Smooth bore with a nominal 1-inch (25-mm) OD and a 7/8-inch (21-mm) ID. Sampling pipe with between 5/8- and 1-inch (15- and 25-mm) ID can be used in specifically approved locations when recommended by manufacturer.
2. Pipe Material: CPVC and complying with UL 1887, "Safety Fire Test of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics."
3. Joints in the sampling pipe shall be airtight. Use solvent cement approved by the pipe manufacturer on all joints except at entry to the detector.
4. Identify piping with labels reading: "Aspirating Smoke Detector Pipe - Do Not Paint or Disturb" along its entire length at regular intervals according to NFPA 72.
5. Support pipes at not more than 60-inch (1520-mm) centers.
6. Fit end of each trunk or branch pipe with an end cap and drilled with a hole appropriately sized to achieve the performance as specified and as calculated by the system design.

F. Sampling Holes:

1. Sampling holes of 5/64 inch (2 mm), or other sized holes per manufacturer's written instructions, shall be separated by not more than the maximum distance allowable for conventional smoke detectors. Intervals may vary according to calculations.
2. Follow manufacturer's written recommendations to determine the number and spacing of sampling points and the distance from sampling points to ceiling or roof structure and to forced ventilation systems.
3. Each sampling point shall be identified by an applied decal.

2.14 NOTIFICATION APPLIANCES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Federal Signal Corporation.
2. GE UTC Fire & Security; A United Technologies Company.
3. Gentex Corporation.
4. Harrington Signal, Inc.
5. Keltron Corporation.
6. Mircom Technologies, Ltd.
7. Potter Electric Signal Company, LLC.
8. Siemens Industry, Inc.; Fire Safety Division.
9. SimplexGrinnell LP.
10. System Sensor.
11. Wheelock; a brand of Eaton.

B. General Requirements for Notification Appliances: Individually addressed, connected to a signaling-line circuit, equipped for mounting as indicated, and with screw terminals for system connections.

C. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

D. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.

E. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.

F. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.

G. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.

1. Rated Light Output:

   a. 177 cd.
   b. 15/30/75/110 cd, selectable in the field.

2. Mounting: Wall mounted unless otherwise indicated.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finished white.

H. Voice/Tone Notification Appliances:

1. Comply with UL 1480.
2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
3. High-Range Units: Rated 2 to 15 W.
4. Low-Range Units: Rated 1 to 2 W.
5. Mounting: semi-recessed or surface mounted and bidirectional.
6. Matching Transformers: Tap range matched to acoustical environment of speaker location.

I. Exit Marking Audible Notification Appliance:

1. Exit marking audible notification appliances shall meet the audibility requirements in NFPA 72.
2. Provide exit marking audible notification appliances at the entrance to all building exits.
3. Provide exit marking audible notification appliances at the entrance to areas of refuge with audible signals distinct from those used for building exit marking.

2.15 FIREFIGHTERS' TWO-WAY TELEPHONE COMMUNICATION SERVICE

A. Dedicated, two-way, supervised, telephone voice communication links between fire-alarm control unit, the fire command center, and remote firefighters' telephone stations. Supervised telephone lines shall be connected to talk circuits by controls in a control module. Provide the following:

1. Common-talk type for firefighter use only.
2. Selective-talk type for use by firefighters and fire wardens.
3. Controls to disconnect phones from talk circuits if too many phones are in use simultaneously. An indicator lamp shall flash if a phone is disconnected from the talk circuits.
4. Addressable firefighters' phone modules to monitor and control a loop of firefighter phones. Module shall be capable of differentiating between normal, off-hook, and trouble conditions.
5. Audible Pulse and Tone Generator, and High-Intensity Lamp: When a remote telephone is taken off the hook, it causes an audible signal to sound and a high-intensity lamp to flash at the fire-alarm control unit.
6. Selector panel controls to provide for simultaneous operation of up to six telephones in selected zones. Indicate ground faults and open or shorted telephone lines on the panel front by individual LEDs.
7. Display: Graphic to indicate location of caller.
8. Remote Telephone Cabinet: Flush- or surface-mounted cabinet as indicated, factory-standard red finish, with handset.

    a. Install one-piece handset to cabinet with vandal-resistant armored cord. Silk-screened or engraved label on cabinet door, designating “Fire Warden Phone" or "Fire Emergency Phone."
    b. With "break-glass" type door access lock.

9. Remote Telephone Jack Stations: Single-gang, stainless-steel-plate mounted plug, engraved “Fire Warden Phone" or "Fire Emergency Phone."
10. Handsets: push-to-talk-type sets stored in a cabinet adjacent to fire-alarm control unit.

2.16 FIREFIGHTERS' SMOKE-CONTROL SYSTEM

A. Initiate Smoke-Management Sequence of Operation:

1. Comply with sequence of operation as described in Section 230993.11 "Sequence of Operations for HVAC DDC."
2. Fire-alarm system shall provide all interfaces and control points required to properly activate smoke-management systems.
3. First fire-alarm system initiating device to go into alarm condition shall activate the smoke-control functions.
4. Subsequent devices going into alarm condition shall have no effect on the smoke-control mode.

B. Addressable Relay Modules:

1. Provide address-setting means on the module. Store an internal identifying code for control panel use to identify the module type.
2. Allow the control panel to switch the relay contacts on command.
3. Have a minimum of two normally open and two normally closed contacts available for field wiring.

4. Listed for controlling HVAC fan motor controllers.

2.17 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. Rating: 24-V ac or dc.
4. Rating: 120-V ac.

B. Material and Finish: Match door hardware.

2.18 GRAPHIC ANNUNCIATOR

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. GE UTC Fire & Security; A United Technologies Company.
2. Harrington Signal, Inc.
3. Keltron Corporation.
4. Mircom Technologies, Ltd.
5. Potter Electric Signal Company, LLC.
6. Siemens Industry, Inc.; Fire Safety Division.
7. SimplexGrinnell LP.

B. Graphic Annunciator Panel: Mounted in an aluminum frame with non-glare, minimum 3/16-inch-(4.76-mm-) thick, clear acrylic cover over graphic representation of the facility. Detector locations shall be represented by red LED lamps. Normal system operation shall be indicated by a lighted, green LED. Trouble and supervisory alarms shall be represented by an amber LED.

