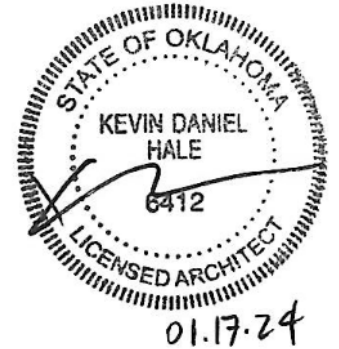


**PROJECT MANUAL
FOR
KIOWA TRIBE
KIOWA CASINO
Highway 183
Hobart, Oklahoma 73651**



OWNER: KIOWA CASINO

GENERAL CONTRACTOR: D2C; Direct 2 Completion

LEAD ARCHITECT: **MASS ARCHITECTS**
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ARCHITECT: **1ARCHITECTURE, LLC**
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PROJECT NO.: 2109-031

DATE: 17 January 2024 – Issue 01: Re-Bid Construction Set

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SECTION 003100
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1.1 EXISTING CONDITIONS

- A. Geotechnical Report: See attached report provided by METCO.
1. This report identifies properties of below grade conditions and offers recommendations for the design of foundations, prepared primarily for the use of Architect.
 2. The recommendations described shall not be construed as a requirement of this Contract, unless specifically referenced in the Contract Documents.
 3. This report, by its nature, cannot reveal all conditions that exist on the site. Should subsurface conditions be found to vary substantially from this report, changes in the design and construction of foundations will be made, with resulting credits or expenditures to the Contract Price accruing to Owner.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION



MIDWEST ENGINEERING & TESTING CORPORATION

GEOTECHNICAL ENGINEERING SERVICES REPORT

For the

**PROPOSED SINGLE-STORY CASINO
HWY 183 AND HWY 9
HOBART, OKLAHOMA**

**Prepared for
AUGUSTA CONTRACTING
2701 HANDI DRIVE
OKLAHOMA CITY, OKLAHOMA 73129**

**Prepared by
MIDWEST ENGINEERING AND TESTING CORPORATION
2025 S. NICKLAS, SUITE 115
OKLAHOMA CITY, OKLAHOMA 73128**

405-681-6737

METCO PROJECT NO: OGR-22028

FEBRUARY 2022



MIDWEST ENGINEERING AND TESTING CORPORATION

February 18, 2022

Augusta Contracting
2701 Handi Drive
Oklahoma City, Oklahoma 73129
Phone: 405-708-1999

Attention: Mr. Jason Unsell, Lead Superintendent

**Subject: Geotechnical Engineering Services Report
Proposed Single-Story Casino
HWY 183 and HWY 9
Hobart, Oklahoma
METCO Project No: OGR-22028**

Dear Mr. Unsell:

Midwest Engineering and Testing Corporation (METCO) is pleased to submit this Geotechnical Engineering Services Report for the above-referenced project. The purpose of our services was to assist the design team in designing foundations and general pavement systems and preparing plans and specifications for construction of the proposed project. Our services were completed in general accordance with the scope of work as outlined in METCO proposal number OGP-21202 dated October 26, 2021. Written authorization was provided Mr. Jason Unsell, Lead Superintendent, of Augusta Contracting on November 3, 2021. A summary report along with our formal detailed geotechnical engineering services report is enclosed for your review. **The entire report should be read in its entirety prior to utilizing any of the presented information for design or construction purposes.**

Executive Summary

A total of 10 soil borings were drilled using truck-mounted solid-stem type drilling equipment. As per the scope of work requested by Augusta Contracting, the borings were drilled within the general vicinity of the proposed new construction areas. These borings were drilled to approximate depths of 6.5 feet to 21.0 feet below existing grade. Location and depth of the borings were selected by Augusta Contracting. Locations of the proposed new construction as well as the soil borings are shown on the Boring Location Plan. Logs of the borings are presented in the Appendix.

Indications of possible fill soils were not encountered in the borings. **However, fill soils may exist to various depths at other site locations.** Below existing grade, the borings generally encountered soils consisting of clay to approximate depths of 6.5 feet to 11.0 feet below existing grade. Standard penetration resistances (N-values) recorded in the soils ranged from 10 to 48 blows per foot (bpf) of penetration indicating stiff to hard consistencies in the cohesive soils. Below the upper soils and extending to boring termination depths of approximately 20.0 feet to 21.0 feet below existing grade, the deeper building borings, encountered soft to moderately hard weathered to un-weathered shale.

Based on laboratory testing, the subsurface tested soils are susceptible to moderate to high swell potential.

Groundwater was encountered in the deeper building borings, at approximate depths of 12.0 feet to 18.0 feet below existing grade, at the time of drilling and end of day. The remaining shallow borings were dry at the time of drilling and end of day. **However, it is possible that transient saturated ground conditions could develop at shallower depths at a later time due to periods of heavy precipitation, landscape watering, leaking water lines or other unforeseen causes.**

It is strongly recommended that the contractor determine the actual groundwater levels prior to construction.

Groundwater and/or seepage water, if encountered at shallow depths, can significantly impact the construction.

Summary of Recommendations

In general, we recommend that all structural improvement areas be drained of any surface water, and stripped of topsoil materials. Further, if any of the following features are encountered, we recommend they be removed: existing underground and/or overhead utilities, **soft soils**, any concrete, gravel, asphalt, old foundations, old underground storage, basements, burn pits and any other deleterious materials encountered at the time of construction. In keeping with local practice, we have presented foundation and site drainage recommendations, which are intended to reduce (but not eliminate) the potential for differential movement related to the swell/collapse of the upper soils. Following the removal of all unsuitable onsite debris and vegetation and excavation to the proposed subgrade level, the construction area should be proof-rolled with a tandem axle dump truck or similar rubber-tired vehicle. Soils which are observed to rut or deflect excessively under the moving load should be undercut; moisture conditioned and re-compacted in place or replaced with properly compacted fill. **Over excavation of such soils could extend to several feet below the exposed subgrade level.** The proof-rolling and undercutting activities should be witnessed by a representative of the geotechnical engineer and should be performed during a period of dry weather. **After proof-rolling is completed and any soft areas or areas exhibiting rutting or pumping are properly corrected,** the subgrade soils should be scarified and compacted, at the optimum moisture content to +3 percent of the optimum moisture content, to at least 95 percent of the standard Proctor maximum dry density ASTM D 698 for a depth of at least 8-inches below the exposed surface. Fill soils should be placed in 8-inch loose lifts and compacted to at least 95% of maximum dry density as determined by ASTM Designation D 698 at -1 percent of optimum moisture content to +3 percent of the optimum moisture content.

Based on the results obtained from our exploration and analysis, the proposed building can be supported on a drilled pier and grade beam foundation system can be used for support of the column loads and wall loads, respectively. The base of the drilled piers should bear a minimum of 3.0 feet or one pier diameter, **whichever is deeper**, into the rock strata. The rock strata were encountered in the deeper building borings, at approximate depths of 10.5 feet to 11.0 feet below existing grade. However, **the rock strata depths may significantly vary across the site.** The drilled piers can be designed for a maximum allowable end bearing pressure of 12,000 psf, based on dead plus design live loads. An allowable skin friction of 1,200 psf can be utilized for that portion of the pier extending more than 3 feet or one pier diameter, whichever is deeper, into the rock strata. **The bearing strata depths should be verified prior to construction. Difficulties might be encountered during drilling due to the nature of the**

subsurface formation. Additional drilling should be performed prior to final design and construction. The drilled piers should be at least 3 pier diameters deep and should be spaced at 3 pier diameter, center to center.

The foundation excavations should be observed and tested by METCO representatives. A field observation and testing letter report should be issued and reviewed by the architect, owner and/or contractor.

The weathering process of shale is erratic and variations in the shale profiles can be expected in small lateral distances.

It should be noted that TCP results in the borings ranged from 2.3 inches for 100 blows to 10.5 inches for 100 blows. **All contractors should review the boring logs and make their own conclusions in regards to the rippability of the rock formations.**

The piers should be reinforced for their full depth with reinforcing steel. Reinforcement quantity should be adequate to resist tensile uplift forces generated by the soils based on soil adhesion of 900 psf over the upper 10 feet of the pier shaft. Soft or loose soil encountered at the bearing level should be removed. All loosened soils should also be removed. If personnel entry into the shaft is required, a 30-inch minimum diameter is recommended.

A slump of 5 to 7 inches is desired to reduce the potential for forming of voids as the casing is extracted and groundwater related problems. Foundation excavations should be filled with concrete as soon as possible to reduce the potential of groundwater related problems. **To reduce difficulties associated with sloughing and/or groundwater related problems and to facilitate observation, the use of temporary may be required.**

Grade beams can be supported on a minimum of 8-inch void space between the bottom of the beams and the underlying soils. Cardboard forms can be used to provide the required void space. Care must be taken to maintain the integrity of the cardboard boxes up to the time the concrete is placed. Wet, damaged, or poorly constructed void boxes may collapse under the weight of the concrete.

As an alternate foundation system, the proposed building can be supported on conventional shallow spread footings **founded on a minimum of 3.0 feet of properly compacted and tested engineered fill.** Shallow spread footings for building columns and continuous footings for bearing walls should be designed for a total allowable soil bearing pressure of 2,000 and 1,600 pounds per square foot, respectively at a minimum depth of 24 inches below final grade. **A gravel base may be required depending on the actual soil conditions at the time of construction. Proper observation of the footing excavations by METCO representatives is essential for the performance of the structure. Once the final design and grading plans are complete, METCO should be contracted for additional analysis.**

The foundation excavations should be observed and tested (DCP and field density) by METCO representatives. A field observation and testing letter report should be issued and reviewed by the architect, owner and/or contractor.

The floor slabs can be grade **supported on a minimum of 3.5 feet** of properly compacted and tested, non-expansive structural fill materials. Proof rolling, as discussed in this report, should be accomplished to identify any soft or unstable soils, which should be removed from the floor slab

area prior to new fill placement and/or floor slab construction. **Any existing undocumented and properly tested fill should be removed prior to fill placement and/or floor slab construction.**

It is recommended that free draining granular mat be placed beneath the floor slab to enhance drainage and provide increased subgrade strength. Polyethylene sheeting should be placed on the granular mat to act as a vapor barrier. The floor slabs should have an adequate number of joints to reduce cracking resulting from any differential movement and shrinkage. The floor slab should not be rigidly connected to columns, walls, or foundations, if possible. **Detailed floor slab recommendations are presented in section 5.5 of this report.**

Although fill material was not observed in the borings, it is possible that fill material may exist to various depths at other site locations within the proposed construction areas. **Typically, we do not recommend relying on fill placed without technical observation for building support. Any existing fill should be removed in its entirety and be replaced with properly compacted low plasticity structural fill.**

It is anticipated that properly compacted structural fill material will settle approximately 1 to 2 percent of the fill height. The higher the clay content, the longer it will take the fill to settle.

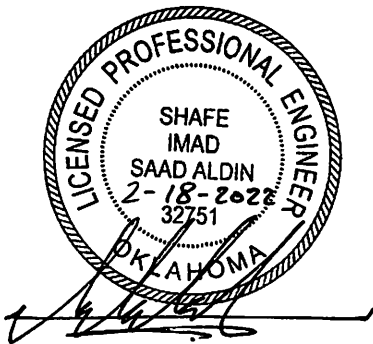
The scope of services did not include an environmental site assessment for determining the presence or absence of toxic or hazardous materials in the soil, surface water, groundwater, or air on, below, or around the site. Any statements regarding colors, odors, suspicious, or unusual items are strictly for informational purposes. Prior to further development of this site, an environmental assessment is advisable.

General

The attached entire report should be read and the contents evaluated prior to utilizing our recommendations in the preparation of the design and construction documents. Please refer to the attached report for a more detailed summary of our analysis and recommendations. It is recommended that METCO be retained to provide observation and testing services during construction. Please do not hesitate to contact our office at 405-681-6737.

Respectfully Submitted,

Midwest Engineering and Testing Corporation
CA No. 4198, Expires 06/30/2023



Shafe Saad Aldin, P.E.
Staff Engineer

Nasir Marakah, P.E.
President

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Figures: Site Location Map, Plan of Borings

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**Geotechnical Engineering Services Report
Proposed Single-Story Casino
HWY 183 and HWY 9
Hobart, Oklahoma
METCO Project No: OGR-22028
February 2022**

1.0 Introduction

Midwest Engineering and Testing Corporation (METCO) has completed a geotechnical exploration and evaluation of the subsurface conditions for the above-referenced project site in general accordance with the scope of work as outlined in METCO proposal number OGP-21202 dated October 26, 2021. Written authorization was provided Mr. Jason Unsell, Lead Superintendent, of Augusta Contracting on November 3, 2021.

2.0 Project Description

Based on project information provided, we understand the proposed construction will consist of the following:

Building	New Single-Story Building Without a Basement Ground Supported Floor Slabs Less than 50-kip Column Loads Less than 3.0 KLF Continuous Loads
Grading	Less Than 2 Feet of Cut/ Fill, Each
Pavement	Asphaltic Concrete and/or Rigid Pavement

Once the final grading plans are available, METCO should be contracted for additional analysis. Modifications to the presented recommendations may be warranted and should be expected based on the final grading plans. Ground elevations at the boring locations should be determined by others prior to any grading activities.

Crushed stone should be used to backfill any deep areas to approximately 5.0 feet below final grade. However, if some settlements can be tolerated, material such as GW, GM, SW, SM (modified) and SC with a plasticity index (PI) of 9 or less should be used to backfill any deep fill areas to approximately 5.0 feet below final grade. Select fill should be placed in loose 6-inch lifts and should be compacted, at 1 percent below optimum to 3 percent above the optimum moisture content, to 98 percent of the modified Proctor maximum dry density ASTM D1557. Any placed fill should be monitored prior to and during construction.

It should be noted that these stricter requirements only apply to deep fill areas (over 5 feet, whether it is undercutting and replacing or raising the grade).

Due to adverse effect on structures, it is recommended that water not be allowed to collect in the foundation excavation or on prepared subgrade of the construction areas either during or after construction. Excessive settlement could result if water is allowed to collect in foundation excavations or on prepared subgrade of the construction areas.

If the groundwater levels are expected to be near the expected excavation levels in the proposed construction areas, dewatering prior to and after construction will be required. The design engineer should consider the effects of groundwater. A comprehensive drainage system should be designed to prevent the damages to the proposed structures, if deemed necessary by the design engineer.

The location of the site is shown on the Site location Map.

3.0 Scope of Work

The purpose of this exploration and evaluation was to assess the subsurface soil conditions at the project site, at the boring locations, in order to help in the evaluation of acceptable foundation and general pavement systems for the proposed project.

Our scope of services included the items presented in the following sections.

3.1 Subsurface Exploration

A total of 10 soil borings were drilled using truck-mounted solid-stem type drilling equipment. As per the scope of work requested by Augusta Contracting, the borings were drilled within the general vicinity of the proposed new construction areas. These borings were drilled to approximate depths of 6.5 feet to 21.0 feet below existing grade. Location and depth of the borings were selected by Augusta Contracting. Locations of the proposed new construction as well as the soil borings are shown on the Boring Location Plan. Logs of the borings are presented in the Appendix.

Soil samples were taken at regular intervals during the drilling process. Samples were identified in the field, placed in sealed plastic bags, and transported to the laboratory for further classification and testing.

When the split spoon sampler was used, Standard Penetration Tests (SPT's) were performed at regular intervals in general accordance with ASTM Designation D1586, samples collected, and results presented on the boring logs. The SPT used in soil borings is performed by driving a 2-inch, O.D., split-spoon sampler into the undisturbed formation located at the bottom of the advanced auger with repeated blows of a 140-pound, pin-guided, automatic hammer falling a vertical distance of 30 inches. The number of blows required to drive the sampler one foot is a measure of the soil consistency.

When the Texas Cone Penetration test was used to evaluate the bedrock, the cone was driven into the bedrock material with a 140-pound automatic hammer that falls 30 inches. After the cone was seated, the distance the TCP is driven was recorded after each of two sequences of 50 blow counts.

3.2 Laboratory Evaluation

Selected samples of the subsurface soils were tested in the laboratory to determine materials properties for further evaluation and approximate unified soil classifications were determined by visual inspection. The laboratory evaluation consisted of visual and textural examinations, moisture content, Atterberg limit tests and percent passing the No. 200 sieve. Results of the

tests are shown on the attached logs of borings and in the appendix. Additionally, pH and soluble sulfates tests were performed on representative samples.

3.3 Engineering Analysis

Engineering analysis and recommendations regarding general foundation design including allowable soil bearing pressures, minimum depth requirements, and estimates of foundation settlement are included in this report. In addition, recommendations were developed addressing site preparation, placement and compaction of fill materials, and site preparation of the floor slab areas.

This geotechnical engineering report presents recommendations derived from existing and available information pertaining to the proposed project; relevant laboratory data, information, and test results; subsurface materials encountered in our borings, and the proposed new construction location. The attached entire report should be read and the contents evaluated so that to facilitate any changes that may be desired. If any changes or corrections are desired, please inform METCO in writing so that we may amend the presented recommendations.

METCO cannot be responsible for the interpretation or implementation of this report by others. METCO should be retained to provide observation and testing during construction. Foundations, earthwork, and all other construction related activities should be observed by METCO. METCO will not accept any responsibility for the performance of the subgrade, foundations, any structure or pavement for this project nor will it accept any responsibility for any conditions which deviated from those described in this report.