1. Comply with UL 864.
2. Operating voltage shall be 24-V dc provided by a local 24-V power supply provided with the annunciator.
3. Include built-in voltage regulation, reverse polarity protection, RS 232/422 serial communications, and a lamp test switch.
4. Semi flush mounted in a NEMA 250, Type 1 cabinet, with key lock and no exposed screws or hinges.
5. Graphic representation of the facility shall be a CAD drawing and each detector shall be represented by an LED in its actual location. CAD drawing shall be at 1/8-inch per foot (10-mm per meter) scale or larger.
6. The LED representing a detector shall flash two times per second while detector is an alarm.

C. Graphic Annunciator Workstation: PC-based, with fire-alarm annunciator software with historical logging, report generation, and a graphic interface showing all alarm points in the system. PC with operating system software, minimum hard drive, digital display monitor, with wireless keyboard and mouse.

2.19 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.20 ADDRESSABLE INTERFACE DEVICE

A. General:

1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall and as required to circuit-breaker shunt trip for power shutdown.

1. Allow the control panel to switch the relay contacts on command.
2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. Control Module:

1. Operate notification devices.
2. Operate solenoids for use in sprinkler service.

2.21 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address of the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply.
5. Loss of power.
6. Low battery.
7. Abnormal test signal.
8. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.22 RADIO ALARM TRANSMITTER

A. Transmitter shall comply with NFPA 1221 and 47 CFR 90.

B. Description: Manufacturer's standard commercial product; factory assembled, wired, and tested; ready for installation and operation.

1. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
2. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station designated by Owner.
3. Normal Power Input: 120-V ac.
4. Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
5. Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports shall withstand 100 mph (160 km/h) with a gust factor of 1.3 without failure.
6. Antenna Cable: Coaxial cable with impedance matched to the transmitter output impedance.
7. Antenna-Cable Connectors: Weatherproof.
8. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.

C. Functional Performance: Unit shall receive alarm, supervisory, or trouble signal from fire-alarm control unit or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote alarm receiving station. Transmitted messages shall correspond to standard designations for fire-reporting system to which the signal is being transmitted and shall include separately designated messages in response to the following events or conditions:

1. Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
2. System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.
3. Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.
4. Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.
5. Local Fire-Alarm-System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.
6. Local Fire-Alarm-System, Supervisory-Alarm Message: Actuated when the building alarm system indicates a supervisory alarm.

2.23 NETWORK COMMUNICATIONS

A. Provide network communications for fire-alarm system according to fire-alarm manufacturer's written requirements.

B. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.

C. Provide integration gateway using BACnet or Modbus for connection to building automation system.

2.24 SYSTEM PRINTER

A. Printer shall be listed and labeled as an integral part of fire-alarm system.

2.25 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by device manufacturer.
2. Finish: Paint of color to match the protected device.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the supervising station.
3. Expand, modify, and supplement existing control equipment as necessary to extend existing control functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

C. Equipment Mounting: Install fire-alarm control unit on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete." Section 033053 "Miscellaneous Cast-in-Place Concrete."

1. Install seismic bracing. Comply with requirements in Section 270548.16 "Seismic Controls for Communications Systems."
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (460-mm) centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Equipment Mounting: Install fire-alarm control unit on finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 270548.16 "Seismic Controls for Communications Systems."

E. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 270548.16 "Seismic Controls for Communications Systems."

F. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
2. Mount manual fire-alarm box on a background of a contrasting color.
3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.

G. Smoke- or Heat-Detector Spacing:

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet (9 m).
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B **in** NFPA 72.
5. HVAC: Locate detectors not closer than 36 inches (910 mm) from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

H. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

I. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.

1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

J. Air-Sampling Smoke Detectors: If using multiple pipe runs, the runs shall be pneumatically balanced.

K. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

L. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

M. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

N. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

O. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.

P. Device Location-Indicating Lights: Locate in public space near the device they monitor.

Q. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that resists 100-mph (160-km/h) wind load with a gust factor of 1.3 without damage.

3.3 PATHWAYS

A. Pathways above recessed ceilings and in non-accessible locations may be routed exposed.

1. Exposed pathways located less than 96 inches (2440 mm) above the floor shall be installed in EMT.

B. Pathways shall be installed in EMT.

C. Exposed EMT shall be painted red enamel.

3.4 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connection to smoke-control system (smoke management) at firefighters' smoke-control system panel.
2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
3. Smoke dampers in air ducts of designated HVAC duct systems.
4. Magnetically held-open doors.
5. Electronically locked doors and access gates.
6. Alarm-initiating connection to elevator recall system and components.
7. Alarm-initiating connection to activate emergency lighting control.
8. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
9. Supervisory connections at valve supervisory switches.
10. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
11. Supervisory connections at elevator shunt-trip breaker.
12. Data communication circuits for connection to building management system.
13. Data communication circuits for connection to mass notification system.
14. Supervisory connections at fire-extinguisher locations.
15. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
16. Supervisory connections at fire-pump engine control panel.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.6 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visual Inspection: Conduct visual inspection prior to testing.

    a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
    b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 284621.11

SECTION 311000
SITE CLEARING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Clearing and protection of vegetation.

B. Removal of existing debris.

1.02 RELATED REQUIREMENTS

A. Section 011000 - Summary: Limitations on Contractor's use of site and premises.

B. Section 011000 - Summary: Sequencing and staging requirements.

C. Section 015000 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.

D. Section 017000 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products.

E. Section 017419 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.

F. Section 024100 - Demolition: Removal of built elements and utilities.

G. Section 312200 - Grading: Topsoil removal.

H. Section 312200 - Grading: Fill material for filling holes, pits, and excavations generated as a result of removal operations.

I. Section 312323 - Fill: Fill material for filling holes, pits, and excavations generated as a result of removal operations.

J. Section 312323 - Fill: Filling holes, pits, and excavations generated as a result of removal operations.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Site Plan: Showing:
   1. Vegetation removal limits.
   2. Areas for temporary construction and field offices.

1.04 QUALITY ASSURANCE

A. Clearing Firm: Company specializing in the type of work required.
   1. Minimum of ___ years of documented experience.

PART 2 PRODUCTS -- NOT USED

2.01 MATERIALS

A. Fill Material: As specified in Section 312200 - Grading

PART 3 EXECUTION

3.01 SITE CLEARING

A. Comply with other requirements specified in Section 017000.

B. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

3.02 EXISTING UTILITIES AND BUILT ELEMENTS

A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.