4.0 Surface and Subsurface Features

4.1 Site Description

The subject property is located on the west side of HWY 183, approximately 0.3 mile north of the intersection of HWY 183 and HWY 9 in Hobart, Oklahoma. The proposed construction area was stripped of vegetation and visually appeared to be relatively level. Utilities and buildings exist in the general vicinity of the proposed construction area. The surface conditions were relatively dry and our truck-mounted drill rig experienced no difficulty in moving around the site.

4.2 Soil Subsurface Conditions

Indications of possible fill soils were not encountered in the borings. **However, fill soils may exist to various depths at other site locations.** Below existing grade, the borings generally encountered soils consisting of clay to approximate depths of 6.5 feet to 11.0 feet below existing grade. Standard penetration resistances (N-values) recorded in the soils ranged from 10 to 48 blows per foot (bpf) of penetration indicating stiff to hard consistencies in the cohesive soils. Below the upper soils and extending to boring termination depths of approximately 20.0 feet to 21.0 feet below existing grade, the deeper building borings, encountered soft to moderately hard weathered to un-weathered shale.

Laboratory tests indicated that the site soils had plasticity indices ranging from 14 to 36 and grain size distribution tests show that the tested soils contain about 94 to 99 percent fines (that

material passing a No. 200 mesh sieve). The encountered soils were classified as CL and CH in accordance with the Unified Soil Classification System.

The pH of the tested soil ranged from 7.2 to 7.6. This limited pH testing should not be interpreted as a comprehensive assessment of the site, but only provides an indication of the tested locations. Results of these tests are presented in the table below.

Soluble sulfate of the tested soil ranged from less than 200 ppm to 3120 ppm. This limited total soluble sulfate testing should not be interpreted as a comprehensive assessment of the site, but only provides an indication of the tested locations. Results of these tests are presented in the table below:

Sample No.	Sample Depth (feet)	pH	Sulfate Concentration (ppm)
B-6	Composite @ 1.0	7.4	<200
B-7	Composite @ 3.0	7.5	200
B-8	Composite @ 5.0	7.6	<200
B-9	Composite @ 1.0	7.2	3120
B-10	Composite @ 3.0	7.6	800

If sulfate rich soils are combined with calcium-based materials, such as cement, lime, fly ash or cement kiln dust, the soils can expand significantly when exposed to moisture.

Based on the results of our laboratory-tests and our experience with other sites in the general vicinity, the on-site tested soils are susceptible to moderate to high swell potential. In keeping with local practice, we have presented foundation and site drainage recommendations, which are intended to reduce (but not eliminate) the potential for differential movement related to the collapse/swell of the upper soils.

Although fill material was not observed in the borings, it is possible that fill material may exist to various depths at other site locations within the proposed construction areas. **Typically, we do not recommend relying on fill placed without technical observation for building support. Any existing undocumented and properly tested fill should be removed in its entirety and be replaced with properly compacted low plasticity structural fill.**

It is anticipated that properly compacted structural fill material will settle approximately 1 to 2 percent of the fill height. The higher the clay content, the longer it will take the fill to settle.

The above description of the subsurface conditions constitutes a generalization that emphasizes the subsurface stratification features and characteristics. The data and information at the specific boring locations are recorded in the boring logs. These logs present a description of subsurface soil and rock, applicable laboratory and field test results, sample location and general stratification. Variations in the stratification presented in the boring logs should be expected across the site and between boring locations as the presented strata description is only indicative of the boring locations.

4.3 Groundwater

Groundwater was encountered in the deeper building borings, at approximate depths of 12.0 feet to 18.0 feet below existing grade, at the time of drilling and end of day. The remaining shallow borings were dry at the time of drilling and end of day. **However, it is possible that transient saturated ground conditions could develop at shallower depths at a later time due to periods of heavy precipitation, landscape watering, leaking water lines or other unforeseen causes.**

It is strongly recommended that the contractor determine the actual groundwater levels prior to construction.

Groundwater and/or seepage water, if encountered at shallow depths, can significantly impact the construction.

4.4 Seismic Considerations

IBC Seismic Zone Coefficients

Earthquake related design parameters may be obtained from the International Building Code 2015 Edition, using **a Site Class C Definition.**

If site-specific earthquake response spectra or other specific design parameters are deemed necessary by the project structural engineer, or are required by the local governmental agency who has jurisdiction over the project, the geotechnical engineer should be promptly informed so that the appropriate analysis can be performed. In addition, design of structures should comply with the requirements of the governing jurisdiction's building codes and standard practices of Oklahoma.

5.0 Evaluation and Recommendations

Based on the results of our fieldwork, laboratory evaluation, and engineering analysis, the proposed building can be supported on a drilled pier foundation system bearing a minimum of 3.0 feet or one pier diameter, whichever is deeper, in the rock strata.

As an alternate foundation system, the proposed building can be supported on shallow spread footings **founded on a minimum of 3.0 feet of properly compacted and tested engineered fill** at a minimum depth of 2.0 feet below final grade.

Other types of foundation systems can be evaluated, if desired.

Once the final grading plans are available, METCO should be contracted for additional analysis. Modifications to the presented recommendations may be warranted and should be expected based on the final grading plans. Ground elevations at the boring locations should be determined by others prior to any grading activities.

Crushed stone should be used to backfill any deep areas to approximately 5.0 feet below final grade. However, if some settlements can be tolerated, material such as GW, GM, SW, SM (modified) and SC with a plasticity index (PI) of 9 or less should be used to backfill any deep fill areas to approximately 5.0 feet below final grade. Select fill should

be placed in loose 6-inch lifts and should be compacted, at 1 percent below optimum to 3 percent above the optimum moisture content, to 98 percent of the modified Proctor maximum dry density ASTM D1557. Any placed fill should be monitored prior to and during construction.

It should be noted that these stricter requirements only apply to deep fill areas (over 5 feet, whether it is undercutting and replacing or raising the grade).

Due to adverse effect on structures, it is recommended that water not be allowed to collect in the foundation excavation or on prepared subgrade of the construction areas either during or after construction. Excessive settlement could result if water is allowed to collect in foundation excavations or on prepared subgrade of the construction areas.

If the groundwater levels are expected to be near the expected excavation levels in the proposed construction areas, dewatering prior to and after construction will be required. The design engineer should consider the effects of groundwater. A comprehensive drainage system should be designed to prevent the damages to the proposed structures, if deemed necessary by the design engineer.

Generally, similar structures as that proposed are designed for post-construction vertical slab movements of less than 1 inch. Consideration must be given to the presence of plastic clays within the proposed construction areas. These soils may exhibit significant volumetric changes with changes in their moisture content. We estimate the potential vertical rise (PVR) to be on the order of 2.8 inches. These movements are based on the worst-case dry soil conditions. It was estimated that the **PVR for a floor slab supported on a minimum of 3.5 feet of low plasticity structural fill to be on the order of less than 1 inch.**

5.1 Site Preparation

Typically, it is recommended that prior to general site grading, **all topsoil, any soft soils**, any existing undocumented fill, if any, old foundations any concrete, any gravel, if any, any asphalt, organic material, any old underground storage tanks, if any, any underground utilities and/or overhead utilities, if any, and any other deleterious materials encountered at the time of construction **and soft soils** should be stripped from the proposed construction area. The depth of required removal should be evaluated by a representative of the geotechnical engineer at the time of construction. The resulting excavations should be widened, as necessary, to allow access to compaction equipment.

The site was stripped of vegetation and graded prior to our field activities.

Once the proposed subgrade level has been exposed, the construction area should be proof-rolled during a period of dry weather. **A representative of the geotechnical engineer should observe the exposed subgrade for soils that rut or deflect under the moving load.** Such soils should be recompacted or replaced with properly compacted fill. **Over excavation of such soils could extend to several feet below the exposed subgrade level. Stabilization of the subgrade soils and/or a gravel base may be required depending on the actual soil conditions at the time of construction. After proof-rolling is completed and any soft areas or areas exhibiting rutting or pumping are properly corrected,** the top 8 inches of the exposed subgrade should be scarified; moisture conditioned, if necessary, and compacted, **at**

the optimum moisture content to +3 percent of optimum moisture content, to 95 percent of the standard Proctor maximum dry density ASTM D698.

Any fill should have a liquid limit of 35 or less and a plasticity index of 5 to 15, be 3 inches or less in particle size, and should be free of organic or any deleterious materials. Fill should be placed in loose 8-inch lifts and should be compacted at **1 percent below optimum to 3 percent above the optimum moisture content**. The first layer of fill material should be placed in a relatively uniform horizontal lift and be keyed into the prepared subgrade soils.

Based on the laboratory test results, most of the on-site tested soils are not-suitable for use as structural fill. However, these soils should be tested in bulk at the time of construction. If a fine-grained clay soil is used for fill, close moisture content control will be required to achieve the recommended degree of compaction. If water is added, it should be uniformly applied and thoroughly mixed into the soil. Structural fill should be compacted to at least 95 percent of standard Proctor maximum dry density as determined by ASTM Designation D 698.

It is recommended that each compacted-engineered lift be tested by a representative of the geotechnical engineer prior to placement of subsequent lifts. It is also recommended that the compacted fill be extended 5 feet beyond the edges of the building.

5.2 Foundation Support

Based on the results obtained from our exploration and analysis, the proposed structure can be supported on a drilled pier and grade beam foundation system for support of the column loads and wall loads, respectively. The base of the drilled piers should bear a minimum of 3.0 feet or one pier diameter, **whichever is deeper**, into the rock strata. The rock strata were encountered in the deeper building borings, at approximate depths of 10.5 feet to 11.0 feet below existing grade. However, **the rock strata depths may significantly vary across the site**. The drilled piers can be designed for a maximum allowable end bearing pressure of 12,000 psf, based on dead plus design live loads. An allowable skin friction of 1,200 psf can be utilized for that portion of the pier extending more than 3 feet or one pier diameter, whichever is deeper, into the rock strata. **The bearing strata depths should be verified prior to construction. Difficulties might be encountered during drilling due to the nature of the subsurface formation. Additional drilling should be performed prior to final design and construction. The drilled piers should be at least 3 pier diameters deep and should be spaced at 3 pier diameter, center to center.**

The weathering process of shale is erratic and variations in the shale profiles can be expected in small lateral distances.

The foundation excavations should be observed and tested by METCO representatives. A field observation and testing letter report should be issued and reviewed by the architect, owner and/or contractor.

It should be noted that TCP results in the borings ranged from 2.3 inches for 100 blows to 10.5 inches for 100 blows. **All contractors should review the boring logs and make their own conclusions in regards to the rippability of the rock formations.**

The piers should be reinforced for their full depth with reinforcing steel. Reinforcement quantity should be adequate to resist tensile uplift forces generated by the soils based on soil adhesion of 900 psf over the upper 10 feet of the pier shaft.

Soft or loose soil encountered at the bearing level should be removed. All loosened soils should also be removed. If personnel entry into the shaft is required, a 30-inch minimum diameter is recommended.

Pier excavations should be observed by a representative of the geotechnical engineer to assess that the foundation soils have adequate strength to support the design loads and are consistent with the soil encountered in our borings. **To reduce difficulties associated with sloughing and/or groundwater related problems and to facilitate observation, the use of temporary casing may be required.**

A slump of 5 to 7 inches is desired to reduce the potential for forming of voids as the casing is extracted. Foundation excavations should be filled with concrete as soon as possible to reduce the potential of groundwater related problems.

Installation of a test pier during the design stage can be beneficial. The installation of a test pier can aid in the evaluation of potential difficulties that might occur during construction and in verifying the depth of the bearing formations and groundwater levels.

5.3 Grade Beams

Grade beams can be supported on a minimum of 8-inch void space between the bottom of the beams and the underlying soils. Cardboard forms can be used to provide the required void space. Care must be taken to maintain the integrity of the cardboard boxes up to the time the concrete is placed. Wet, damaged, or poorly constructed void boxes may collapse under the weight of the concrete. It is recommended that suitable rigid protection be installed along the outer and inner edges of the grade beams to prevent backfill material from collecting in the void space beneath the grade beams.

5.4 Alternate Foundation System

As an alternate foundation system, the proposed structure can be supported on conventional shallow foundation systems. Shallow spread footings for building columns and continuous footings for bearing walls should be designed for a total allowable soil bearing pressure of 2,000 and 1,600 pounds per square foot, respectively, **bearing on a minimum of 3.0 feet of properly compacted and tested engineered fill at a minimum depth of 24 inches below final grade. A gravel base may be required depending on the actual soil conditions at the time of construction.** To reduce the possibility of local bearing capacity failure, **minimum dimensions of 24 inches for column footings and 18 inches for continuous footings** should be used in foundation design. The footings should be provided with appropriate reinforcement as determined by the structural engineer. **Proper observation of the footing excavations by METCO representatives is essential for the performance of the structure. Once the final design and grading plans are complete, METCO should be contracted for additional analysis.**

The foundation excavations should be observed and tested (DCP and field density) by METCO representatives. A field observation and testing letter report should be issued and reviewed by the architect, owner and/or contractor.

A one third increase in bearing value can be used for wind and seismic load considerations. Since the recommended bearing value is a net value, the weight of the concrete in the footings may be assumed to be 50 pounds per square foot. The weight of the soil backfill may be neglected for downward load contribution.

A representative of METCO should observe the foundation excavations prior to steel or concrete placement to assess that the foundation materials are capable of supporting the design loads and are consistent with the materials discussed in this report. **Soft or loose soil zones encountered at the bottom of the footing, excavations should be removed to the level of stiff or dense soil as directed by the geotechnical engineer.** Cavities formed as a result of excavation of soft or loose soil zones should be backfilled with engineered fill, as determined by the geotechnical engineer. METCO should be contacted to evaluate moisture issues, if needed.

An ultimate coefficient of friction of 0.47 can be used between the base of footings and the floor slab and the supporting soils to resist lateral loads. In addition, lateral loads can be resisted by a uniform ultimate passive key resistance of 120 pounds per square foot, for keys embedded at least 2.0 feet below final grade. A one third increase in the passive value can be used for wind and seismic loads. The frictional resistance and the passive resistance of the soils can be combined without any reductions in determining the total lateral resistance.

We estimate that foundations designed and constructed in accordance with the above recommendations will experience total settlements generally less than 1-inch with differential settlements generally less than $\frac{3}{4}$ inches within the building area. **It should be noted that additional settlements of approximately 1 to 2 percent of placed fill height should be accounted for in the design.** Consolidation testing was beyond the scope of this exploration.

5.5 Floor Slab Recommendations

Floor slabs can be grade supported **on a minimum of 3.5 feet** of properly compacted and tested, non-expansive structural fill materials. **Floor slabs should be supported directly by 4.0 inches to 6.0 inches of Aggregate Base Course (ABC); over 38 inches to 36 inches of non-expansive soil meeting the requirements outlined above.** This material will act as a leveling base and aid in concrete curing. This material will not act as a positive moisture break to prevent moisture rise to the slab. If the floor covering is considered moisture sensitive, plastic sheeting should be placed over the base course.

Any fill that was placed without proper documentation and testing should be removed and replaced with properly compacted and tested engineered fill.

A modulus of subgrade reaction (k) of 100 pounds per cubic inch is recommended for floor slabs overlying the graded gravel base and a compacted subgrade. The floor slabs should have an adequate number of joints to reduce cracking resulting from possible differential movements. The floor slabs should not be rigidly connected to columns, walls, or foundations, if possible. **Floor slab design is not typically the area of expertise of the Geotechnical Engineer and should be verified by the Structural Engineer of Record.**

All construction activity may cause damage and deterioration to the prepared subgrade. We recommend our field representative observe the final subgrade prior to placement of the slab on grade and perform further testing as necessary.

5.6 Pavement Recommendations

We have assumed typical area soil parameters for pavement design. Our study did not include CBR testing or detailed pavement analysis for the subgrade soils or imported soils. A more detailed analysis of the subgrade and traffic conditions should be made in large areas of pavement, or where pavements are subject to significant traffic. The results of such analysis will provide the needed information for the design of an economical and serviceable pavement.

The pavement thicknesses presented in the table below are considered area typical and minimum for the assumed parameters. **Thinner pavement sections than those presented in the table might be warranted due to budgetary considerations.** However, Augusta Contracting and all parties involved should be aware that increased maintenance costs and lower pavement life might be expected with thinner pavement sections. The subgrade should be prepared as recommended in this report.

With an assumed CBR value of 3, a typical standard pavement section consisting of the following could be used:

<u>Asphalt Concrete Flexible Pavement Thickness (Inches)</u>		
Pavement Materials	Car Parking	Driveways
Asphaltic Surface Course	2"	2"
Asphaltic Binder Course	3"	5"
Crushed Stone Base	8"	8"
<u>Concrete Rigid Pavement Thickness (Inches)</u>		
Pavement Materials	Car Parking	Driveways, trash dumpsters area, areas of large loads from small steel wheels
Concrete Pavement	5"	7"
Crushed Stone Base	8"	8"

Providing the proper pavement type and thickness will result in better distribution of surface loads to the subgrade without causing deformation of the surface. Proper compaction, fine grading and proof-rolling should precede pavement placement. The work should be done in accordance with Oklahoma State Department of Transportation guidelines or other applicable guidelines.

The base stone should not get saturated and water should not be allowed to pond behind curbs. To allow water entering the base stone a path to exit, base stone should extend through the slope in down grade areas.

The pavement concrete should have a compressive strength of at least 3,500 psi with 3% to 6% air entrainment. This concrete should be saw-cut as directed by the design engineer. The pavement should be adequately reinforced with steel. As a minimum, the reinforcement steel should be No. 3 bars on a maximum spacing of 18 inches each way. The final pavement section should be designed by the Civil Engineer.

5.7 Stabilization

If sulfate rich soils are combined with calcium-based materials, such as cement, lime, fly ash or cement kiln dust, the soils can expand significantly when exposed to moisture.

Stabilization of the subgrade soils with calcium-based materials may not be appropriate for the intended purposes.

METCO did not perform any mix design and is not fully aware of the nature of the chemical reaction between the soil and the stabilizing agents. Preliminary sulfate test results are included in the table in the report. A detailed mix design should be performed in accordance with ASTM D4609 and OHD L-50 to ensure that the soil stabilizing agents are compatible.

Sulfate tests and other appropriate tests should be performed prior to the final selection of the stabilizing material.

5.8 Drainage Considerations

Due to adverse effect on structures, it is recommended that water not be allowed to collect in the foundation excavation or on prepared subgrade of the construction area either during or after construction. Excessive settlement could result if water is allowed to collect in foundation excavations or on prepared subgrade of the construction areas.

Undercut or excavated areas should be sloped toward one corner to facilitate removal of any collected rainwater, or positive run-off. The contractor should exercise care in creating drainage paths for water during the construction phase of the project. Curbing adjacent to landscaped areas should be designed deep enough to act as a barrier between the landscape irrigation and the subgrade soil. Surface run-off from roofs, parking areas, etc., should be discharged away from the structures. To reduce infiltration of surface water around the perimeter of the building and beneath the floor slabs, positive drainage should be provided. If groundwater issues are encountered during construction, METCO should be contacted.

5.9 Excavation and Temporary Slopes

The contractor, designated as "responsible person" in OSHA Construction Standards for Excavations, 29 CFR Part 1926, is solely responsible for planning and implementing all safety procedures. All excavation height, slope, and depth must adhere to all specifications outlined in local, state, and federal safety regulations.

METCO does not assume any responsibility for construction site safety or any party's, including the contractor, compliance with the applicable local, state, and federal safety regulations or any other applicable regulations.

5.10 Trench Backfill

All required trench backfill should be mechanically compacted in layers to at least 95% of the standard Proctor maximum dry density as determined by ASTM Designation D 698. Some settlement of the backfill may be expected and any utilities within the trenches or concrete walks supported on the trench backfill should be designed to accept these differential movements.

5.11 Weather Considerations

The upper soils encountered at this site may be sensitive to moisture variations and construction traffic disturbances during wet weather. The soil strength is significantly reduced when the soil is wet and significant delays in the grading and compaction activities can take place. Thus, it is recommended to perform construction activities during periods of dry weather.

5.12 Construction Monitoring

METCO should be retained to provide observations and testing of soil exposures created during project construction in order to verify that soil conditions are as anticipated and are as encountered in our borings. Construction activities pertaining to earthwork, foundations, and all other related activities should also be observed by METCO representatives. METCO cannot accept any responsibility for the performance of the subgrade, foundations, any structure or pavement for this project. Furthermore, METCO cannot accept any responsibility for conditions which deviated from those described in this report.

6.0 General

The conclusions and recommendations presented in this report are subject to the following general conditions:

6.1 Use of Report

This preliminary report has been prepared for the exclusive use of Augusta Contracting, for the specific application for the Proposed Single-Story Casino, HWY 183 and HWY 9 in Hobart, Oklahoma. This report should not be appropriate for other structures or purposes. We recommend that parties contemplating other structures or purposes contact us. Unless our written approval is provided, we make no representation and assume no responsibility to other parties regarding this report.

6.2 Level of Care

The recommendations contained in this report are based on the available subsurface information obtained by METCO, and design details furnished for the proposed project. If there are any revisions to the plans for this project, or if deviations from the subsurface conditions noted in this report are encountered during construction, METCO should be notified immediately to determine if changes in the foundation recommendations are required. If METCO is not retained to perform these functions, METCO will not be responsible for the impact of those conditions on the project.


Services performed by the geotechnical engineer for this project have been conducted with that level of care and skill ordinarily exercised by members of the profession currently practicing in this area. **No warranty, expressed or implied, is made.**

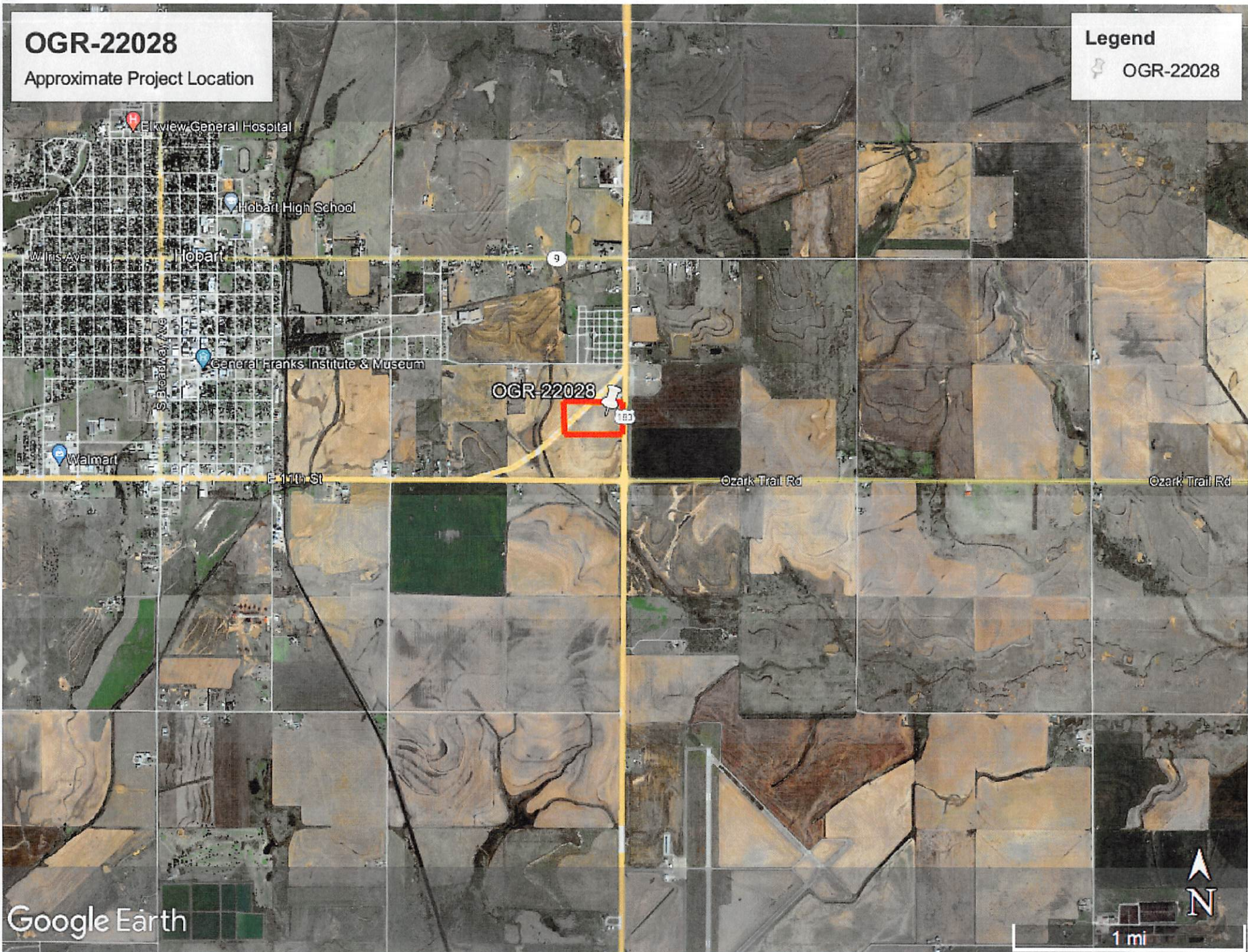
APPENDIX

OGR-22028

Approximate Project Location

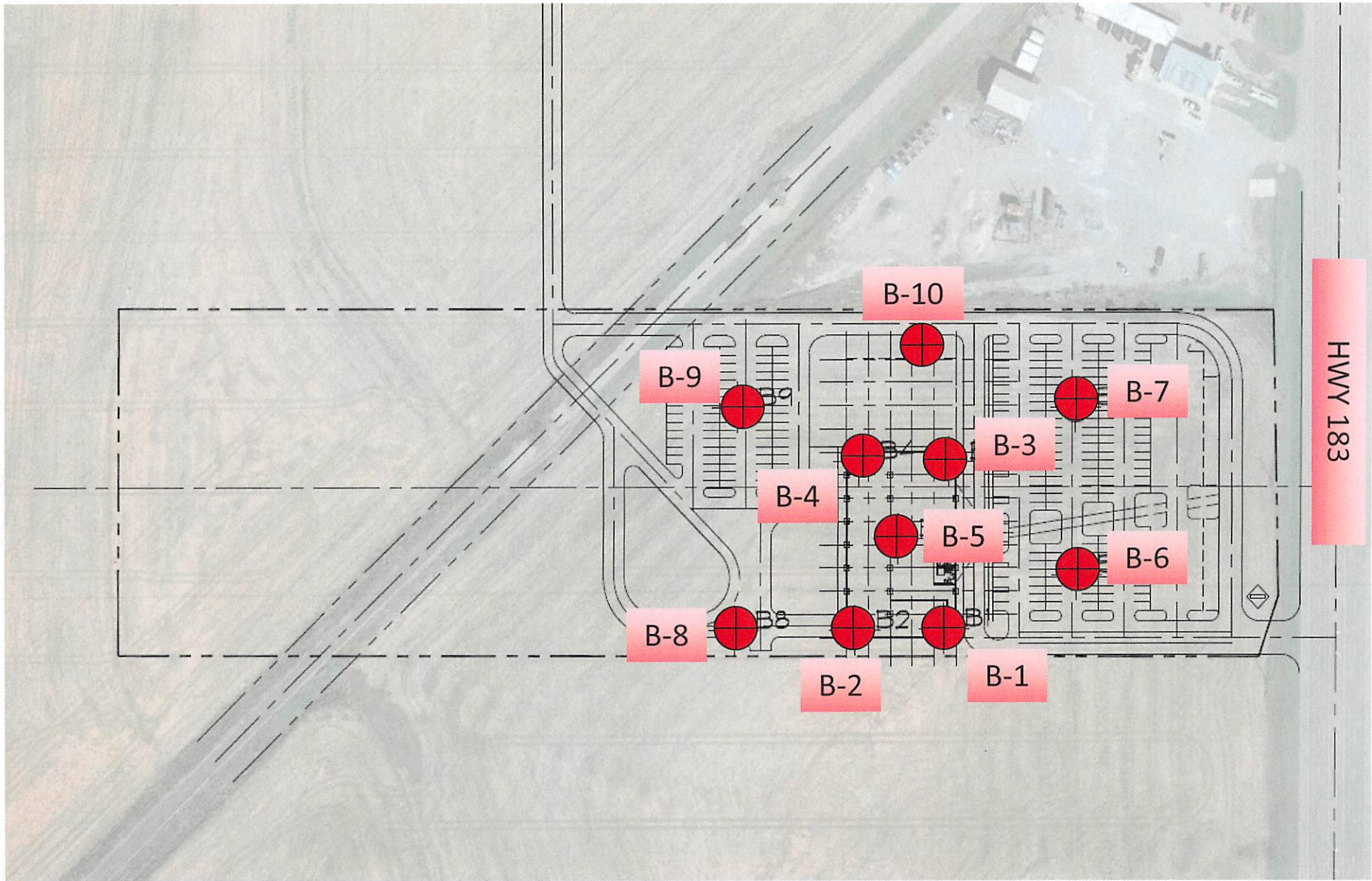
Legend

 OGR-22028



Google Earth

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PLAN OF BORINGS

**Proposed Single-Story Casino
 HWY 183 and HWY 9
 Hobart, Oklahoma**



Approximate Boring Location
 Not to Scale

METCO JOB#: OGR-22028

FIGURE 1

LOG OF BORING B-2

PROJECT: Proposed Single-Story Casino, HWY 183 and HWY 9, Hobart, Oklahoma Project No.: OGR-22028
 Date Drilled: 1/25/2022 Location: See Plan of Borings (Figure 1) Elevation: N/A
 Depth To Water At Completion: 14.0' Depth To Water On: End of Day Was: 14.0'
 Drilled By: Kalyn Logger: Stephen Approximate Completion Depth: 21.0'

DEPTH FEET	SYMBOL	SAMPLE TYPE	DESCRIPTION	MC %	LL	PL	PI	-#200 %	swell %	PP TSF
1	[Diagonal Hatching]	3/6"	Dark brown lean <u>Clay</u> with roots, stiff (CL)	20	49	20	29	98		
2		5/6"								
3		8/6"								
4	[Diagonal Hatching]	3/6"	Dark brown to reddish brown lean <u>Clay</u> with calcareous nodules, stiff to hard (CL)	22	49	21	28	97		
5		4/6"								
6		6/6"								
7		8/6"								
8		4/6"								
9		7/6"								
10		12/6"								
11		14/6"								
12		24/6"								
13		50/6"								
13	[Horizontal Hatching]	100/6.5"	Reddish brown <u>Shale</u> , soft to moderately hard TC @ 12.5' : 50/4.5", 50/2.0"	17	41	21	20	99		
16	[Horizontal Hatching]	100/4.0"	Reddish brown <u>Shale</u> , moderately hard to soft TC @ 15.0' : 50/2.5", 50/1.5"	17						
21	[Diagonal Hatching]	100/10.5"	Reddish brown weathered <u>Shale</u> , soft TC @ 20.0' : 50/5.0", 50/5.5"	17	37	21	16	97		
22										
23										
24										
25										
26										
27										
28										
29										
30										

NOTES:



LOG OF BORING B-3

PROJECT: Proposed Single-Story Casino, HWY 183 and HWY 9, Hobart, Oklahoma Project No.: OGR-22028
 Date Drilled: 1/25/2022 Location: See Plan of Borings (Figure 1) Elevation: N/A
 Depth To Water At Completion: 15.0' Depth To Water On: End of Day Was: 15.0'
 Drilled By: Kalyn Logger: Stephen Approximate Completion Depth: 20.5'

DEPTH FEET	SYMBOL	SAMPLE TYPE	DESCRIPTION	MC %	LL	PL	PI	-#200 %	swell %	PP TSF	
1		3/6"	Dark brown to reddish brown lean <u>Clay</u> with calcareous nodules, stiff (CL)	17	48	19	29	97			
2		5/6"									
3		8/6"									
4		3/6"	Reddish brown fat <u>Clay</u> with calcareous nodules, stiff to very stiff (CH)	21	53	20	33	95			
5		6/6"									
6		8/6"									
7		5/6"	Reddish brown lean <u>Clay</u> with calcareous nodules, very stiff to hard (CL)	21	46	21	25	97			
8		7/6"									
9		10/6"									
10		4/6"									
11		36/6"	Reddish brown <u>Shale</u> , moderately hard	13	32	18	14	98			
12		50/4"									
13		100/2.5"	TC @ 12.5' : 50/1.5", 50/1.0"	15	37	20	17	99			
14											
15											
16		100/4.3"	TC @ 15.0' : 50/2.8", 50/1.5"	16							
17											
18											
19											
20											
21		100/4.5"	TC @ 20.0' : 50/3.0", 50/1.5"	15	36	20	16	99			
22											
23											
24											
25											
26											
27											
28											
29											
30											

NOTES:



LOG OF BORING B-4

PROJECT: Proposed Single-Story Casino, HWY 183 and HWY 9, Hobart, Oklahoma Project No.: OGR-22028
 Date Drilled: 1/25/2022 Location: See Plan of Borings (Figure 1) Elevation: N/A
 Depth To Water At Completion: 15.0' Depth To Water On: End of Day Was: 15.0'
 Drilled By: Kalyn Logger: Stephen Approximate Completion Depth: 20.5'

DEPTH FEET	SYMBOL	SAMPLE TYPE	DESCRIPTION	MC %	LL	PL	PI	-#200 %	swell %	PP TSF
1	[Diagonal Hatching]	4/6"	Dark brown lean <u>Clay</u> with roots, very stiff to stiff (CL)	19	49	21	28	97		
2		7/6"								
3		11/6"								
4	[Diagonal Hatching]	3/6"	Reddish brown fat <u>Clay</u> with calcareous nodules, stiff (CH)	21	50	20	30	96		
5		5/6"								
6		9/6"								
7	[Diagonal Hatching]	3/6"	Reddish brown lean <u>Clay</u> with calcareous nodules, stiff to hard (CL)	18	41	17	24	94		
8		7/6"								
9		9/6"								
10		10/6"								
11	[Diagonal Hatching]	28/6" 50/6"	Reddish brown <u>Shale</u> , soft to moderately hard	12	32	18	14	99		
12	[Horizontal Hatching]									
13		100/4.8"	TC @ 12.5' : 50/2.8", 50/2.0"	15						
14										
15										
16	[Horizontal Hatching]	100/2.5"	TC @ 15.0' : 50/1.5", 50/1.0"	15	37	21	16	99		
17	[Horizontal Hatching]									
18	[Horizontal Hatching]									
19	[Horizontal Hatching]									
20	[Horizontal Hatching]									
21	[Horizontal Hatching]	100/4.5"	TC @ 20.0' : 50/3.0", 50/1.5"	17						
22										
23										
24										
25										
26										
27										
28										
29										
30										

NOTES:



LOG OF BORING B-5

PROJECT: Proposed Single-Story Casino, HWY 183 and HWY 9, Hobart, Oklahoma Project No.: OGR-22028
 Date Drilled: 1/25/2022 Location: See Plan of Borings (Figure 1) Elevation: N/A
 Depth To Water At Completion: 15.0' Depth To Water On: End of Day Was: 15.0'
 Drilled By: Kalyn Logger: Stephen Approximate Completion Depth: 20.0'