B. Protect existing utilities to remain from damage.

C. Do not disrupt public utilities without permit from authority having jurisdiction.

D. Protect existing structures and other elements that are not to be removed.

3.03 VEGETATION

A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, playing fields, lawns, and planting beds.

B. Do not begin clearing until vegetation to be relocated has been removed.

C. Do not remove or damage vegetation beyond the limits indicated on drawings.
   1. 40 feet (12 m) outside the building perimeter.
   2. 10 feet (3.1 m) each side of surface walkways, patios, surface parking, and utility lines less than 12 inches (305 mm) in diameter.
   3. 15 feet (4.6 m) each side of roadway curbs and main utility trenches.
   4. 25 feet (7.5 m) outside perimeter of pervious paving areas that must not be compacted by construction traffic.
   5. Exception: Specific trees and vegetation indicated on drawings to be removed.
   6. Exception: Selective thinning of undergrowth specified elsewhere.

D. Install substantial, highly visible fences at least 3 feet high (at least 1 m high) to prevent inadvertent damage to vegetation to remain:
   1. At vegetation removal limits.
   2. Around trees to remain within vegetation removal limits; locate no closer to tree than at the drip line.
   3. Around other vegetation to remain within vegetation removal limits.
   4. See Section 015000 for fence construction requirements.

E. In areas where vegetation must be removed but no construction will occur other than pervious paving, remove vegetation with minimum disturbance of the subsoil.

F. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated.
   1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
   2. Trees: Sell if marketable; if not, treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches (450 mm).
   3. Existing Stumps: Treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches (450 mm).
   4. Sod: Re-use on site if possible; otherwise sell if marketable, and if not, treat as specified for other vegetation removed.
   5. Fill holes left by removal of stumps and roots, using suitable fill material, with top surface neat in appearance and smooth enough not to constitute a hazard to pedestrians.

G. Dead Wood: Remove all dead trees (standing or down), limbs, and dry brush on entire site; treat as specified for vegetation removed.

H. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

3.04 DEBRIS

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

B. Leave site in clean condition, ready for subsequent work.

C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION 311000

SECTION 312200
GRADING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Removal of topsoil.

B. Rough grading the site for site structures.

C. Finish grading.

1.02 RELATED REQUIREMENTS

A. Section 311000 - Site Clearing.

B. Section 312316 - Excavation.

C. Section 312323 - Fill: Filling and compaction.

1.03 PRICE AND PAYMENT PROCEDURES

A. See Section 012200 - Unit Prices, for general requirements relating to unit prices for this work.

B. Topsoil: Applies to Unit Price _____ .
   1. Measurement Method: By the cubic foot (cubic meter).
   2. Measurement Method: By the square yard (square meter) down to a drawing-defined elevation.
   3. Includes: Excavating existing topsoil, stockpiling, scarifying substrate surface, placing where required, compacting, and dewatering.

1.04 SUBMITTALS

A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with City of South Jordan, Public Works Department standards.
   1. Maintain one copy on site.

PART 2 PRODUCTS

2.01 MATERIALS

A. Topsoil: See Section 312323.

B. Topsoil - Soil Type ____: Topsoil excavated on-site.
   1. Graded.
   2. Free of roots, rocks larger than 1/2 inch (12 mm), subsoil, debris, large weeds and foreign matter.

C. Other Fill Materials: See Section 312323.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench mark and intended elevations for the Work are as indicated.

B. Verify the absence of standing or ponding water.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Stake and flag locations of known utilities.

C. Locate, identify, and protect from damage above- and below-grade utilities to remain.

D. Notify utility company to remove and relocate utilities.

E. Provide temporary means and methods to remove all standing or ponding water from areas prior to grading.

F. Protect site features to remain, including but not limited to bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs, from damage by grading equipment and vehicular traffic.

G. Protect trees to remain by providing substantial fencing around entire tree at the outer tips of its branches; no grading is to be performed inside this line.

H. Protect plants, lawns, rock outcroppings, and other features to remain as a portion of final landscaping.

3.03 ROUGH GRADING

A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.

B. Do not remove topsoil when wet.

C. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.

D. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.

E. When excavating through roots, perform work by hand and cut roots with sharp axe.

F. See Section 312323 for filling procedures.

G. Benching Slopes: Horizontally bench existing slopes greater than 1:4 to key fill material to slope for firm bearing.

H. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

I. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack surface water control.

3.04 SOIL REMOVAL

A. Stockpile subsoil to be re-used on site;

3.05 FINISH GRADING

A. Before Finish Grading:
   1. Verify building and trench backfilling have been inspected.
   2. Verify subgrade has been contoured and compacted.

B. Remove debris, roots, branches, stones, in excess of 1/2 inch (13 mm) in size. Remove soil contaminated with petroleum products.

C. Where topsoil is to be placed, scarify surface to depth of 3 inches (75 mm).

D. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 inches (75 mm).

E. Place topsoil where required to level finish grade.

F. Place topsoil to thickness as indicated.

G. Place topsoil during dry weather.

H. Remove roots, weeds, rocks, and foreign material while spreading.

I. Near plants spread topsoil manually to prevent damage.

J. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.

K. Lightly compact placed topsoil.

L. Maintain stability of topsoil during inclement weather. Replace topsoil in areas where surface water has eroded thickness below specifications.

3.06 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) (30 mm) from required elevation.

B. Top Surface of Finish Grade: Plus or minus 0.04 foot (1/2 inch) (13 mm).

3.07 REPAIR AND RESTORATION

A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.

B. Trees to Remain: If damaged due to this work, trim broken branches and repair bark wounds; if root damage has occurred, obtain instructions from Architect as to remedy.

C. Other Existing Vegetation to Remain: If damaged due to this work, replace with vegetation of equivalent species and size.

3.08 FIELD QUALITY CONTROL

A. See Section 312323 for compaction density testing.

3.09 CLEANING

A. Remove unused stockpiled topsoil. Grade stockpile area to prevent standing water.

B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION 312200

SECTION 312316
EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Excavating for building volume below grade, footings, pile caps, slabs-on-grade, paving, site structures, and utilities within the building.

B. Trenching for utilities outside the building to utility main connections.

1.02 RELATED REQUIREMENTS

A. Section 017000 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring. General requirements for dewatering of excavations and water control.