DEPTH FEET	SYMBOL	SAMPLE TYPE	DESCRIPTION	MC %	LL	PL	PI	-#200 %	swell %	PP TSF
1		4/6"	Dark brown lean <u>Clay</u> with roots, very stiff (CL)	17	48	20	28	95		
2		7/6"								
3		12/6"								
4		5/6"								
5		7/6" 9/6"								
6		5/6"	Reddish brown lean <u>Clay</u> with iron stains, very stiff to hard (CL)	19	44	18	26	93		
7		7/6"								
8		12/6"								
9		5/6"								
10		10/6" 15/6"								
11		21/6"	Reddish brown weathered <u>Shale</u> , soft to moderately hard	15						
12		23/6"								
13		50/6"								
14		100/7.8"								
15										
16		100/3.5"	Reddish brown <u>Shale</u> , moderately hard	16	38	21	17	99		
17										
18										
19										
20		100/2.3"								
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										

NOTES:



LOG OF BORING B-6

PROJECT: Proposed Single-Story Casino, HWY 183 and HWY 9, Hobart, Oklahoma Project No.: OGR-22028
 Date Drilled: 1/25/2022 Location: See Plan of Borings (Figure 1) Elevation: N/A
 Depth To Water At Completion: Dry Depth To Water On: End of Day Was: Dry
 Drilled By: Kalyn Logger: Stephen Approximate Completion Depth: 6.5'


DEPTH FEET	SYMBOL	SAMPLE TYPE	DESCRIPTION	MC %	LL	PL	PI	-#200 %	swell %	PP TSF
1		4/6"	Dark brown lean <u>Clay</u> with calcareous inclusion, very stiff to stiff (CL)	18	49	21	28	96		
2		7/6"								
3		11/6"								
4		4/6"	Brown to reddish brown lean <u>Clay</u> with iron stains and calcareous nodules, stiff to very stiff (CL)	21	49	19	30	96		
5		6/6"								
6		9/6"								
7		6/6"		18	45	20	25	96		
8	9/6"									
9	14/6"									
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NOTES:



LOG OF BORING B-7

PROJECT: Proposed Single-Story Casino, HWY 183 and HWY 9, Hobart, Oklahoma Project No.: OGR-22028
 Date Drilled: 1/25/2022 Location: See Plan of Borings (Figure 1) Elevation: N/A
 Depth To Water At Completion: Dry Depth To Water On: End of Day Was: Dry
 Drilled By: Kalyn Logger: Stephen Approximate Completion Depth: 6.5'

DEPTH FEET	SYMBOL	SAMPLE TYPE	DESCRIPTION	MC %	LL	PL	PI	#200 %	swell %	PP TSF
1		5/6"	Dark brown to reddish brown lean Clay with calcareous nodules, very stiff to stiff (CL)	18	49	20	29	97		
2		9/6"								
3		12/6"								
4		3/6"								
5		4/6"								
6		9/6"								
6		4/6"		18	43	18	25	95		
6		4/6"								
6		9/6"								
7										
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NOTES:



LOG OF BORING B-8

PROJECT: Proposed Single-Story Casino, HWY 183 and HWY 9, Hobart, Oklahoma Project No.: OGR-22028
 Date Drilled: 1/25/2022 Location: See Plan of Borings (Figure 1) Elevation: N/A
 Depth To Water At Completion: Dry Depth To Water On: End of Day Was: Dry
 Drilled By: Kalyn Logger: Stephen Approximate Completion Depth: 6.5'



DEPTH FEET	SYMBOL	SAMPLE TYPE	DESCRIPTION	MC %	LL	PL	PI	-#200 %	swell %	PP TSF
1		4/6"	Dark brown lean <u>Clay</u> with calcareous nodules, very stiff to stiff (CL)	19	49	22	27	98		
2		8/6"								
3		12/6"								
4		3/6"	Dark brown lean <u>Clay</u> with calcareous nodules and iron stains, stiff to very stiff (CL)	22	48	21	27	97		
5		5/6"								
6		8/6"								
7		5/6"		18	41	18	23	96		
8		8/6"								
9		13/6"								
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NOTES:



LOG OF BORING B-9

PROJECT: Proposed Single-Story Casino, HWY 183 and HWY 9, Hobart, Oklahoma Project No.: OGR-22028
 Date Drilled: 1/25/2022 Location: See Plan of Borings (Figure 1) Elevation: N/A
 Depth To Water At Completion: Dry Depth To Water On: End of Day Was: Dry
 Drilled By: Kalyn Logger: Stephen Approximate Completion Depth: 6.5'

DEPTH FEET	SYMBOL	SAMPLE TYPE	DESCRIPTION	MC %	LL	PL	PI	-#200 %	swell %	PP TSF
1		4/6"	Dark brown to reddish brown lean <u>Clay</u> with calcareous nodules, stiff (CL)	17	48	20	28	97		
2		7/6"								
3		8/6"								
4		5/6"								
5		6/6" 8/6"								
6		4/6"	Reddish brown lean <u>Clay</u> with calcareous nodules and iron stains, stiff (CL)	19	45	19	26	97		
7		5/6" 8/6"								
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LOG OF BORING B-10

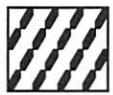
PROJECT: Proposed Single-Story Casino, HWY 183 and HWY 9, Hobart, Oklahoma Project No.: OGR-22028
 Date Drilled: 1/25/2022 Location: See Plan of Borings (Figure 1) Elevation: N/A
 Depth To Water At Completion: Dry Depth To Water On: End of Day Was: Dry
 Drilled By: Kalyn Logger: Stephen Approximate Completion Depth: 6.5'

DEPTH FEET	SYMBOL	SAMPLE TYPE	DESCRIPTION	MC %	LL	PL	PI	#200 %	swell %	PP TSF
1		5/6"	Brown lean <u>Clay</u> with calcareous nodules, very stiff to stiff (CL)	16	48	19	29	94		
2		8/6"								
3		9/6"								
4		6/6"	Brown fat <u>Clay</u> with calcareous nodules, stiff to very stiff (CH)	20	55	19	36	95		
5		8/6"								
5		8/6"								
6		5/6"	Reddish brown lean <u>Clay</u> with calcareous nodules, very stiff (CL)	19	44	18	26	96		
7		7/6"								
7		12/6"								
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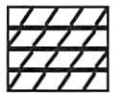
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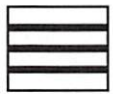
KEY TO SYMBOLS & PATTERNS USED ON BORING LOGS



Lean Clay/Fat Clay



Weathered Shale



Shale



Standard Penetration Test



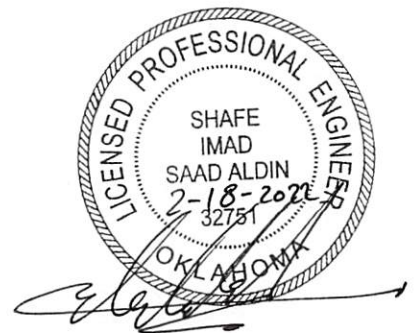
Bag Sample



Texas Cone Penetrometer Test

ABBREVIATIONS USED

- MC, % Moisture Content expressed in percentage
- LL Liquid Limit
- PI Plasticity Index
- DD, PCF Dry Density expressed in pounds per cubic feet
- #200, % Soil Fraction Passing No. 200 Sieve expressed in percentage
- swell, % Free swell under overburden pressure expressed in percentage
- PP, TSF Pocket Penetrometer Reading expressed in tons per square feet



**SECTION 008000
SUPPLEMENTARY CONDITIONS**

1.1 SUPPLEMENTS

- A. The following supplements modify, change, delete from or add to the "General Conditions of the Contract for Construction", AIA Document A201, Seventeenth Edition, 2017. Where any Article of the General Conditions is modified or any Paragraph, Subparagraph or Clause thereof is modified or deleted by these supplements, the unaltered provision of the Article, Paragraph, Subparagraph or Clause shall remain in effect.

1.2 REFERENCE TO DIVISION 01

- A. With regard to provisions of General Conditions related to project administrative or work-related requirements of the Contract, some of those paragraphs are modified or deleted from General Conditions, and are specified in Division 01, "General Requirements" of the Specifications.

ARTICLE 1 GENERAL PROVISIONS

Add the following new paragraphs:

1.1.9 MISCELLANEOUS DEFINITIONS

1.1.9.1 The term "Product" as used in these Contract Documents includes materials, systems, and equipment.

1.1.9.2 The term "provide" as used in this Project Manual means to furnish and install.

1.2 CORRELATION AND INTENT OF THE CONTRACT DOCUMENTS

Add the following new subparagraphs:

1.2.4 The inter-relation of the Project Manual, the Drawings and the schedules is as follows: The Project Manual determines the quality, nature and setting of the several materials; the Drawings establish the quantities, dimensions and details; and the schedules give the location. The documents are to be considered as one and whatever is called for by any one shall be as binding as if called for by all.

1.2.5 Should the drawings disagree in themselves, or with the Project Manual, or if proprietary information disagrees with performance requirements in either the Drawings or the Project Manual, the better quality or greater quantity of the Work or materials shall be estimated upon, and unless otherwise ordered by the Architect in writing, shall be performed or furnished. Should discrepancies or doubt occur, do not proceed with the Work or estimate without clarification from the Architect. Contractor shall request clarification in sufficient time to avoid delays and/or any adjustments in the contract sum.

ARTICLE 3 CONTRACTOR

3.2 REVIEW OF CONTRACT DOCUMENTS AND FIELD CONDITIONS BY CONTRACTOR

Add following sentences to subparagraph 3.2.2:

3.2.2.1 If a dimensional discrepancy exists, Contractor shall take field measurements required for proper fabrication and installation of work. Upon commencement of any item of work, Contractor shall be responsible for dimensions related to such item of Work and shall make any corrections necessary to make work properly fit at no additional cost to Owner.

3.2.2.2 Before ordering any material or doing any work, Contractor shall verify dimensions and check conditions in order to assure himself that they properly reflect those on the Drawings. Any inconsistency shall be brought to attention of the Architect. In the event that discrepancies occur between ordered material and actual conditions, of which Architect was not notified beforehand, costs to correct such discrepancies shall be borne by Contractor.

3.3 SUPERVISION AND CONSTRUCTION PROCEDURES

Supplement as provided in Division 01.

3.4 LABOR AND MATERIALS

Add the following new paragraph:

3.4.4 Within 15 days after the Contract has been executed, the Owner and the Architect will consider a formal request for the substitution of products in place of those specified only under the conditions set forth in the General Requirements of the Specifications, Division 01. Refer to Division 01 for supplemental information.

3.5 WARRANTY

Supplement as provided in Division 01.

3.8 ALLOWANCES

Supplement as provided in Division 01.

3.10 CONTRACTOR'S CONSTRUCTION PROGRESS SCHEDULES

Supplement as provided in Division 01.

3.11 DOCUMENTS AND SAMPLES AT THE SITE

Supplement as provided in Division 01.

3.12 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

Supplement as provided in Division 01, Section 011000, Summary.

3.13 USE OF SITE

Supplement as provided in Division 01.

3.14 CUTTING AND PATCHING

Supplement as provided in Division 01.

3.15 CLEANING UP

Supplement as provided in Division 01.

ARTICLE 6 CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS

Add the following new paragraph

6.1.5 Coordinated construction work under this Contract includes, but is not limited to, providing concealed blocking as noted for attachment of separate contract items in locations necessary for the actual items to be installed. Provide proper dimensional coordination of separate contract supplied items for general construction work and trim that is to meet and/or adjoin Furniture, Fixtures, Equipment and Accessories.

6.1.6 It is a requirement of the Contractor's work schedule to provide the cooperation, coordination and exchange of information necessary for a timely execution of separate contract work.

ARTICLE 7 CHANGES IN THE WORK

7.1 GENERAL

Supplement as provided in Division 1.

Add the following new paragraphs:

7.1.4 Except as provided in this article, no oral statement, or direction of Architect or Owner shall be treated as a Change Order or entitle Contractor to an adjustment to the Contract Sum or the Contract Time.

7.1.5 Unit prices shall be inclusive of all costs including mark-up for overhead and profit and shall be applied to units of measure as defined in the Contract Documents for each category of Work. Contractor shall identify overhead and profit amounts for each unit price.

7.1.6 The allowance for the combined overhead and profit included in the total cost to the Owner shall be based on the following schedule:

7.1.6.1 For the Contractor, for Work performed by the Contractor's own forces, 15 percent of the cost.

7.1.6.2 For the Contractor, for Work performed by the Contractor's Subcontractor, 10 percent of the amount due the Subcontractor.

7.1.6.3 For each Subcontractor or Sub-subcontractor involved, for Work performed by that Subcontractor's or Sub-subcontractor's own forces, 15 percent of the cost.

7.1.6.4 For each Subcontractor, for Work performed by the Subcontractor's Sub-subcontractors, 10 percent of the amount due the Sub-subcontractor.

7.1.6.5 In order to facilitate checking of quotations for extras or credits, all proposals, except those so minor that their propriety can be seen by inspection, shall be accompanied by a complete itemization of costs including labor, materials and Subcontracts. Labor and materials shall be itemized in the manner prescribed above. Where major cost items are Subcontracts, they shall be itemized also. In no case will a change involving over \$2,000.00 be approved without such itemization.

ARTICLE 8 - TIME

8.3 DELAYS AND EXTENSIONS OF TIME

Add the following new paragraphs

8.3.4 Apart from extension of time, no payment or claim for damages shall be made to Contractor as compensation for damages for any ordinary delays or hindrances from any cause whatsoever in the progress of the Work, notwithstanding whether such delay be avoidable or unavoidable.

8.3.5 In order to claim an inclement weather delay day, Contractor must:

8.3.5.1 Document, in writing, that the weather on the particular day was of such nature (rain, wind, snow, ice, and subsequent resultant effects) that it significantly impacted its ability to make progress on critical path work items. Utilize NOAA weather data from a nearby site as the back-up for all claims.

8.3.5.2 Submit such delay claims on a weekly basis, not more than 7 days following the last day of occurrence.

8.3.5.3 Summarize the number of days claimed for the entire month accompanying each month's application for payment.

ARTICLE 9 PAYMENTS AND COMPLETION

9.2 SCHEDULE OF VALUES

Supplement as provided in Division 01.

9.3 APPLICATIONS FOR PAYMENT

Supplement as provided in Division 01.

Add the following new subparagraph:

9.3.4 Unless otherwise stated in the Owner-Contractor Agreement, the Owner will retain, until Final Payment, 10 percent of the amount due the Contractor on account of progress payments, payable 30 days after Substantial Completion and/or satisfactory evidence to the owner that all payments, bills, and claims have been paid.

Add following Sub-subparagraphs:

9.3.4 Monthly Applications for Payment shall include waivers of liens for all work included in previous months' application for payment. Waiver of Liens for subcontractors and materialmen shall be total amount paid prior to previous months' application for payment.

9.5 DECISIONS TO WITHHOLD CERTIFICATION

Add following Sub-subparagraph **9.5.1.8** to Subparagraph **9.5.1**:

9.5.1.8 Failure to submit written plan indicating action by Contractor to regain time schedule for completion of Work within Contract Time.

9.5.1.9 Failure to keep record documents current.

9.8 SUBSTANTIAL COMPLETION

Supplement as provided in Division 01.

9.10 FINAL COMPLETION AND FINAL PAYMENT

Add the following new paragraph

9.10.2.1 In addition to the items listed in 9.10.2, the Contractor shall deliver 2 hard copies and 2 electronic copies (PDF format on thumb drive) sets of the following items to the Owner before final payment will be made:

1. Other close-out submittals as specified in Division 01.
2. Project record documents as specified in Division 01.
3. Operations and maintenance data as specified in Division 01.
4. All warranties as required on specific products or portions of the Work, in format outlined in Division 01.
5. Spare parts, overages, and maintenance materials as outlined in Division 01 and described in the various technical sections.
6. Certificates of occupancy.
7. Copies of all inspection tags from authorities having jurisdiction.
8. Executed Certificate of Substantial Completion.

ARTICLE 11 INSURANCE AND BONDS

Refer to Owner-Contractor Agreement

ARTICLE 13 MISCELLANEOUS PROVISIONS

13.5 TESTS AND INSPECTIONS

Supplement as provided in Division 01, Section 014000, Quality Requirements.

END OF DOCUMENT

**SECTION 011000
SUMMARY**

PART 1 GENERAL

1.1 PROJECT

- A. Project Name: Kiowa Casino.
- B. Owner's Name: Kiowa Tribe.
- C. Architect's Name: 1Architecture, LLC; 1319 E. 6th St.; Tulsa, Oklahoma 74120.
- D. The Project consists of the construction of a new, 25,000 s.f. (approx.) casino with attached restaurant and including offices and auxiliary support spaces, with associated site work, located in Hobart, Oklahoma

1.2 CONTRACT DESCRIPTION

- A. Contract Type: Single prime contract.

1.3 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.

1.4 CONTRACTOR USE OF SITE AND PREMISES

- A. Construction Operations: Limited to areas noted on Drawings.
- B. Arrange use of site and premises to allow:
 - 1. Owner occupancy.
 - 2. Work by Others.
 - 3. Work by Owner.
- C. Provide access to and from site as required by law and by Owner:
 - 1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
 - 2. Do not obstruct roadways, sidewalks, or other public ways without permit.
- D. Time Restrictions:
 - 1. Limit conduct of especially noisy, malodorous, and dusty exterior work as approved and coordinated with Owner.
- E. Utility Outages and Shutdown:
 - 1. Prevent accidental disruption of utility services to other facilities.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 012000
PRICE AND PAYMENT PROCEDURES

PART 1 GENERAL

1.1 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.

1.2 SCHEDULE OF VALUES

- A. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit draft to Architect for approval.
- B. Forms filled out by hand will not be accepted.
- C. Submit Schedule of Values in duplicate within 15 days after date of Owner-Contractor Agreement.

1.3 APPLICATIONS FOR PROGRESS PAYMENTS

- A. Payment Period: Submit at intervals stipulated in the Agreement.
- B. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit sample to Architect for approval.
- C. Forms filled out by hand will not be accepted.
- D. For each item, provide a column for listing each of the following:
 - 1. Item Number.
 - 2. Description of work.
 - 3. Scheduled Values.
 - 4. Previous Applications.
 - 5. Work in Place and Stored Materials under this Application.
 - 6. Authorized Change Orders.
 - 7. Total Completed and Stored to Date of Application.
 - 8. Percentage of Completion.
 - 9. Balance to Finish.
 - 10. Retainage.
 - a. Retainage will be 5% of total amount per Application for Payment.
- E. Execute certification by signature of authorized officer.
- F. Use data from approved Schedule of Values. Provide dollar value in each column for each line item for portion of work performed and for stored products.
- G. List each authorized Change Order as a separate line item, listing Change Order number and dollar amount as for an original item of work.
- H. Submit one electronic and three hard-copies of each Application for Payment.
- I. Include the following with the application:
 - 1. Transmittal letter as specified for submittals in Section 013000.
 - 2. Construction progress schedule, revised and current as specified in Section 013000.
- J. 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.

1.4 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 five days.
 - D. Computation of Change in Contract Amount: As specified in the Agreement and Conditions of the Contract.
 - 1. For change requested by Architect for work falling under a fixed price contract, the amount will be based on Contractor's price quotation.
 - 2. For change requested by Contractor, the amount will be based on the Contractor's request for a Change Order as approved by Architect.
 - 3. For pre-determined unit prices and quantities, the amount will be based on the fixed unit prices.
 - 4. For change ordered by Architect without a quotation from Contractor, the amount will be determined by Architect based on the Contractor's substantiation of costs as specified for Time and Material work.
 - E. Substantiation of Costs: Provide full information required for evaluation.
 - 1. On request, provide the following data:
 - a. Quantities of products, labor, and equipment.
 - b. Taxes, insurance, and bonds.
 - c. Overhead and profit.
 - d. Justification for any change in Contract Time.
 - e. Credit for deletions from Contract, similarly documented.
 - 2. Support each claim for additional costs with additional information:
 - a. Origin and date of claim.
 - b. Dates and times work was performed, and by whom.
 - c. Time records and wage rates paid.
 - d. Invoices and receipts for products, equipment, and subcontracts, similarly documented.
 - 3. For Time and Material work, submit itemized account and supporting data after completion of change, within time limits indicated in the Conditions of the Contract.
 - F. Execution of Change Orders: Architect will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.
 - G. 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.
 - H. Promptly enter changes in Project Record Documents.
- 1.5 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.

END OF SECTION

SECTION 012100 ALLOWANCES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Cash allowances.
- B. Contingency allowance.
- C. Inspecting and testing allowances.
- D. Payment and modification procedures relating to allowances.

1.2 CASH ALLOWANCES

- A. Costs Included in Cash Allowances: Cost of product to Contractor or subcontractor, less applicable trade discounts, less cost of delivery to site , less applicable taxes .
- B. Costs Not Included in Cash Allowances: Product delivery to site and handling at the site, including unloading, uncrating, and storage; protection of products from elements and from damage; and labor for installation and finishing.
- C. Architect Responsibilities:
 - 1. Consult with Contractor for consideration and selection of products, suppliers , and installers.
 - 2. Select products in consultation with Owner and transmit decision to Contractor.
 - 3. Prepare Change Order.
- D. Contractor Responsibilities:
 - 1. Assist Architect in selection of products, suppliers , and installers.
 - 2. Obtain proposals from suppliers and installers and offer recommendations.
 - 3. On notification of which products have been selected, execute purchase agreement with designated supplier and installer.
 - 4. Arrange for and process shop drawings, product data, and samples. Arrange for delivery.
 - 5. Promptly inspect products upon delivery for completeness, damage, and defects. Submit claims for transportation damage.
- E. Differences in costs will be adjusted by Change Order.

1.3 CONTINGENCY ALLOWANCE

- A. Contractor's costs for products, delivery, installation, labor, insurance, payroll, taxes, bonding, equipment rental, overhead and profit will be included in Change Orders authorizing expenditure of funds from this Contingency Allowance.
- B. Funds will be drawn from the Contingency Allowance only by Change Order.
- C. At closeout of Contract, funds remaining in Contingency Allowance will be credited to Owner by Change Order.

1.4 INSPECTING AND TESTING ALLOWANCES

- A. Costs Included in Inspecting and Testing Allowances: Cost of engaging an inspecting or testing agency; execution of inspecting and tests; and reporting results.
- B. Costs Not Included in the Inspecting and Testing Allowances:
 - 1. Costs of incidental labor and facilities required to assist inspecting or testing agency.
 - 2. Costs of testing services used by Contractor separate from Contract Document requirements.
 - 3. Costs of retesting upon failure of previous tests as determined by Architect.
- C. Payment Procedures:
 - 1. Submit one copy of the inspecting or testing firm's invoice with next application for payment.
 - 2. Pay invoice on approval by Architect.
- D. Differences in cost will be adjusted by Change Order.

1.5 ALLOWANCES SCHEDULE

- A. To be determined.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

**SECTION 012200
UNIT PRICES**

PART 1 GENERAL

1.1 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.

1.2 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.

1.3 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.

1.4 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. Take all measurements and compute quantities. Measurements and quantities will be verified by Architect.
- C. Assist by providing necessary equipment, workers, and survey personnel as required.
- D. Measurement Devices:
 - 1. Weigh Scales: Inspected, tested and certified by the applicable state Weights and Measures department within the past year.
 - 2. Platform Scales: Of sufficient size and capacity to accommodate the conveying vehicle.
 - 3. Metering Devices: Inspected, tested and certified by the applicable state department within the past year.
- E. Measurement by Weight: Concrete reinforcing steel, rolled or formed steel or other metal shapes will be measured by handbook weights. Welded assemblies will be measured by handbook or scale weight.
- F. Measurement by Volume: Measured by cubic dimension using mean length, width and height or thickness.
- G. Measurement by Area: Measured by square dimension using mean length and width or radius.
- H. Linear Measurement: Measured by linear dimension, at the item centerline or mean chord.
- I. Stipulated Price Measurement: Items measured by weight, volume, area, or linear means or combination, as appropriate, as a completed item or unit of the Work.
- J. Perform surveys required to determine quantities, including control surveys to establish measurement reference lines. Notify Architect prior to starting work.
- K. Contractor's Engineer Responsibilities: Sign surveyor's field notes or keep duplicate field notes, calculate and certify quantities for payment purposes.

1.5 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.

1.6 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. The individual specification sections may modify these options or may identify a specific formula or percentage price reduction.
- D. The authority of Architect to assess the defect and identify payment adjustment is final.

1.7 SCHEDULE OF UNIT PRICES

- A. To be determined.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

**SECTION 012300
ALTERNATES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Description of Alternates.

1.2 ACCEPTANCE OF ALTERNATES

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

1.3 SCHEDULE OF ALTERNATES

- A. To be determined.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

**SECTION 013000
ADMINISTRATIVE REQUIREMENTS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electronic document submittal service.
- B. Preconstruction meeting.
- C. Progress meetings.
- D. Construction progress schedule.
- E. Progress photographs.
- F. Submittals for review, information, and project closeout.
- G. Submittal procedures.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 PRECONSTRUCTION MEETING

- A. Owner will schedule a meeting after Notice of Award.
- 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. Designation of personnel representing the parties to Contract and <1|A/E|>.
 - 6. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
 - 7. Scheduling.
- D. 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.

3.2 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the work at maximum bi-monthly intervals.
- B. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.
- C. Attendance Required:
 - 1. Contractor.
 - 2. Owner.
 - 3. Architect.
 - 4. Contractor's superintendent.
 - 5. Major subcontractors.
- D. Agenda:
 - 1. Review minutes of previous meetings.
 - 2. Review of work progress.
 - 3. Field observations, problems, and decisions.
 - 4. Identification of problems that impede, or will impede, planned progress.
 - 5. Review of submittals schedule and status of submittals.
 - 6. Review of off-site fabrication and delivery schedules.
 - 7. Maintenance of progress schedule.

8. Corrective measures to regain projected schedules.
 9. Planned progress during succeeding work period.
 10. Coordination of projected progress.
 11. Maintenance of quality and work standards.
 12. Effect of proposed changes on progress schedule and coordination.
 13. Other business relating to 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.
- 3.3 CONSTRUCTION PROGRESS SCHEDULE - SEE SECTION 013216
- A. Within 10 days after date of the Agreement, submit preliminary schedule defining planned operations for the first 60 days of work, with a general outline for remainder of work.
 - B. If preliminary schedule requires revision after review, submit revised schedule within 10 days.
 - C. Within 20 days after review of preliminary schedule, submit draft of proposed complete schedule for review.
 1. Include written certification that major contractors have reviewed and accepted proposed schedule.
 - D. Within 10 days after joint review, submit complete schedule.
 - E. Submit updated schedule with each Application for Payment.
- 3.4 PROGRESS PHOTOGRAPHS
- A. Submit photographs with each application for payment, taken not more than 3 days prior to submission of application for payment.
 - B. Photography Type: Digital; electronic files.
 - C. In addition to periodic, recurring views, take photographs of each of the following events:
 1. Completion of site clearing.
 2. Excavations in progress.
 3. Foundations in progress and upon completion.
 4. Structural framing in progress and upon completion.
 5. Enclosure of building, upon completion.
 6. Final completion, minimum of ten (10) photos.
 - D. Views:
 1. Provide non-aerial photographs from four cardinal views at each specified time, until date of Substantial Completion.
 2. Consult with Architect for instructions on views required.
 3. Provide factual presentation.
 4. Provide correct exposure and focus, high resolution and sharpness, maximum depth of field, and minimum distortion.
 - E. Digital Photographs: 24 bit color, minimum resolution of 1024 by 768, in JPG format; provide files unaltered by photo editing software.
 1. Delivery Medium: Via email.
 2. File Naming: Include project identification, date and time of view, and view identification.
 3. PDF File: Assemble all photos into printable pages in PDF format, with 2 to 3 photos per page, each photo labeled with file name; one PDF file per submittal.
 4. Hard Copy: Printed hardcopy (grayscale) of PDF file and point of view sketch.
- 3.5 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 the 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.

3.6 SUBMITTALS FOR INFORMATION

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

3.7 SUBMITTALS FOR PROJECT CLOSEOUT

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

3.8 SUBMITTAL PROCEDURES

- A. General Requirements:
 - 1. Transmit using approved form.
 - 2. Sequentially identify each item. For revised submittals use original number and a sequential numerical suffix.
 - 3. Identify: Project; Contractor; subcontractor or supplier; pertinent drawing and detail number; and specification section number and article/paragraph, as appropriate on each copy.
 - 4. 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.
 - 5. Schedule submittals to expedite the Project, and coordinate submission of related items.
 - 6. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.
 - 7. Provide space for Contractor and Architect review stamps.
 - 8. When revised for resubmission, identify all changes made since previous submission.
 - 9. Distribute reviewed submittals. Instruct parties to promptly report inability to comply with requirements.
 - 10. Submittals not requested will not be recognized or processed.
 - 11. No extension of the Contract Time will be authorized due to Contractor's failure to provide submittals in advance of the Work to permit processing or for submitting materials which do not meet minimum standards as indicated in the Specifications.
 - 12. Manufacturer's product data sheets listing multiple items must be clearly marked to indicate the specific material or product submitted for use in the Work

END OF SECTION

**SECTION 013216
CONSTRUCTION PROGRESS SCHEDULE**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Preliminary schedule.
- B. Construction progress schedule, bar chart type.

1.2 REFERENCE STANDARDS

- A. AGC (CPSM) - Construction Planning and Scheduling Manual 2004.
- B. M-H (CPM) - CPM in Construction Management - Project Management with CPM 2015.

1.3 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.
- D. Within 10 days after joint review, submit complete schedule.
- E. Submit updated schedule with each Application for Payment.
- F. Submit the number of opaque reproductions that Contractor requires, plus two copies that will be retained by Architect.

1.4 QUALITY ASSURANCE

- A. Scheduler: Contractor's personnel or specialist Consultant specializing in CPM scheduling with one years minimum experience in scheduling construction work of a complexity comparable to this Project, and having use of computer facilities capable of delivering a detailed graphic printout within 48 hours of request.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 PRELIMINARY SCHEDULE

- A. Prepare preliminary schedule in the form of a horizontal bar chart.

3.2 BAR CHARTS

- A. Include a separate bar for each major portion of Work or operation.
- B. Identify the first work day of each week.
- C. Indicate major completion milestones.

3.3 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.
- C. After review, revise as necessary as result of review, and resubmit within 10 days.

3.4 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.

3.5 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

SECTION 014000
QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Submittals.
- B. References and standards.
- C. Testing and inspection agencies and services.
- D. Control of installation.
- E. Mock-ups.
- F. Tolerances.
- G. Manufacturers' field services.
- H. Defect Assessment.

1.2 RELATED REQUIREMENTS

- A. Section 014216 - Definitions.

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Testing Agency Qualifications:
 - 1. Prior to start of Work, submit agency name, address, and telephone number, and names of full time registered Engineer and responsible officer.
 - 2. Submit copy of report of laboratory facilities inspection made by NIST Construction Materials Reference Laboratory during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.
- C. Design Data: Submit for Architect's knowledge as contract administrator for the limited purpose of assessing compliance with information given and the design concept expressed in the contract documents, or for Owner's information.
- D. Test Reports: After each test/inspection, promptly submit two copies of report to Architect and to Contractor.
 - 1. Test report submittals are for Architect's knowledge as contract administrator for the limited purpose of assessing compliance with information given and the design concept expressed in the contract documents, or for Owner's information.
- E. Certificates: When specified in individual specification sections, submit certification by the manufacturer and Contractor or installation/application subcontractor to Architect, in quantities specified for Product Data.
 - 1. Indicate material or product complies with or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
 - 2. Certificates may be recent or previous test results on material or product, but must be acceptable to Architect.
- F. Manufacturer's Instructions: When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, for the Owner's information. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.
- G. Manufacturer's Field Reports: Submit reports for Architect's benefit as contract administrator or for Owner.
 - 1. Submit for information for the limited purpose of assessing compliance with information given and the design concept expressed in the contract documents.
- H. Erection Drawings: Submit drawings for Architect's benefit as contract administrator or for Owner.
 - 1. Submit for information for the limited purpose of assessing compliance with information given and the design concept expressed in the contract documents.

1.4 REFERENCES AND STANDARDS

- A. For products and workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Comply with reference standard of date of issue current on date of Contract Documents, except where a specific date is established by applicable code.
- C. Obtain copies of standards where required by product specification sections.
- D. Maintain copy at project site during submittals, planning, and progress of the specific work, until Substantial Completion.
- E. Should specified reference standards conflict with Contract Documents, request clarification from Architect before proceeding.
- F. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of Architect shall be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.5 TESTING AND INSPECTION AGENCIES AND SERVICES

- A. Contractor shall employ and pay for services of an independent testing agency to perform other specified testing.
- B. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 CONTROL OF INSTALLATION

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

3.2 MOCK-UPS

- A. Before installing portions of the Work where mock-ups are required, construct mock-ups in location and size indicated for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work. The purpose of mock-up is to demonstrate the proposed range of aesthetic effects and workmanship.
- B. Accepted mock-ups establish the standard of quality the Architect will use to judge the Work.
- C. Room Mock-ups: Construct room mock-ups as indicated on drawings. Coordinate installation of materials, products, and assemblies as required in specification sections; finish according to requirements. Provide required lighting and any supplemental lighting where required to enable Architect to evaluate quality of the mock-up.
 - 1. Provide mock-up of typical office as directed by Architect.
- D. Notify Architect fifteen (15) working days in advance of dates and times when mock-ups will be constructed.
- E. Provide supervisory personnel who will oversee mock-up construction. Provide workers that will be employed during the construction at Project.

- F. Apply finish materials to demonstrate the proposed range of materials, colors, and workmanship.
- G. Obtain Architect's approval of mock-ups before starting work, fabrication, or construction.
 - 1. Architect will issue written comments within seven (7) working days of initial review and each subsequent follow up review of each mock-up.
 - 2. Make corrections as necessary until Architect's approval is issued.
- H. Accepted mock-ups shall be a comparison standard for the remaining Work.