B. Section 024100 - Demolition: Shoring and underpinning existing structures.

C. Section 311000 - Site Clearing: Vegetation and existing debris removal.

D. Section 312200 - Grading: Soil removal from surface of site.

E. Section 312200 - Grading: Grading.

F. Section 312323 - Fill: Fill materials, backfilling, and compacting.

1.03 PRICE AND PAYMENT PROCEDURES

A. Unit Price ____ : Excavating Soil Materials.
   1. Measurement Method: By the cubic foot (cubic meter).
   2. Includes: Excavating to required elevations, loading and placing materials in stockpile, and dewatering.
   3. Does Not Include Over-Excavation: Payment will not be made for over-excavated work nor for replacement materials.

B. See Section 312323 for measurement and payment provisions related to fill.

1.04 REFERENCE STANDARDS

A. 29 CFR 1926 - Safety and Health Regulations for Construction; Current Edition.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Temporary Support and Excavation Protection Plan.

C. Project Record Documents: Record drawings at project closeout according to 017000 - Execution and Closeout Requirements. Show locations of installed support materials left in place, including referenced locations and depths, on drawings.

D. Field Quality Control Submittals: Document visual inspection of load-bearing excavated surfaces.

1.06 QUALITY ASSURANCE

A. Temporary Support and Excavation Protection Plan:
   1. Indicate sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property.
   2. Include drawings and calculations for bracing and shoring.
   3. Bracing and shoring design to meet requirements of OSHA's Excavation Standard, 29 CFR 1926, Subpart P.

B. Designer Qualifications: For design of temporary shoring and bracing, employ a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

C. Shoring Installer Qualifications: Company specializing in performing the shoring and bracing work of this section.

PART 2 PRODUCTS

2.01 MATERIALS

A. Bedding and Fill to Correct Over-Excavation:
   1. See Section 312323 for bedding and corrective fill materials at general excavations.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench mark and intended elevations for the work are as indicated.

B. Survey existing adjacent structures and improvements and establish exact elevations at fixed points to act as benchmarks.
   1. Resurvey benchmarks during installation of excavation support and protection systems and notify Owner if any changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

C. Determine the prevailing groundwater level prior to excavation. If the proposed excavation extends less than 1 foot (305 mm) into the prevailing groundwater, control groundwater intrusion with perimeter drains routed to sump pumps, or as directed by Architect. If the proposed excavation extends more than 1 foot (305 mm) into the prevailing groundwater, control groundwater intrusion with a comprehensive dewatering procedures, or as directed by Geotechnical Engineer.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. See Section 311000 for clearing, grubbing, and removal of existing debris.

C. See Section 312200 for topsoil removal.

D. Locate, identify, and protect utilities that remain and protect from damage.

E. Notify utility company to remove and relocate utilities.

F. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

G. Protect plants, lawns, rock outcroppings, and other features to remain.

H. Grade top perimeter of excavation to prevent surface water from draining into excavation. Provide temporary means and methods, as required, to maintain surface water diversion until no longer needed, or as directed by Architect.

I. See Sections 017000 and 024100 for underpinning and shoring of adjacent structures that could be damaged by excavating work.

3.03 EXCAVATING

A. Excavate to accommodate new structures and construction operations.
   1. Excavate to the specified elevations.
   2. Excavate to the length and width required to safely install, adjust, and remove any forms, bracing, or supports necessary for the installation of the work.
   3. Cut utility trenches wide enough to allow inspection of installed utilities.
   4. See Section 312316.26 for required excavation clearances for pipes in utility trenches.
   5. Hand trim excavations. Remove loose matter.

B. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

C. Do not interfere with 45 degree bearing splay of foundations.

D. Remove lumped subsoil, boulders, and rock up to 1/3 cubic yard (0.25 cu m) measured by volume. See Section 312316.26 for removal of larger material.

E. Provide temporary means and methods, as required, to remove all water from excavations until directed by Architect. Remove and replace soils deemed suitable by classification and which are excessively moist due to lack of dewatering or surface water control.

3.04 SUBGRADE PREPARATION

A. See Section 312323 for subgrade preparation at general excavations.

3.05 FILLING AND BACKFILLING

A. Do not fill or backfill until all debris, water, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from excavation.

B. See Section 312323 for fill, backfill, and compaction requirements at general excavations.

C. See Section 312200 for rough and final grading and topsoil replacement requirements.

3.06 REPAIR

A. Correct areas that are over-excavated and load-bearing surfaces that are disturbed; see Section 312323.

3.07 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for general requirements for field inspection and testing.

B. Provide for visual inspection of load-bearing excavated surfaces by Architect before placement of foundations.

3.08 CLEANING

A. Remove excess excavated material from site.

3.09 PROTECTION

A. Divert surface flow from rains or water discharges from the excavation.

B. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.

C. Protect open excavations from rainfall, runoff, freezing groundwater, or excessive drying so as to maintain foundation subgrade in satisfactory, undisturbed condition.

D. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

E. Keep excavations free of standing water and completely free of water during concrete placement.

END OF SECTION 312316

SECTION 312323
FILL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Filling, backfilling, and compacting for building volume below grade, footings, slabs-on-grade, paving, and utilities within the building.

B. Backfilling and compacting for utilities outside the building to utility main connections.

C. Filling holes, pits, and excavations generated as a result of removal (demolition) operations.

1.02 RELATED REQUIREMENTS

A. Geotechnical report; bore hole locations and findings of subsurface materials.

B. Section 015713 - Temporary Erosion and Sediment Control: Slope protection and erosion control.

C. Section 033000 - Cast-in-Place Concrete.

D. Section 134713 - Cathodic Protection.

E. Section 310519 - Geosynthetics for Earthwork.

F. Section 312200 - Grading: Removal and handling of soil to be re-used.

G. Section 312200 - Grading: Site grading.

H. Section 312316 - Excavation: Removal and handling of soil to be re-used.

I. Section 312316.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.

J. .

1.03 PRICE AND PAYMENT PROCEDURES

A. See Section 012200 - Unit Prices, for general requirements applicable to unit prices for earthwork.

B. General Fill: Applies to Unit Price _____ .
   1. Measurement Method: By the cubic foot (cubic meter).
   2. Measurement Method: By the square yard (square meter) down to a drawing-defined elevation.
   3. Includes: Excavating existing soil, stockpiling, scarifying substrate surface, placing where required, compacting, and dewatering.

C. Structural Fill: Applies to Unit Price _____ .
   1. Measurement Method: By the cubic foot (cubic meter).
   2. Measurement Method: By the square yard (square meter) down to a drawing-defined elevation.
   3. Includes: Excavating existing soil, stockpiling, scarifying substrate surface, placing where required, compacting, and dewatering.