3.3 TOLERANCES

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

3.4 TESTING AND INSPECTION

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

3.5 MANUFACTURERS' FIELD SERVICES

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

3.6 DEFECT ASSESSMENT

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

END OF SECTION

**SECTION 014100
REGULATORY REQUIREMENTS**

PART 1 GENERAL

1.1 SUMMARY OF REFERENCE STANDARDS

- A. Regulatory requirements applicable to this project are the following:
1. ATBCB ADAAG - Americans with Disabilities Act Accessibility Guidelines, 2010 edition.
 2. 29 CFR 1910 - Occupational Safety and Health Standards, current edition; as a work place.
 3. ICC/ANSI A117.1 and Federal Fair Housing.
 4. ICC (IFC) - ICC International Fire Code, latest edition adopted.
 5. ICC (IBC) - ICC International Building Code, latest edition adopted.
 6. ICC (IPC) - ICC International Plumbing Code, latest edition adopted.
 7. ICC (IMC) - ICC International Mechanical Code, latest edition adopted.
 8. ICC (IFGC) - ICC International Fuel Gas Code,
 9. IECC (IECC) - International Energy Conservation Code, latest edition adopted.
 10. Erosion and Sedimentation Control Regulations: Local jurisdiction.
 11. NFPA 70 - National Electrical Code, latest edition adopted.
 12. NFPA 101 - Life Safety Code, latest edition adopted.
 13. Regulatory requirements as described in each specification Section.
 14. Texas Accessibility Standards (for projects with state of Texas).

1.2 RELATED REQUIREMENTS

- A. Section 014000 - Quality Requirements.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 014216
DEFINITIONS

PART 1 GENERAL

1.1 SUMMARY

- A. This section supplements the definitions contained in the General Conditions.
- B. Other definitions are included in individual specification sections.

1.2 DEFINITIONS

- A. Day: Business/working day.
- B. Furnish: To supply, deliver, unload, and inspect for damage.
- C. Install: To unpack, assemble, erect, apply, place, finish, cure, protect, clean, start up, and make ready for use.
- D. 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.
- E. Provide: To furnish and install.
- F. Supply: Same as Furnish.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 015000
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Temporary utilities.
- B. Temporary sanitary facilities.
- C. Vehicular access and parking.
- D. Project identification sign.
- E. Field offices.

1.2 RELATED REQUIREMENTS

- A. A. NFPA 241: Standard For Safeguarding Construction, Alteration, and Demolition Operations".
www.nfpa.org.

1.3 TEMPORARY UTILITIES

- A. Provide and pay for all electrical power, lighting, water, heating and cooling, and ventilation required for construction purposes.
- B. New permanent facilities may be used.
- C. Use trigger-operated nozzles for water hoses, to avoid waste of water.

1.4 TEMPORARY SANITARY FACILITIES

- A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization.
- B. New permanent facilities may not be used during construction operations.
- C. Maintain daily in clean and sanitary condition.
- D. At end of construction, return facilities to same or better condition as originally found.

1.5 EXTERIOR ENCLOSURES

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

1.6 VEHICULAR ACCESS AND PARKING

- A. Comply with regulations relating to use of streets and sidewalks, access to emergency facilities, and access for emergency vehicles.
- B. Coordinate access and haul routes with governing authorities and 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.

1.7 PROJECT IDENTIFICATION

- A. Provide a project identification sign of design and construction as approved by Architect. Submit proposed design for review prior to fabrication.
- B. Erect on site at location established by Architect.
- C. No other signs are allowed without Owner permission except those required by law.

1.8 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. Grade site as indicated.
- C. Clean and repair damage caused by installation or use of temporary work.
- D. Restore new permanent facilities used during construction to specified condition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 016000 PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 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.

1.2 RELATED REQUIREMENTS

- A. Section 017419 - Construction Waste Management and Disposal: Waste disposal requirements potentially affecting product selection, packaging and substitutions.

1.3 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

2.1 NEW PRODUCTS

- A. Provide new products unless specifically required or permitted by the Contract Documents.
- B. Where other criteria are met, Contractor shall give preference to products that:
 - 1. Are extracted, harvested, and/or manufactured closer to the location of the project.
 - 2. Have longer documented life span under normal use.
 - 3. Result in less construction waste. See Section 017419
 - 4. Are made of vegetable materials that are rapidly renewable.
 - 5. Are made of recycled materials.

2.2 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. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

2.3 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

3.1 SUBSTITUTION PROCEDURES

- A. Comply with requirements specified in this section. Substitutions shall be considered for comparable product(s) which have the indicated qualities or basis-of-design characteristics related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of the specified product(s).
- B. Architect will consider requests for substitutions only within 15 days after date of Agreement.
- C. Substitutions will be considered when a product becomes unavailable through no fault of the Contractor.
- D. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.
- E. A request for substitution constitutes a representation that the submitter:
 - 1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
 - 2. Will provide the same warranty for the substitution as for the specified product.
 - 3. Will coordinate installation and make changes to other Work that may be required for the Work to be complete with no additional cost to Owner.
 - 4. Waives claims for additional costs or time extension that may subsequently become apparent.
- F. Substitutions will not be considered at any time, when they are indicated or implied on shop drawing or product data submittals, without separate written request on form hereto attached, or when acceptance will require revision to the Contract Documents.
- G. Substitution Submittal Procedure:
 - 1. Submit one PDF of request for substitution for consideration. Limit each request to one proposed substitution. Submit on form at the end of this Section.
 - 2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence. Burden of proof is on proposer.
 - 3. The Architect will notify Contractor in writing of decision to accept or reject request.
 - 4. If substitution is not acceptable, Contractor will provide specified product (s).

3.2 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.

3.3 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.

- B. Store and protect products in accordance with manufacturers' instructions.
- C. Store with seals and labels intact and legible.
- D. Store sensitive products in weathertight, climate-controlled enclosures in an environment favorable to product.
- E. For exterior storage of fabricated products, place on sloped supports above ground.
- F. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.
- G. Comply with manufacturer's warranty conditions, if any.
- H. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- I. Prevent contact with material that may cause corrosion, discoloration, or staining.
- J. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- K. 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

**SECTION 017000
EXECUTION AND CLOSEOUT REQUIREMENTS**

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. 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.
- C. Cutting and Patching: Submit written request in advance of cutting or alteration that affects:
 - 1. Structural integrity of any element of Project.
 - 2. Integrity of weather exposed or moisture resistant element.
 - 3. Efficiency, maintenance, or safety of any operational element.
 - 4. Visual qualities of sight exposed elements.
 - 5. Work of Owner or separate Contractor.
 - 6. Include in request:
 - a. Identification of Project.
 - b. Location and description of affected work.
 - c. Necessity for cutting or alteration.
 - d. Description of proposed work and products to be used.
 - e. Effect on work of Owner or separate Contractor.
 - f. Written permission of affected separate Contractor.
 - g. Date and time work will be executed.
- D. Project Record Documents: Accurately record actual locations of capped and active utilities.

1.3 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

2.1 PATCHING MATERIALS

- A. New Materials: As specified in product sections; match existing products and work for patching and extending work.
- B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.
- C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 016000 - Product Requirements.

PART 3 EXECUTION

3.1 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.

3.2 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.

3.3 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 electronic copies to Architect, Owner, participants, and those affected by decisions made.

3.4 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.

3.5 CUTTING AND PATCHING

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes.
 - 1. Repairing includes:
 - a. Replacing defective parts
 - b. Refinishing damaged surfaces
 - c. Touching up with matching materials
 - d. Properly adjusting operating equipment.
- B. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- C. Whenever possible, execute the work by methods that avoid cutting or patching.
- D. 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.
- E. 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.
- F. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.
- G. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
- H. Restore work with new products in accordance with requirements of Contract Documents.
- I. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- J. 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.
- K. 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.

3.6 PROGRESS CLEANING

- A. Dispose of materials lawfully.
 - 1. Containerize hazardous and sanitary waste materials separately from other waste.
 - 2. Mark containers appropriately and dispose of legally, according to regulations.
- B. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
- C. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.
- D. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.
- E. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.
- F. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.

3.7 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. Protect work from spilled liquids. If work is exposed to spilled liquids, immediately remove protective coverings, dry out work, and replace protective coverings.
- G. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- H. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

3.8 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.

3.9 DEMONSTRATION AND INSTRUCTION

- A. See Section 017900 - Demonstration and Training.

3.10 ADJUSTING

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.

3.11 FINAL CLEANING

- A. Execute final cleaning prior to final project assessment.
 - 1. Clean areas to be occupied by Owner prior to final completion before Owner occupancy.
- B. Use cleaning materials that are nonhazardous.
- C. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
- D. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.
- E. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
- F. Clean filters of operating equipment.
- G. Clean debris from roofs, scuppers, overflow drains, area drains, and drainage systems.
- H. Clean site; sweep paved areas, rake clean landscaped surfaces.
- I. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.
- J. Engage an experienced, licensed exterminator to make a final inspection and rid Project of rodents, insects, and other pests. Prepare a report and provide to Owner with a copy of warranty.

3.12 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
1. Prepare a list of items to be completed and corrected (punch list), identify the value of items on the list, and reasons why the Work is not complete. Include an expected date of completion.
 2. Advise Owner of pending insurance changeover requirements.
 3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents
 4. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 5. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs and photographic negatives, damage or settlement surveys, property surveys, and similar final record information.
 6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
 7. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 8. Complete startup testing of systems.
 9. Submit test/adjust/balance records, if any.
 10. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 11. Advise Owner of changeover in heat and other utilities.
 12. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
 13. Complete final cleaning requirements, including touchup painting.
 14. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

3.13 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. Accompany Project Coordinator on Contractor's preliminary final inspection.
- H. Notify Architect when work is considered finally complete and ready for Architect's Substantial Completion final inspection.
- I. Complete items of work determined by Architect listed in executed Certificate of Substantial Completion.

3.14 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

**SECTION 017800
CLOSEOUT SUBMITTALS**

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 013000 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
- B. Individual Product Sections: Specific requirements for operation and maintenance data.
- C. Individual Product Sections: Warranties required for specific products or Work.

1.3 SUBMITTALS

- A. Project Record Documents: Submit documents to Architect with claim for final Application for Payment.
- B. Operation and Maintenance Data:
 - 1. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Architect will review draft and return one copy with comments.
 - 2. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
 - 3. Submit one 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.
 - 4. 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

3.1 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.

3.2 OPERATION AND MAINTENANCE DATA

- A. Source Data: For each product or system, list names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
- B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.
- D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3.3 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.
- 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.

3.4 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

- A. For Each Item of Equipment and Each System:
 1. Description of unit or system, and component parts.
 2. Identify function, normal operating characteristics, and limiting conditions.
 3. Include performance curves, with engineering data and tests.
 4. Complete nomenclature and model number of replaceable parts.
- B. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
- C. 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.
- D. Provide servicing and lubrication schedule, and list of lubricants required.
- E. Include manufacturer's printed operation and maintenance instructions.
- F. Include sequence of operation by controls manufacturer.
- G. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

- H. Additional Requirements: As specified in individual product specification sections.

3.5 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

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

3.6 WARRANTIES AND BONDS

- A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.
- 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. Manual: Bind in commercial quality 8-1/2 by 11 inch three D side ring binders with durable plastic covers.
- F. Cover: Identify each binder with typed or printed title WARRANTIES AND BONDS, with title of Project; name, address and telephone number of Contractor and equipment supplier; and name of responsible company principal.
- G. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification section in which specified, and the name of product or work item.

- H. Separate each warranty or bond with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

END OF SECTION

**SECTION 017900
DEMONSTRATION AND TRAINING**

PART 1 GENERAL

1.1 SUMMARY

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

1.2 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures; except:
- B. Draft Training Plans: Owner will designate personnel to be trained; tailor training to needs and skill-level of attendees.
 - 1. Submit to Commissioning Authority for review and inclusion in overall training plan.
 - 2. Submit not less than four weeks prior to start of training.
 - 3. Revise and resubmit until acceptable.
 - 4. Provide an overall schedule showing all training sessions.
 - 5. Include at least the following for each training session:
 - a. Identification, date, time, and duration.
 - b. Description of products and/or systems to be covered.
 - c. Name of firm and person conducting training; include qualifications.
 - d. Intended audience, such as job description.
 - e. Objectives of training and suggested methods of ensuring adequate training.
 - f. Methods to be used, such as classroom lecture, live demonstrations, hands-on, etc.
 - g. Media to be used, such as slides, hand-outs, etc.
 - h. Training equipment required, such as projector, projection screen, etc., to be provided by Contractor.
- 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. Training Reports:
 - 1. Identification of each training session, date, time, and duration.
 - 2. Sign-in sheet showing names and job titles of attendees.
 - 3. List of attendee questions and written answers given, including copies of and references to supporting documentation required for clarification; include answers to questions that could not be answered in original training session.
 - 4. Include Commissioning Authority's formal acceptance of training session.

1.3 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

3.1 DEMONSTRATION - GENERAL

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

3.2 TRAINING - GENERAL

- A. Commissioning Authority will prepare the Training Plan based on draft plans submitted.
- B. Conduct training on-site unless otherwise indicated.
- C. Owner will provide classroom and seating at no cost to Contractor.
- D. Do not start training until Functional Testing is complete, unless otherwise specified or approved by the Commissioning Authority.
- E. Provide training in minimum two hour segments.
- F. The Commissioning Authority is responsible for determining that the training was satisfactorily completed and will provide approval forms.
- G. Training schedule will be subject to availability of Owner's personnel to be trained; 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.
- H. 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.
- I. 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.
- J. 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

SECTION 030516
UNDERSLAB VAPOR BARRIER - STEGO

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Sheet vapor barrier under concrete slabs on grade.

1.2 REFERENCE STANDARDS

- A. 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.
- B. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs 2017.

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturers' data on manufactured products.
- C. Test Data: Submit report of tests showing compliance with specified requirements.
- D. Samples: Submit samples of underslab vapor barrier to be used.
- E. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent construction.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Underslab Vapor Barrier:
 - 1. Water Vapor Permeance: Not more than 0.010 perms, maximum.
 - 2. Complying with ASTM E1745 Class A.
 - 3. Thickness: 15 mils.
 - 4. Basis of Design:
 - a. Stego Industries LLC; Stego Wrap Vapor Barrier (15-mil): www.stegoindustries.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- B. Accessory Products: Vapor barrier manufacturer's recommended tape, adhesive, mastic, etc., for sealing seams and penetrations in vapor barrier.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that surface over which vapor barrier is to be installed is complete and ready before proceeding with installation of vapor barrier.

3.2 INSTALLATION

- A. Install vapor barrier in accordance with manufacturer's instructions and ASTM E1643.
- B. Install vapor barrier under interior slabs on grade; lap sheet over footings and seal to foundation walls.
- C. Lap joints minimum 6 inches.
- D. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions.
- E. No penetration of vapor barrier is allowed except for reinforcing steel and permanent utilities.
- F. Repair damaged vapor retarder before covering with other materials.

END OF SECTION

**SECTION 033511
CONCRETE FLOOR FINISHES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Surface treatments for concrete floors and slabs.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with concrete floor placement and concrete floor curing.

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's published data on each finishing product, including information on compatibility of different products and limitations.
- C. Maintenance Data: Provide data on maintenance and renewal of applied finishes.

1.4 MOCK-UP

- A. For coatings, construct mock-up area under conditions similar to those that will exist during application, with coatings applied.
- B. Mock-Up Size: 10 feet square.
- C. Locate where directed.
- D. Mock-up may remain as part of the work.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's sealed packaging, including application instructions.

1.6 FIELD CONDITIONS

- A. Maintain light level equivalent to a minimum 200 W light source at 8 feet above the floor surface over each 20 foot square area of floor being finished.
- B. Do not finish floors until interior heating system is operational.
- C. Maintain ambient temperature of 50 degrees F minimum.

PART 2 PRODUCTS

2.1 COATINGS

- A. High Gloss Clear Coating: Transparent, non-yellowing, water- or solvent-based coating.
 - 1. Composition: Acrylic polymer-based.
 - 2. Nonvolatile Content: 15 percent, minimum, when measured by volume.
 - 3. Products:
 - a. Dayton Superior Corporation; Ultra Seal EF: www.daytonsuperior.com/#sle.
 - b. Euclid Chemical Company; ULTRAGUARD: www.euclidchemical.com/#sle.
 - c. PROSOCO, Inc; LSGuard: www.prosoco.com/consolideck/#sle.
 - d. SpecChem, LLC; Deco Shine: www.specchemllc.com/#sle.
 - e. W. R. Meadows, Inc; Decra-Seal W/B: www.wrmeadows.com/#sle.
 - f. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.1 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.

3.2 GENERAL

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

3.3 COATING APPLICATION

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

END OF SECTION

**SECTION 042000
UNIT MASONRY**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Clay facing brick.
- B. Mortar.
- C. Reinforcement and anchorage.
- D. Flashings.
- E. Lintels.
- F. Accessories.

1.2 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- B. ASTM C67/C67M - Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile 2021.
- C. ASTM C90 - Standard Specification for Loadbearing Concrete Masonry Units 2022.
- D. ASTM C91/C91M - Standard Specification for Masonry Cement 2018.
- E. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar 2018.
- F. ASTM C150/C150M - Standard Specification for Portland Cement 2021.
- G. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes 2018.
- H. ASTM C216 - Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale) 2022.
- I. ASTM C270 - Standard Specification for Mortar for Unit Masonry 2019a, with Editorial Revision.
- J. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry 2020.
- K. ASTM C1714/C1714M - Standard Specification for Preblended Dry Mortar Mix for Unit Masonry 2019a.
- L. BIA Technical Notes No. 7 - Water Penetration Resistance – Design and Detailing 2017.
- M. BIA Technical Notes No. 13 - Ceramic Glazed Brick Exterior Walls 2017.
- N. BIA Technical Notes No. 28B - Brick Veneer/Steel Stud Walls 2005.
- O. BIA Technical Notes No. 46 - Maintenance of Brick Masonry 2017.
- P. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures 2016.