D. Granular Fill: Applies to Unit Price _____ .
   1. Measurement Method: By the cubic foot (cubic meter).
   2. Measurement Method: By the square yard (square meter) down to a drawing-defined elevation.
   3. Includes: Excavating existing material, stockpiling, scarifying substrate surface, placing where required, compacting, and dewatering.

E. Aggregates: Applies to Unit Price _____ .
   1. Measurement Method: By the cubic foot (cubic meter).

2. Measurement Method: By the square yard (square meter) down to a drawing-defined elevation.
3. Includes: Excavating existing material, stockpiling, scarifying substrate surface, placing where required, compacting, and dewatering.

1.04 DEFINITIONS

A. Finish Grade Elevations: Indicated on drawings.

B. Subgrade Elevations: Indicated on drawings.

C. Subgrade Elevations: 4 inches (100 mm) below finish grade elevations indicated on drawings, unless otherwise indicated.

D. Finish Grade Elevations: 4 inches (100 mm) above subgrade elevations indicated on drawings , unless otherwise indicated.

1.05 REFERENCE STANDARDS

A. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil–Aggregate Subbase, Base, and Surface Courses; 2017 (Reapproved 2021).

B. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop; 2022, with Errata .

C. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates; 2019.

D. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.

E. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2012 (Reapproved 2021).

F. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method; 2015, with Editorial Revision (2016).

G. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)); 2012 (Reapproved 2021).

H. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 2015.

I. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2017, with Editorial Revision (2020).

J. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 2017, with Editorial Revision (2018).

1.06 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Soil Samples: 10 pounds (4.5 kg) sample of each type of fill; submit in air-tight containers to testing laboratory.

C. Materials Sources: Submit name of imported materials source.

D. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used, including manufactured fill.

E. Compaction Density Test Reports.

F. Manufacturer's Instructions.

G. Designer's Qualification Statement.

H. Manufacturer's Qualification Statement.

I. Testing Agency Qualification Statement.

J. Specimen Warranty.

1.07 QUALITY ASSURANCE

A. Designer Qualifications: Perform design of structural fill under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than ten years of documented experience.

C. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

D. Copies of Documents at Project Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

B. When fill materials need to be stored on site, locate stockpiles where indicated.
   1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
   2. Prevent contamination.
   3. Protect stockpiles from erosion and deterioration of materials.

1.09 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 FILL MATERIALS

A. General Fill - Fill Type Per Geotech Report: Complying with State of Utah Highway Department standard.

B. Granular Fill - Fill Type Per Geotech Report: Coarse aggregate, complying with State of Utah Highway Department standard.

C. Topsoil: See Section 312200.

2.02 ACCESSORIES

A. Geotextile: Non-biodegradable, woven.

2.03 SOURCE QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for general requirements for testing and analysis of soil material.

B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.

C. If tests indicate materials do not meet specified requirements, change material and retest.

D. Provide materials of each type from same source throughout the Work.
   1. Ongoing Testing: Provide third-party testing indicating compliance with ASTM D6817/D6817M. Test at intervals that comply with ASTM D7557/D7557M.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench marks and intended elevations for the Work are as indicated.

B. Identify required lines, levels, contours, and datum locations.

C. See Section 312200 for additional requirements.

D. Verify subdrainage, dampproofing, or waterproofing installation has been inspected.

E. Verify structural ability of unsupported walls to support imposed loads by the fill.

F. Verify underground tanks are anchored to their own foundations to avoid flotation after backfilling.

G. Verify areas to be filled are not compromised with surface or ground water.

3.02 PREPARATION

A. Scarify and proof roll subgrade surface to a depth of 6 inches (150 mm) to identify soft spots.

B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.

C. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

3.03 FILLING

A. Fill to contours and elevations indicated using unfrozen materials.

B. Fill up to subgrade elevations unless otherwise indicated.

C. Employ a placement method that does not disturb or damage other work.

D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

E. Maintain optimum moisture content of fill materials to attain required compaction density.

F. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches (150 mm) compacted depth.

G. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches (200 mm) compacted depth.

H. Slope grade away from building minimum 2 inches in 10 feet (50 mm in 3 m), unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

I. Correct areas that are over-excavated.
   1. Load-bearing foundation surfaces: Use structural fill, flush to required elevation, compacted to 100 percent of maximum dry density.
   2. Other areas: Use general fill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.

J. Compaction Density Unless Otherwise Specified or Indicated:
   1. Under paving, slabs-on-grade, and similar construction: 97 percent of maximum dry density.
   2. At other locations: 95 percent of maximum dry density.

K. Reshape and re-compact fills subjected to vehicular traffic.

L. Maintain temporary means and methods, as required, to remove all water while fill is being placed as required, or until directed by the Architect. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

3.04 FILL AT SPECIFIC LOCATIONS

A. Use general fill unless otherwise specified or indicated.

B. Structural Fill at footings and foundation:
   1. Fill up to subgrade elevations.
   2. Maximum depth per lift: 6 inches (150 mm), compacted.
   3. Compact to minimum 95 percent of maximum dry density.

C. Under Interior Slabs-On-Grade:
   1. Use granular fill.
   2. Depth: 4 inches (100 mm) deep.
   3. Compact to 95 percent of maximum dry density.

4. Cover with sand.
   a. Depth: 2 inches (50 mm).
   b. Compact to 95 percent of maximum dry density.
5. place.

D. Over Subdrainage Piping at Foundation Perimeter and Under Slabs:
1. Drainage fill and geotextile: Section 310519.
2. Cover drainage fill with general fill.
3. Fill up to subgrade elevation.
4. Compact to 95 percent of maximum dry density.

E. Over Buried Utility Piping, Conduits, and Duct Bank in Trenches and _____:
1. Bedding: Use general fill.
2. Cover with general fill.
3. Fill up to subgrade elevation.
4. Compact in maximum 8 inch (200 mm) lifts to 95 percent of maximum dry density.

3.05 TOLERANCES

A. Top Surface of General Filling: Plus or minus 1 inch (25 mm) from required elevations.

B. Top Surface of Filling Under Paved Areas: Plus or minus 1 inch (25 mm) from required elevations.

3.06 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for general requirements for field inspection and testing.