1.3 ADMINISTRATIVE REQUIREMENTS

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

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for masonry units, mortar, and masonry accessories.
- C. Samples: Submit four samples of facing brick units to illustrate color, texture, and extremes of color range.
- D. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.
- E. Manufacturer's Certificate: Certify that water repellent admixture manufacturer has certified masonry unit manufacturer as an approved user of water repellent admixture in the manufacture of concrete block.
- F. Test Reports: Concrete masonry manufacturer's test reports for units with integral water repellent admixture.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.

1.5 QUALITY ASSURANCE

- A. Comply with provisions of TMS 402/602, except where exceeded by requirements of the contract documents.
- B. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section with minimum three years of documented experience.
- C. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.6 MOCK-UP

- A. Construct a masonry wall as a mock-up panel sized 8 feet long by 6 feet high; include mortar, accessories, structural backup, and flashings (with lap joint, corner, and end dam) in mock-up.
- B. Locate where directed.
- C. Mock-up may remain as part of the Work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

PART 2 PRODUCTS

2.1 BRICK UNITS

- A. Manufacturers:
 - 1. Acme Brick: brick.com.
 - 2. Boral Bricks, Inc: www.boralbricks.com/#sle.
 - 3. Endicott Clay Products Co: www.endicott.com/#sle.
 - 4. General Shale Brick: www.generalshale.com/#sle.
 - 5. Substitutions: See section 016000 - Product Requirements.
- B. Facing Brick: ASTM C216, Type FBS Smooth, Grade SW.
 - 1. Color and texture: As scheduled.
 - 2. Nominal size: As indicated on drawings.
 - 3. Special shapes: Molded units as required by conditions indicated, unless standard units can be sawn to produce equivalent effect.
 - 4. Compressive strength: As indicated on drawings, measured in accordance with ASTM C67/C67M.

2.2 MORTAR MATERIALS

- A. Masonry Cement: ASTM C91/C91M, Type N.
 - 1. Colored Mortar: Premixed cement as required to match Architect's color sample.
- B. Portland Cement: ASTM C150/C150M, Type I; color as required to produce approved color sample.
 - 1. Not more than 0.60 percent alkali.
- C. Hydrated Lime: ASTM C207, Type S.
- D. Mortar Aggregate: ASTM C144.
- E. Water: Clean and potable.
- F. Accelerating Admixture: Nonchloride type for use in cold weather.
- G. Packaged Dry Material for Mortar for Unit Masonry: Premixed Portland cement, hydrated lime, and sand; complying with ASTM C1714/C1714M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
 - 1. Color: Mineral pigments added as required to produce approved color sample.
 - 2. Water-repellent mortar for use with water repellent masonry units.
 - 3. Manufacturers:
 - a. Amerimix, an Oldcastle brand; AMX 410: www.amerimix.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

2.3 REINFORCEMENT AND ANCHORAGE

- A. Manufacturers:
 - 1. Hohmann & Barnard, Inc: www.h-b.com/#sle.
 - 2. WIRE-BOND; []www.wirebond.com/#sle.
 - 3. Substitutions: See Section 016000 - Product Requirements.
- B. Flexible Anchors: 2-piece anchors that permit differential movement between masonry and building frame, sized to provide not less than 5/8 inch of mortar coverage from masonry face.
 - 1. Steel frame: Crimped wire anchors for welding to frame, 0.25 inch thick, with trapezoidal wire ties 0.1875 inch thick, hot dip galvanized to ASTM A 153/A 153M, Class B.
- C. Masonry Veneer Anchors: 2-piece anchors that permit differential movement between masonry veneer and structural backup, hot dip galvanized to ASTM A 153/A 153M, Class B.
 - 1. Anchor plates: Not less than 0.075 inch thick, designed for fastening to structural backup through sheathing by two fasteners; provide design with legs that penetrate sheathing and insulation to provide positive anchorage.
 - 2. Wire ties: Manufacturer's standard shape, 0.1875 inch thick.
 - 3. Vertical adjustment: Not less than 3-1/2 inches.
- D. Metal-to-Metal Fasteners: Self-drilling, self-tapping screws; corrosion resistant finish or hot dip galvanized to ASTM A153/A153M.
 - 1. Manufacturers:
 - a. ITW Commercial Construction North America; Teks Select Series: www.ITWBuildex.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

2.4 FLASHINGS

- A. Stainless Steel/Polymer Fabric Flashing: ASTM A240/A240M; 2 mil type 304 stainless steel sheet bonded on one side to one sheet of polymer fabric.
 - 1. Manufacturers:
 - a. Hohmann & Barnard, Inc; Mighty-Flash Stainless Flashing: www.h-b.com/#sle.
 - b. York Manufacturing, Inc; Multi-Flash SS: www.yorkmfg.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
- B. Flashing Sealant/Adhesives: Silicone, polyurethane, or silyl-terminated polyether/polyurethane or other type required or recommended by flashing manufacturer; type capable of adhering to type of flashing used.

2.5 ACCESSORIES

- A. Preformed Control Joints: Rubber material. Provide with corner and tee accessories, fused joints.
 - 1. Manufacturers:
 - a. Blok-Lok Limited: www.blok-lok.com/#sle.
 - b. Hohmann & Barnard, Inc: www.h-b.com/#sle.
 - c. WIRE-BOND: www.wirebond.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- B. Joint Filler: Closed cell polyvinyl chloride; oversized 50 percent to joint width; self expanding; in maximum lengths available.
 - 1. Manufacturers:
 - a. Hohmann & Barnard, Inc: www.h-b.com/#sle.
 - b. WIRE-BOND: www.wirebond.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
- C. Cavity Mortar Control: Semi-rigid polyethylene or polyester mesh panels, sized to thickness of wall cavity, and designed to prevent mortar droppings from clogging weeps and cavity vents and allow proper cavity drainage.
 - 1. Mortar Diverter: Semi-rigid mesh designed for installation at flashing locations.
 - a. Manufacturers:
 - 1) Advanced Building Products Inc; Mortar Break DT: www.advancedbuildingproducts.com/#sle.
 - 2) Mortar Net Solutions: www.mortarnet.com/#sle.

- 3) Substitutions: See Section 016000 - Product Requirements.
 - D. Weeps:
 - 1. Type: Molded PVC grilles, insect resistant.
 - 2. Manufacturers:
 - a. Advanced Building Products, Inc: www.advancedbuildingproducts.com/#sle.
 - b. Blok-Lok Limited: www.blok-lok.com/#sle.
 - c. Hohmann & Barnard, Inc; QV - Quadro-Vent: www.h-b.com/#sle.
 - d. WIRE-BOND: www.wirebond.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
 - E. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.
- 2.6 LINTELS
- A. Steel Lintels - See Section 055000.
- 2.7 MORTAR MIXING
- A. Mortar for Unit Masonry: ASTM C270, using the Property Specification.
 - 1. Exterior, non-loadbearing masonry: Type N.
 - B. Colored Mortar: Proportion selected pigments and other ingredients to match Architect's sample, without exceeding manufacturer's recommended pigment-to-cement ratio.
 - C. Admixtures: Add to mixture at manufacturer's recommended rate and in accordance with manufacturer's instructions; mix uniformly.
 - D. Mixing: Use mechanical batch mixer and comply with referenced standards.

PART 3 EXECUTION

- 3.1 EXAMINATION
- A. Verify that field conditions are acceptable and are ready to receive masonry.
 - B. Verify that related items provided under other sections are properly sized and located.
 - C. Verify that built-in items are in proper location, and ready for roughing into masonry work.
- 3.2 PREPARATION
- A. Direct and coordinate placement of metal anchors supplied for installation under other sections.
 - B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.
- 3.3 COLD AND HOT WEATHER REQUIREMENTS
- A. Comply with requirements of TMS 402/602 or applicable building code, whichever is more stringent.
- 3.4 COURSING
- A. Establish lines, levels, and coursing indicated. Protect from displacement.
 - B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
 - C. Brick Units:
 - 1. Bond: As indicated.
 - 2. Coursing: Three units and three mortar joints to equal 8 inches.
 - 3. Mortar Joints: Concave.
- 3.5 PLACING AND BONDING
- A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
 - B. Lay hollow masonry units with face shell bedding on head and bed joints.
 - C. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
 - D. Remove excess mortar and mortar smears as work progresses.
 - E. Interlock intersections and external corners.

- F. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- G. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
- H. Cut mortar joints flush where wall tile is scheduled or resilient base is scheduled.
- I. Isolate masonry partitions from vertical structural framing members with a control joint as indicated.
- J. Isolate top joint of masonry partitions from horizontal structural framing members and slabs or decks with compressible joint filler.

3.6 WEEPS/CAVITY VENTS

- A. Install weeps in veneer walls at 24 inches on center horizontally above through-wall flashing, above shelf angles and lintels, and at bottom of walls.
- B. Install cavity vents in veneer walls at 32 inches on center horizontally below shelf angles and lintels and near top of walls.

3.7 CAVITY MORTAR CONTROL

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

3.8 REINFORCEMENT AND ANCHORAGE - GENERAL

- A. Unless otherwise indicated on drawings or specified under specific wall type, install horizontal joint reinforcement 16 inches on center.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.
- C. Place continuous joint reinforcement in first and second joint below top of walls.
- D. Lap joint reinforcement ends minimum 6 inches.
- E. Fasten anchors to structural framing and embed in masonry joints as masonry is laid. Unless otherwise indicated on drawings or closer spacing is indicated under specific wall type, space anchors at maximum of 36 inches horizontally and 24 inches vertically.

3.9 REINFORCEMENT AND ANCHORAGE - MASONRY VENEER

- A. Stud Back-Up: Secure veneer anchors to stud framed back-up and embed into masonry veneer at maximum 16 inches on center vertically and 24 inches on center horizontally. Place additional anchors at perimeter of openings and ends of panels, so maximum spacing of anchors is 8 inches on center.

3.10 MASONRY FLASHINGS

- A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.
 - 1. Extend flashings full width at such interruptions and at least 6 inches, minimum, into adjacent masonry or turn up flashing ends at least 1 inch, minimum, to form watertight pan at non-masonry construction.
 - 2. Remove or cover protrusions or sharp edges that could puncture flashings.
 - 3. Seal lapped ends and penetrations of flashing before covering with mortar.
- B. Terminate flashing up 8 inches minimum on vertical surface of backing:
- C. Lap end joints of flashings at least 6 inches, minimum, and seal watertight with flashing sealant/adhesive.

3.11 LINTELS

- A. Install steel lintels over openings.
- B. Maintain minimum 4 inch bearing on each side of opening.

3.12 CONTROL AND EXPANSION JOINTS

- A. Do not continue horizontal joint reinforcement through control or expansion joints.
- B. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.
- C. Size control joints as indicated on drawings; if not indicated, 3/4 inch wide and deep.
- D. Form expansion joint as detailed on drawings.

3.13 BUILT-IN WORK

- A. As work progresses, install built-in metal door frames and glazed frames and other items to be built into the work and furnished under other sections.
- B. Install built-in items plumb, level, and true to line.
- C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout.
 - 1. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.
- D. Do not build into masonry construction organic materials that are subject to deterioration.

3.14 TOLERANCES

- A. Maximum Variation from Alignment of Columns: 1/4 inch.
- B. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
- C. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.
- D. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
- E. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.
- F. Maximum Variation of Mortar Joint Thickness: Head joint, minus 1/4 inch, plus 3/8 inch.
- G. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.15 CUTTING AND FITTING

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

3.16 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 014000 - Quality Requirements.
- B. Clay Masonry Unit Tests: Test each variety of clay masonry in accordance with ASTM C67/C67M requirements, sampling 5 randomly chosen units for each 50,000 installed.
- C. Mortar Tests: Test each type of mortar in accordance with ASTM C780, testing with same frequency as masonry samples.

3.17 CLEANING

- A. Remove excess mortar and mortar droppings.
- B. Replace defective mortar. Match adjacent work.
- C. Clean soiled surfaces with cleaning solution.
- D. Use non-metallic tools in cleaning operations.

3.18 PROTECTION

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

END OF SECTION

SECTION 042616
ADHERED MASONRY VENEER

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Thin stone.
- B. Adhesives.
- C. Accessories.

1.2 REFERENCE STANDARDS

- A. BIA Technical Notes No. 7 - Water Penetration Resistance – Design and Detailing 2017.
- B. BIA Technical Notes No. 28B - Brick Veneer/Steel Stud Walls 2005.
- C. BIA Technical Notes No. 46 - Maintenance of Brick Masonry 2017.
- D. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation 2021.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week before starting work of this section.

1.4 SUBMITTALS

- A. Product Data: Provide data for thin brick units, mortar, and adhesive.
- B. Samples: Submit four samples of thin brick units to illustrate color, texture, and extremes of color range.
- C. Manufacturer's Certificate: Certify that thin brick units, adhesives, mortar, and grout meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum five years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of type specified and with at least five years of documented experience.

1.6 MOCK-UP

- A. Construct a separate mock-up panel sized 8 feet long by 6 feet high; include mortar, grout, adhesives, accessories, substrate, and representative wall openings in mock-up.
- B. Locate where directed.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.
- B. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

1.8 FIELD CONDITIONS

- A. Do not install adhesives in an unventilated environment.
- B. Cold and Hot Weather Requirements: Comply with requirements of TMS 402/602 or applicable building code, whichever is more stringent.

1.9 WARRANTY

- A. Provide manufacturer's system warranty against defects in materials and workmanship of manufactured materials.
 - 1. Warranty Period: One year after Substantial Completion.

PART 2 PRODUCTS

2.1 THIN STONE

- A. Manufactured Stone:
 - 1. Acceptable Products: As scheduled or selected by Architect.

2.2 ADHESIVE MATERIALS

- A. Manufacturers:
 - 1. LATICRETE International, Inc: www.laticrete.com/#sle.
 - 2. Mapei Corporation: www.mapei.com/#sle.
 - 3. Parex USA Inc: www.parexusa.com/#sle.
- B. Thin-Set Mortar: ANSI A118.4, polymer-modified; freeze-thaw stable.

2.3 FLASHINGS

- A. Stainless Steel: ASTM A666, Type 304, soft temper; 26 gage, 0.0187 inch thick; finish 2B to 2D.
- B. Flashing Sealant/Adhesives: Silicone, polyurethane, or silyl-terminated polyether/polyurethane, or other type required or recommended by flashing manufacturer; type capable of adhering to type of flashing used.

2.4 ACCESSORIES

- A. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.
- B. Air and Water Barrier: Single component, fluid applied, vapor permeable; waterproofing, crack isolation, and air barrier membrane.
 - 1. Manufacturers:
 - a. LATICRETE International, Inc; LATICRETE MVIS Air & Water Barrier: www.laticrete.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive thin brick veneer.
- B. Verify that related items provided under other sections are properly sized and located.
- C. Verify that built-in items are in proper location, and ready for installation of thin brick veneer.

3.2 INSTALLATION

- A. Exterior Applications: Comply with TCNA (HB) Method W244E.

3.3 PLACING AND BONDING

- A. Remove excess mortar as work progresses.
- B. Interlock intersections and external corners, except for units laid in stack bond.
- C. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove and replace.
- D. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

3.4 MASONRY FLASHINGS

- A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.
 - 1. Extend flashings full width at such interruptions at least 6 inches, minimum, to form watertight pan.
 - 2. Remove or cover protrusions or sharp edges that could puncture flashings.
 - 3. Seal lapped ends and penetrations of flashing before covering with mortar.
- B. Extend metal flashings to within 1/4 inch of exterior face of masonry.
- C. Lap end joints of flashings at least 6 inches, minimum, and seal watertight with flashing sealant/adhesive.

3.5 CONTROL AND EXPANSION JOINTS

- A. Form joints as detailed on drawings.

3.6 TOLERANCES

- A. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
- B. Maximum Variation from Plane of Wall: 1/4 inch in 10 feet and 1/2 inch in 20 feet or more.
- C. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
- D. Maximum Variation from Level Coursing: 1/8 inch in 3 feet and 1/4 inch in 10 feet; 1/2 inch in 30 feet.
- E. Maximum Variation of Joint Thickness: 1/8 inch in 3 ft.

3.7 CUTTING AND FITTING

- A. Cut and fit for pipes and conduit. Coordinate with other sections of work to provide correct size, shape, and location.

3.8 CLEANING

- A. Remove excess mortar and mortar smears as work progresses.
- B. Replace defective mortar. Match adjacent work.
- C. Clean soiled surfaces with cleaning solution.
- D. Use non-metallic tools in cleaning operations.

3.9 PROTECTION

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

END OF SECTION

SECTION 051213
ARCHITECTURALLY-EXPOSED STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Additional requirements for structural steel members designated as architecturally-exposed structural steel (AESS).

1.2 DEFINITIONS

- A. Architecturally-Exposed Structural Steel: Structural steel complying with designated AESS category as defined in AISC 303.

1.3 REFERENCE STANDARDS

- A. AISC 303 - Code of Standard Practice for Steel Buildings and Bridges 2016.
- B. AISC 360 - Specification for Structural Steel Buildings 2016 (Revised 2021).
- C. ASTM A6/A6M - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling 2021.
- D. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- E. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes 2021a.
- F. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings 2020.
- G. ASTM A1085/A1085M - Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS) 2015.
- H. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength 2022.
- I. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination 2020.
- J. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020, with Errata (2022).
- K. SSPC-SP 1 - Solvent Cleaning 2015, with Editorial Revision (2016).
- L. SSPC-SP 6 - Commercial Blast Cleaning 2007.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Schedule and conduct a preinstallation meeting at project site one week prior to start of work of this section; require attendance by all affected installers. Coordinate requirements for shipping, special handling, storage, attachment of safety cables and temporary erection bracing, final coating, touch-up painting, mock-up coordination, Architect's observations, and other requirements for AESS.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Detailing for fabrication of AESS components.
 - 1. Provide erection documents clearly indicating which members are AESS members and the AESS category of each part.
 - 2. Include details that clearly identify AESS requirements found in this specification. Provide connections for AESS consistent with concepts shown on drawings.
 - 3. Indicate welds by AWS A2.4 symbols, distinguishing between shop and field welds, and show size, length and type of each weld. Identify grinding, finish and profile of welds as defined by the designated AESS category.
 - 4. Indicate orientation of hollow structural section (HSS) seams and mill marks (where applicable).