B. Soil Fill Materials:
1. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.
2. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D698 ("standard Proctor"), ASTM D1557 ("modified Proctor"), or AASHTO T 180.
3. If tests indicate work does not meet specified requirements, remove work, replace and retest.
4. Proof roll compacted fill at surfaces that will be under slabs-on-grade.

3.07 CLEANING

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

B. Leave unused materials in a neat, compact stockpile.

C. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

D. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION 312323

SECTION 331416
SITE WATER UTILITY DISTRIBUTION PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Water pipe for site conveyance lines.

B. Pipe valves.

C. Fire hydrants.

1.02 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete for thrust restraints.

B. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

C. Section 330110.58 - Disinfection of Water Utility Piping Systems: Disinfection of site service utility water piping.

D. Section 330561 - Concrete Manholes.

E. Section 330569 - Concrete Trenchways: For routing of water utilities.

1.03 PRICE AND PAYMENT PROCEDURES

A. See Section 012200 - Unit Prices, for additional unit price requirements.

B. Pipe and Fittings: By the linear foot (linear meter). Includes hand trimming excavation, pipe and fittings, bedding, concrete thrust restraints, connection to building service piping, and to municipal utility water source.

C. Valves: By the unit. Includes valve, fittings and accessories.

D. Hydrant: By the unit. Includes hand trimming excavation, gravel sump, hydrant, valve, connection, and accessories.

1.04 REFERENCE STANDARDS

A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.

B. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2021.

C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.

D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.

E. ASME B18.2.2 - Nuts for General Applications: Machine Screw Nuts; and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series); 2022.

F. ASME B18.5.2.1M - Metric Round Head Short Square Neck Bolts; 2006 (Reaffirmed 2011).

G. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.

H. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.

I. ASTM A563/A563M - Standard Specification for Carbon and Alloy Steel Nuts (Inch and Metric); 2021a.

J. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.

K. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.

L. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2023.

M. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80; 2020.

N. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020.

O. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter; 2022.

P. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals; 2019.

Q. ASTM F1267 - Standard Specification for Metal, Expanded, Steel; 2018.

R. ASTM F1807 - Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring, or Alternate Stainless Steel Clamps, for SDR9 Cross-Linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing; 2023.

S. ASTM F1960 - Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-Linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing; 2023b.

T. ASTM F2080 - Standard Specification for Cold-Expansion Fittings with Metal Compression-Sleeves for Crosslinked Polyethylene (PEX) Pipe and SDR9 Polyethylene of Raised Temperature (PE-RT) Pipe; 2019.

U. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.

V. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.

W. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2023.

X. AWWA C115/A21.15 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges; 2020.

Y. AWWA C200 - Steel Water Pipe, 6 in. (150 mm) and Larger; 2023.

Z. AWWA C203 - Coal-Tar Protective Coatings and Linings for Steel Water Pipe; 2020.

AA. AWWA C205 - Cement–Mortar Protective Lining and Coating for Steel Water Pipe—4 in. (100 mm) and Larger—Shop Applied; 2024.

BB. AWWA C206 - Field Welding of Steel Water Pipe; 2023.

CC. AWWA C207 - Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm); 2023.

DD. AWWA C208 - Dimensions for Fabricated Steel Water Pipe Fittings; 2022.

EE. AWWA C209 - Tape Coatings for Steel Water Pipe and Fittings; 2019.

FF. AWWA C210 - Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings; 2024.

GG. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service; 2019.

HH. AWWA C502 - Dry-Barrel Fire Hydrants; 2024.

II. AWWA C504 - Rubber-Seated Butterfly Valves; 2023.

JJ. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-In. Through 48-In. (50-mm Through 1,200-mm) NPS; 2017.

KK. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service; 2023.

LL. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances; 2023.

MM. AWWA C602 - Cement-Mortar Lining of Water Pipelines in Place - 4 In. (100 mm) and Larger; 2023.

NN. AWWA C606 - Grooved and Shouldered Joints; 2022.

OO. AWWA C800 - Underground Service Line Valves and Fittings; 2021.

PP. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. through 60 In. (100 mm through 1500 mm); 2022.

QQ. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 3/4 In. (19 mm) Through 3 In. (76 mm), for Water Service; 2020.

RR. AWWA C904 - Cross-Linked Polyethylene (PEX) Pressure Tubing, ½ In. (13 mm) Through 3 In. (76 mm), for Water Service; 2016.

SS. AWWA M11 - Steel Pipe - A Guide for Design and Installation; 2017, with Addendum (2019).

TT. NSF 61 - Drinking Water System Components - Health Effects; 2022, with Errata.

UU. UL 246 - Hydrants for Fire-Protection Service; Current Edition, Including All Revisions.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.06 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.

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

D. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.07 QUALITY ASSURANCE

A. Perform Work in accordance with utility company requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers with labeling in place.

B. Protect crosslinked polyethylene tubing from direct and indirect UV exposure.

1.09 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 WATER PIPE

A. Ductile Iron Pipe: AWWA C151/A21.51:
   1. Fittings: Ductile iron, standard thickness.
   2. Joints: AWWA C111/A21.11, Styrene butadiene rubber (SBR) or vulcanized SBR gasket with rods.
   3. Jackets: AWWA C105/A21.5 polyethylene jacket.

B. Copper Tubing: ASTM B88, Type K, Annealed:
   1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
   2. Joints: Compression connection or AWS A5.8M/A5.8, BCuP silver braze.

C. PVC Pipe: ASTM D1785 Schedule 40.
   1. Fittings: ASTM D2466, PVC.
   2. Joints: ASTM D2855, solvent weld.

D. PVC Pipe: AWWA C900 Class 100:

1. Fittings: AWWA C111/A21.11, Schedule 40 per ASTM D2466 or schedule 80 per ASTM D2467.
2. Joints: ASTM D3139 compression gasket ring.

E. Polyethylene Pipe: ASTM D3035, for 45 psig pressure rating (ASTM D3035, for 315 kPa pressure rating):
1. Fittings: AWWA C901, molded or fabricated.
2. Joints: Compression.

F. Polyethylene Pipe: AWWA C901:
1. Fittings: AWWA C901, molded or fabricated.
2. Joints: Compression.

G. Crosslinked Polyethylene Tubing: AWWA C904.
1. Fittings: AWWA C800, insert-stiffener type.
2. Joints: Cold expansion fittings with PEX reinforcing rings, complying with ASTM F1960

H. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Water Service" in large letters.

2.02 VALVES

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Gate Valves Up To 3 Inches (75 mm): Per South Jordan City Public Utilities Standards and Specifications

C. Gate Valves 3 Inches (75 mm) and Over: Per South Jordan City Public Utilities Standards and Specifications

D. Ball Valves Up To 2 Inches (50 mm): Per Sotuht Jordan City Public Utilities Standards and Specifications

E. Swing Check Valves From 2 Inches to 24 Inches (50 mm to 600 mm): Per South Jordan City Public Utilities and Specifications

F. Butterfly Valves From 2 Inches to 24 Inches (50 mm to 600 mm): Per South Jordan City Public Utilities Standards and Specifications

2.03 HYDRANTS

A. Hydrants: Type as required by utility company.

B. Hydrant Extensions: Fabricate in multiples of 6 inches (150 mm) with rod and coupling to increase barrel length.

C. Hose and Streamer Connection: Match sizes with utility company, two hose nozzles , one pumper nozzle.

D. Pressure Rating: According to utility company.

E. Finish: Primer and two coats of enamel in color required by utility company.

2.04 BEDDING AND COVER MATERIALS

A. Bedding: As specified in Section 312316.13.

B. Cover: As specified in Section 312316.13.

2.05 ACCESSORIES

A. Concrete for Thrust Restraints: Concrete type specified in Section 033000.

B. Manhole and Cover: Refer to Section 330561.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that building service connection and municipal utility water main size, location, and invert are as indicated.

3.02 PREPARATION

A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare pipe connections to equipment with flanges or unions.

3.03 TRENCHING

A. See the sections on excavation and fill for additional requirements.

B. Hand trim excavation for accurate placement of pipe to elevations indicated.

C. Form and place concrete for pipe thrust restraints at each change of pipe direction. Place concrete to permit full access to pipe and pipe accessories. Provide ____ square feet (____ sq m) thrust restraint bearing on subsoil.

D. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.04 INSTALLATION - PIPE

A. Maintain separation of water main from sewer piping in accordance with UTAH code.

B. Group piping with other site piping work whenever practical.

C. Establish elevations of buried piping to ensure not less than _____ feet (_____ m) of cover.

D. Install pipe to indicated elevation to within tolerance of 5/8 inches (16 mm).

E. Install ductile iron piping and fittings to AWWA C600.

F. Install crosslinked polyethylene tubing and fittings to AWWA C904.

G. Route pipe in straight line.

H. Install pipe to allow for expansion and contraction without stressing pipe or joints.

I. Install access fittings to permit disinfection of water system performed under Section 330110.58.

J. Slope water pipe and position drains at low points.

K. Install trace wire 6 inches (150 mm) above top of pipe; coordinate with Section 312316.13.

3.05 INSTALLATION - VALVES, HYDRANTS, BACKFLOW PREVENTERS

A. Set valves on solid bearing.

B. Center and plumb valve box over valve. Set box cover flush with finished grade.

C. Set hydrants plumb; locate pumper nozzle perpendicular to and facing roadway in accordance with Section 211100.

D. Set hydrants to grade, with nozzles at least 20 inches (500 mm) above ground in accordance with Section 211100.

E. Locate control valve 4 inches (100 mm) away from hydrant.

F. Provide a drainage pit 36 inches (900 mm) square by 24 inches (600 mm) deep filled with 2 inches (50 mm) washed gravel. Encase elbow of hydrant in gravel to 6 inches (150 mm) above drain opening. Do not connect drain opening to sewer.

G. Paint hydrants in accordance with Section 099113.

H. Install backflow preventers in accordance with requirements of local water utility and local authority having jurisdiction.

I. Support backflow preventer independently of surrounding pipe using pipe stanchions.

J. Outdoor Enclosures:
   1. Caged or Insulated without Heat Source:
      a. Install in accordance with manufacturer's recommendations.
      b. Anchor enclosure to flat, concrete base.
      c. Concrete Base Height: 2 inches (50 mm).
      d. Connect drain connection where required and route to suitable termination point.
   2. Insulated with Electric Heat Source:
      a. Install in accordance with manufacturer's recommendations.
      b. Anchor enclosure to flat, concrete base.
      c. Concrete Base Height: 2 inches (50 mm).
      d. Connect drain connection where required and route to suitable termination point.
      e. Electric Connections: See Section 260583.

3.06 SERVICE CONNECTIONS

A. Provide water service to utility company requirements with reduced pressure backflow preventer and water meter with bypass valves and sand strainer.

B. Provide sleeve in retaining wall for service main. Support with reinforced concrete bridge. Calk enlarged sleeve watertight.

C. Anchor service main to interior surface of foundation wall.

D. Provide 18 gauge, 1/20 inch (1.30 mm) galvanized sheet metal sleeve surrounding service main to 6 inches (150 mm) above floor and 6 feet (1,800 mm) minimum below grade. Size for 2 inches (50 mm) minimum of glass fiber insulation stuffing.

3.07 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Perform field inspection and testing in accordance with Section 014000.

C. Pressure test water piping to ____ pounds per square inch (____ kPa).

D. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

END OF SECTION 331416

SECTION 333113
SITE SANITARY SEWERAGE GRAVITY PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sanitary sewerage drainage piping, fittings, and accessories.

B. Connection of building sanitary drainage system to municipal sewers.

C. Cleanout access.

1.02 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete for cleanout base pad construction.

B. Section 312316 - Excavation: Excavating of trenches.

C. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

D. Section 312323 - Fill: Bedding and backfilling.

E. Section 330561 - Concrete Manholes.

F. Section 330569 - Concrete Trenchways: For routing of sewage utilities.

1.03 PRICE AND PAYMENT PROCEDURES

A. See Section 012200 - Unit Prices, for additional unit price requirements.

B. Pipe and Fittings:
   1. Basis of Measurement: By the linear foot (meter).
   2. Basis of Payment: Includes hand trimming excavation, bedding, pipe and fittings, connection to building service piping and to municipal sewer.

C. Cleanout:
   1. Basis of Measurement: By the unit
   2. Basis of Payment: Includes hand trimming excavating, foundation pad, unit installation with accessories, connection to sewer piping.

1.04 DEFINITIONS

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.05 REFERENCE STANDARDS

A. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2021.

B. ASTM A746 - Standard Specification for Ductile Iron Gravity Sewer Pipe; 2018 (Reapproved 2022).

C. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.

D. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2020.

E. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping; 2020.

F. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2021.

G. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2023.

H. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials; 2021.

I. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2023.

1.06 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the installation of sewer with size, location and installation of service utilities.

B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

C. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.07 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data indicating pipe, pipe accessories,

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

D. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.

E. Field Quality Control Submittals: Document results of field quality control testing.

F. Project Record Documents:
1. Record location of pipe runs, connections, manholes, cleanouts, and invert elevations.
2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.01 SEWER PIPE MATERIALS

A. Provide products that comply with applicable code(s). Jordan Basin Sewer Improvement District

2.02 PIPE ACCESSORIES

A. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Sewer Service" in large letters.

2.03 CLEANOUT MANHOLE

A. Lid and Frame: Cast iron construction.

B. Shaft Construction and Concentric Cone Top Section: Reinforced precast Concrete pipe sections, lipped male/female dry joints, cast steel ladder rungs into shaft sections at 12 inches (300 mm); nominal shaft diameter of 48 inches (900 mm).

C. Base Pad: Cast-in-place concrete of type specified in Section 033000, levelled top surface to receive concrete shaft sections, sleeved to receive sanitary sewer pipe sections.

2.04 BEDDING AND COVER MATERIALS

A. Pipe Bedding Material: As specified in Section 312323.

B. Pipe Cover Material: As specified in Section 312323.

PART 3 EXECUTION

3.01 GENERAL

A. Perform work in accordance with applicable code(s).

3.02 TRENCHING

A. See Section 312316.13 for additional requirements.

B. Hand trim excavation for accurate placement of pipe to elevations indicated.

C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.03 INSTALLATION - PIPE

A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.

B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.

1. Plastic Pipe: Also comply with ASTM D2321.

C. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).

D. Connect to building sanitary sewer outlet and municipal sewer system, through installed sleeves.

E. Install trace wire 6 inches (150 mm) above top of pipe; coordinate with Section 312316.13.

3.04 INSTALLATION - CLEANOUTS

A. Form bottom of excavation clean and smooth to correct elevation.

B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.

C. Establish elevations and pipe inverts for inlets and outlets as indicated.

D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

3.05 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 014000.

B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

C. Pressure Test: Test in accordance with Jordan Basin Improvement District.

D. Infiltration Test: Test in accordance with Jordan Basin Improvement District

E. Deflection Test: Test in accordance with Jordan Basin Improvement District

3.06 PROTECTION

A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION 333113

SECTION 334211
STORMWATER GRAVITY PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Stormwater drainage piping.

B. Stormwater pipe accessories.

1.02 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete for cleanout base pad construction.

B. Section 312316 - Excavation: Excavating of trenches.

C. Section 312316.13 - Trenching: Excavating, bedding, and backfilling.

D. Section 312323 - Fill: Bedding and backfilling.

E. Section 330561 - Concrete Manholes.

F. Section 334230 - Stormwater Drains.

G. Section 334600 - Stormwater Management.

1.03 PRICE AND PAYMENT PROCEDURES

A. See Section 012200 - Unit Prices, for additional unit price requirements.

B. Pipe and Fittings:
   1. Basis of Measurement: By the linear foot (meter).
   2. Basis of Payment: Includes hand trimming excavation, bedding and backfilling, pipe and fittings, connection to building service piping and to municipal system.

1.04 REFERENCE STANDARDS

A. AASHTO M 252 - Standard Specification for Corrugated Polyethylene Pipe, 75- to 250-mm (3- to 10-in.) Diameter; 2024.

B. AASHTO M 294 - Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter; 2021.

C. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.

D. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2021.

E. ASTM C14 - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe; 2020.

F. ASTM C14M - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe (Metric); 2020.

G. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe; 2022a.

H. ASTM C76M - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric); 2022a.

I. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets; 2021.

J. ASTM C443M - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric); 2021.

K. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2020a.

L. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.

M. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2020.

N. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping; 2020.

O. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2021.

P. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2023.

Q. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials; 2021.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the installation of stormwater gravity piping with size, location and installation of stormwater drains according to Section 334230.

B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

C. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.06 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data indicating pipe, pipe accessories, and _____.

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

D. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.

E. Field Quality Control Submittals: Document results of field quality control testing.

F. Project Record Documents:
   1. Record location of pipe runs, connections, and invert elevations.
   2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.01 STORMWATER PIPE MATERIALS

A. Provide products that comply with applicable code(s).

B. Concrete Pipe: Reinforced, ASTM C76 (ASTM C76M), Class II with Wall type A; mesh reinforcement; inside nominal diameter of ____ inches (____ mm), bell and spigot end joints.

C. Reinforced Concrete Pipe Joint Device: ASTM C443 (ASTM C443M) rubber compression gasket joint.

D. Plastic Pipe: ASTM D3350, High Density Polyethylene (HDPE) corrugated wall pipe with integrally formed smooth liner; inside nominal diameter of _____ inch (_____ mm), meeting the requirements of AASHTO M 252, Type S, for diameters between 3 inches (75 mm) and 10 inches (250 mm) and AASHTO M 294, Type S, for diameters between 12 inches (300 mm) and 60 inches (1500 mm), soil-tight, bell and spigot joints with rubber gaskets, with pipe and fittings manufactured from virgin PE compounds with cell classification 3254420C.

E. Corrugated Steel Pipe: AASHTO M 36 Type I; nominal diameter of ____ inches (____ mm), _____ end joints; helical lock seam; coated inside and out with 0.050 inch (1.3 mm) thick bituminous coating.

2.02 PIPE ACCESSORIES

A. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

B. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Stormwater Service" in large letters.

2.03 BEDDING AND COVER MATERIALS

A. Bedding: As specified in Section 312316.13.

B. Cover: As specified in Section 312316.13.

PART 3 EXECUTION

3.01 TRENCHING

A. See Section 312316 - Excavation and Section 312323 - Fill for additional requirements.

B. Hand trim excavation for accurate placement of pipe to elevations indicated.

C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.02 INSTALLATION

A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.

B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.

C. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).

D. Connect to building storm drainage system, foundation drainage system, and utility/municipal system.

E. Make connections through walls through sleeved openings, where provided.

F. Install continuous trace wire 6 inches (150 mm) above top of pipe; coordinate with Section 312316.13.

3.03 FIELD QUALITY CONTROL

A. Perform field inspection in accordance with Section 014000 - Quality Requirements.

B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

3.04 PROTECTION

A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION 334211