5. Indicate type, size, finish and length of bolts, distinguishing between shop and field bolts. Identify high-strength bolted slip-critical, direct-tensioned shear/bearing connections. Indicate orientation of bolt heads.
 6. Indicate which surfaces or edges are exposed and what class of surface preparation is being used.
 7. Indicate special tolerances and erection requirements as noted on drawings or defined by the designated AESS category.
 8. Indicate vent or drainage holes for HSS members.
- C. AESS 1, AESS 2, AESS 3, AESS 4, and AESS C Samples: Provide samples of specific AESS characteristics. Samples may be small size samples or components of conventional structural steel demonstrating specific AESS characteristics, including surface preparation, sharp edges ground smooth, continuous weld appearance, weld show through, and fabrication mark removal.
- D. Qualification data for fabricator and erector to demonstrate their capabilities and experience. Include lists of completed projects names and address, names and addresses of architects and owners, photographs showing detail of installed AESS, and other information specified.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: In addition to those qualifications listed in Section 051200, engage an AISC Certified Fabricator, experienced in fabricating AESS similar to that indicated for this project with a record of successful in-service performance, as well as sufficient production capacity to fabricate AESS without delaying the work.
- B. Erector Qualifications: In addition to those qualifications listed in Section 051200, engage an AISC Certified Erector, experienced in erecting AESS work similar in material, design, and extent to that indicated for this project and with a record of successful in-service performance.
- C. Comply with applicable provisions of AISC 303, Section 10 for the designated AESS category.
- D. Contractor to engage a quality assurance agency per requirements of AISC 360, Chapter N and AISC 303, Section 10.

1.7 MOCK-UP

- A. Provide mock-ups for each level of AESS finish for Architect's approval.
- B. See Section 014000 - Quality Requirements for additional requirements.
- C. Locate mock-ups where directed. Mock-ups to be full-size unless Architect approves smaller models. Alternatively, when a mock-up is not practical, the first piece of an element or connection can be used to determine acceptability.
- D. Notify Architect one week in advance of dates and times when mock-ups will be available for review.
- E. Demonstrate applicable AESS characteristics for specified category of AESS on elements and joints in mock-up.
- F. Build mock-ups using member sizes and materials indicated for final work.
- G. Mock-up to demonstrate weld quality, contouring of welds at aligned walls of members, specified surface preparation, and finish coating.
- H. HSS members to extend at least 6 inches from joint in mock-up.
- I. Obtain Architect's written approval of mock-ups before starting fabrication.
- J. Retain and maintain mock-ups during construction in an undisturbed condition as a standard for judging completed work.
- K. Approved mock-ups in an undisturbed condition at Date of Substantial Completion may become part of completed work.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Handle finished pieces in accordance with Section 10 of AISC 303, using nylon-type slings, or chains with softeners, or wire ropes with softeners such that they are not damaged.
- B. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration. Use special care in handling to prevent twisting or warping of AESS members.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Comply with Section 051200, except as amended in this section for aesthetic purposes.

2.2 FABRICATION

- A. Fabricate and assemble AESS in shop to greatest extent possible. Locate field joints in AESS assemblies at concealed locations or as approved by Architect. Detail AESS assemblies to minimize field handling and expedite erection.
- B. Permissible tolerances for member depth, width, out of square, and camber and sweep to be as specified in ASTM A6/A6M, ASTM A500/A500M, and ASTM A1085/A1085M.
- C. Use special care in handling and shipping of AESS both before and after shop painting to minimize damage to any shop finish. Use nylon-type slings or softeners when using chains or wire rope slings.
- D. Bolted Connections:
 - 1. Make in accordance with Section 051200. Provide bolt type and finish as noted herein.
- E. Welded Connections:
 - 1. Comply with AWS D1.1/D1.1M and Section 051200.
 - 2. Assemble and weld built-up sections by methods that will maintain alignment of members without warp exceeding tolerances of this section.
- F. Surface Preparation:
 - 1. Remove blemishes or unsightly surfaces resulting from temporary braces or fixtures.
 - 2. Remove backing and run out tabs.
- G. Fabricate AESS in accordance with categories defined in AISC 303, as follows:
 - 1. AESS 1: Basic elements.
 - 2. AESS 2: Feature elements viewed at a distance greater than 20 feet (feature elements not in close view).
 - 3. AESS 3: Feature elements viewed at a distance less than 20 feet (feature elements in close view).
 - 4. AESS 4: Showcase elements with special surface and edge treatment beyond fabrication (showcase elements).
 - 5. AESS C: Custom elements; fabricate to requirements of AESS 1 and the following characteristics:

2.3 PAINT SYSTEM

- A. Compatibility: All components/procedures of AESS paint system to conform to coating system specified, submitted, and approved per Section 099100. As a minimum, identify required surface preparation, primer, intermediate coat (if applicable), and finish coat. Primer, intermediate coating, and finish coating to be from a single manufacturer combined in a system documented by manufacturer with adequate guidance for fabricator to procure and execute.
- B. Primer: As specified in Section 099100. Primer to comply with all federal standards for VOC, lead and chromate levels.
- C. Finish Coating: Field apply intermediate and top coats per Section 09 9000.

2.4 SHOP PRIMING

- A. Surface Preparation:
 - 1. Provide surface preparations to meet SSPC-SP 6.
 - 2. Coordinate required surface profile with approved paint submittal prior to beginning surface preparation.
 - 3. Prior to blasting, remove any grease and oil using solvent cleaning to meet SSPC-SP 1.
 - 4. Remove weld spatter, slivers and similar surface discontinuities.
 - 5. Ease sharp corners resulting from shearing, flame cutting or grinding.
- B. Shop prime structural steel members. Do not prime surfaces that will be fireproofed, field welded, in contact with concrete, or high strength bolted with slip-critical connections.
 - 1. Extend priming of members partially embedded in concrete or mortar to a depth of 2 inches.

- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's instructions to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 - 2. Apply two coats of shop primer to surfaces that are inaccessible after assembly or erection.

2.5 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by hot-dip process to AESS indicated for galvanizing according to ASTM A123/A123M. Fabricate such that all connections of assemblies are made in the field with bolted connections where possible.

2.6 MATERIALS

- A. General: Meet requirements of 051200 as amended below.
- B. Tension Control, High-Strength Bolts, Nuts, and Washers: Per section 051200, Tension Control Bolts. Provide standard carbon steel finish rounded bolt heads with twist off bolts; ASTM F3125/F3125M.

2.7 SOURCE QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Structural Requirements:
 - 1. Comply with quality control requirements per AISC 360, Chapter N and AISC 303, Section 10. Refer to Section 051200 for additional requirements.
- C. AESS 1 and 2 Acceptance: Architect to observe AESS in the shop at a viewing distance consistent with final installation and determine acceptability based on qualification data and submittals. Quality assurance agency has no responsibility for enforcing requirements related to aesthetic effect.
- D. AESS 3,4, and C Acceptance: Architect to observe AESS in the shop at a viewing distance consistent with final installation and determine acceptability based on approved mock-up. Quality assurance agency has no responsibility for enforcing requirements related to aesthetic effect.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Erector to check all AESS members upon delivery for twist, kinks, gouges or other imperfections which may result in rejection of appearance of member. Coordinate remedial action with fabricator prior to erecting steel.

3.2 PREPARATION

- A. Provide connections for temporary shoring, bracing and supports only where noted on approved fabrication documents. Temporary connections not shown are to be made at locations not exposed to view in final structure or as approved by Architect.
- B. Handle, lift and align pieces using nylon straps or chains with softeners required to maintain appearance of AESS through process of erection.

3.3 ERECTION

- A. AESS 1 and 2: Basic elements; feature elements not in close view:
 - 1. Employ special care to handle and erect AESS. Erect finished pieces using nylon straps or chains with softeners such that they are not damaged.
 - 2. Place weld tabs for temporary bracing and safety cabling at points concealed from view in completed structure or where approved by Architect during pre-installation meeting. Obtain Architect approval of methods for removing temporary devices and finishing AESS members prior to erection.
 - 3. AESS Erection Tolerances: Erect to standard frame tolerances for structural steel per Chapter 7 of AISC 303.
 - 4. Set AESS accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

5. Remove blemishes or unsightly surfaces resulting from temporary braces or fixtures.
 6. Remove all backing and run out tabs.
 7. When temporary braces or fixtures are required to facilitate erection, take care to avoid any blemishes, holes or unsightly surfaces resulting from use or removal of such temporary elements.
 8. Bolted Connections: Align bolt heads on same side of connection as indicated on approved fabrication or erection documents.
 9. Welded Connections: Comply with AWS D1.1/D1.1M and Section 051200. Appearance and quality of welds to be consistent. Employ methods that will maintain alignment of members without warp exceeding tolerance of this section.
 10. Remove weld spatter exposed to view.
 11. Grind off projections larger than 1/16 inch at field butt and plug welds.
 12. Continuous Welds: Where continuous welding is noted on drawings, provide continuous welds of a uniform size and profile.
 13. Do not enlarge holes in members by burning or by using drift pins. Ream holes that must be enlarged to admit bolts. Replace connection plates that are misaligned where holes cannot be aligned with acceptable final appearance.
 14. Splice members only where indicated.
 15. Obtain permission for any torch cutting or field fabrication from Architect. Finish sections thermally cut during erection to a surface appearance consistent with mock-up.
- B. AESS 3: Feature elements in close view:
1. Erect to requirements of AESS 1 and 2 and as follows:
- C. AESS 4: Showcase elements:
1. Erect to requirements of AESS 3 and as follows:
 2. Grind welds smooth.
 3. Minimize Weld Show Through: At locations where welding on far side of an exposed connection creates distortion, grind distortion and marking of steel to a smooth profile with adjacent material.
 4. Filling of Weld Access Holes: Where holes must be cut in web at intersection with flanges on W shapes and structural tees to permit field welding of flanges, fill holes with joint filler.
 5. Where welds are indicated to be ground, contoured, or blended, oversize welds as required and grind to provide a smooth transition and match profile on approved mock-up.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Structural Requirements:
1. Comply with quality control requirements per AISC 360, Chapter N and AISC 303, Section 10. Refer to Section 051200 for additional requirements.
 2. Quality assurance agency to review work for compliance with requirements of AISC 360, Chapter N and AISC 303, Section 10.
- C. AESS 1 and 2 Acceptance: Architect to observe AESS in place and determine acceptability based on qualification data and submittals. Quality assurance agency has no responsibility for enforcing requirements related to aesthetic effect.
- D. AESS 3,4, and C Acceptance: Architect to observe AESS in place and determine acceptability based on qualification data and submittals as well as on approved mock-up. Quality assurance agency has no responsibility for enforcing requirements related to aesthetic effect.

3.5 CLEANING

- A. Touch-up Painting: Complete cleaning and touch-up painting of field welds, bolted connections, and abraded areas of shop paint to blend with adjacent surfaces of AESS. Perform touch-up work in accordance with manufacturer's instructions and as specified in Section 099113, 099123, and 099600.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas. Repair galvanized surfaces in accordance with ASTM A780/A780M.

END OF SECTION

**SECTION 054000
COLD-FORMED METAL FRAMING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Formed steel stud exterior wall framing.

1.2 REFERENCE STANDARDS

- A. AISI S100-12 - North American Specification for the Design of Cold-Formed Steel Structural Members 2012.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- D. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable 2021a.
- E. ASTM C955 - Standard Specification for Cold-Formed Steel Structural Framing Members 2018, with Editorial Revision.
- F. ASTM C1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories 2020.
- G. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020, with Errata (2022).
- H. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic) 2019.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with work of other sections that is to be installed in or adjacent to the metal framing system, including but not limited to structural anchors, cladding anchors, utilities, insulation, and firestopping.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on standard framing members; describe materials and finish, product criteria, limitations.
- C. Product Data: Provide manufacturer's data on factory-made framing connectors, showing compliance with requirements.
- D. Shop Drawings: Indicate component details, framed openings, bearing, anchorage, loading, welds, and type and location of fasteners, and accessories or items required of related work.
 - 1. Indicate stud layout.
 - 2. Describe method for securing studs to tracks and for bolted framing connections.
 - 3. Design data:
 - a. Shop drawings signed and sealed by a professional structural engineer.
- E. Manufacturer's Installation Instructions: Indicate special procedures, conditions requiring special attention.
- F. Designer's Qualification Statement.
- G. Manufacturer's Qualification Statement.

1.5 QUALITY ASSURANCE

- A. Designer Qualifications: Design framing system under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.
- B. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, and with minimum three years of documented experience.

- C. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience.

1.6 MOCK-UP

- A. Provide mock-up of exterior framed wall, including components specified elsewhere, such as insulation, sheathing, door frame, and exterior wall finish.
- B. Mock-Up Size: As indicated on drawings.
- C. Location: As directed.
- D. Mock-up may remain as part of the Work.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Metal Framing:
 - 1. CEMCO: www.cemcosteel.com/#sle.
 - 2. ClarkDietrich Building Systems: www.clarkdietrich.com/#sle.
 - 3. Marino: www.marinoware.com/#sle.
 - 4. The Steel Network, Inc: www.SteelNetwork.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.
- B. Framing Connectors and Accessories:
 - 1. Same manufacturer as metal framing.
 - 2. Simpson Strong Tie: www.strongtie.com/#sle.
 - 3. Substitutions: See Section 016000 - Product Requirements.

2.2 FRAMING SYSTEM

- A. Provide primary and secondary framing members, bridging, bracing, plates, gussets, clips, fittings, reinforcement, and fastenings as required to provide a complete framing system.
- B. Design Requirements: Provide completed framing system having the following characteristics:
 - 1. Structural Performance: Design, engineer, fabricate, and erect to withstand specified design loads for project conditions within required limits.
 - 2. Design Loads: In accordance with applicable codes.
 - 3. Live load deflection meeting the following, unless otherwise indicated:
 - a. Exterior Walls: Maximum horizontal deflection under wind load of 1/180 of span.
 - b. Design non-axial loadbearing framing to accommodate not less than 1/2 in vertical deflection.
 - 4. Able to tolerate movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperature ranges.
 - 5. Able to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.
- C. Shop fabricate framing system to the greatest extent possible.
- D. Deliver to site in largest practical sections.

2.3 FRAMING MATERIALS

- A. Studs and Track: ASTM C955; studs formed to channel, "C", or "Sigma" shape with punched web; U-shaped track in matching nominal width and compatible height.
 - 1. Gage and Depth: As required to meet specified performance levels.
 - 2. Galvanized in accordance with ASTM A653/A653M, G60/Z180 coating.
 - 3. Provide components fabricated from ASTM A1008/A1008M Designation SS (structural steel).
- B. Framing Connectors: Factory-made, formed steel sheet.
 - 1. Material: ASTM A653/A653M SS Grade 33 and 40 (minimum), with G90/Z275 hot dipped galvanized coating for base metal thickness less than 10 gage, 0.1345 inch, and factory punched holes and slots.

2. Structural Performance: Maintain load and movement capacity required by applicable code, when evaluated in accordance with AISI S100-12.
3. Movement Connections: Provide mechanical anchorage devices that accommodate movement using slotted holes, shouldered screws or screws and anti-friction or stepped bushings, while maintaining structural performance of framing. Provide movement connections where indicated on drawings.
 - a. Where top of stud wall terminates below structural floor or roof, connect studs to structure in manner allowing vertical and horizontal movement of slab without affecting studs; allow for minimum movement of 1/2 inch.
 - b. Provide top track preassembled with connection devices spaced to fit stud spacing indicated on drawings; minimum track length of 10 feet.
4. Fixed Connections: Provide non-movement connections for tie-down to foundation, floor-to-floor tie-down, roof-to-wall tie-down, joist hangers, gusset plates, and stiffeners.
5. Wall Stud Bridging Connections: Provide mechanical load-transferring devices that accommodate wind load torsion and weak axis buckling induced by axial compression loads. Provide bridging connections where indicated on the drawings.

2.4 FASTENERS

- A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot dip galvanized per ASTM A153/A153M.
 1. Products:
 - a. ITW Commercial Construction North America; ITW CCNA-Buildex Tek's Select Series: www.ITWBuildex.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- B. Anchorage Devices: Powder actuated and Drilled expansion bolts.
- C. Welding: Comply with AWS D1.1/D1.1M.

2.5 ACCESSORIES

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

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.
- B. Verify field measurements and adjust installation as required.

3.2 INSTALLATION OF STUDS

- A. Install components in accordance with manufacturers' instructions and ASTM C1007 requirements.
- B. Align floor and ceiling tracks; locate to wall layout. Secure in place with fasteners at maximum 24 inches on center. Coordinate installation of sealant with floor and ceiling tracks.
- C. Place studs at 16 inches on center; not more than 2 inches from abutting walls and at each side of openings. Connect studs to tracks using clip and tie method.
- D. Construct corners using minimum of three studs. Install double studs at wall openings, door and window jambs.
- E. Coordinate placement of insulation in multiple stud spaces made inaccessible after erection.
- F. Install intermediate studs above and below openings to align with wall stud spacing.
- G. Provide deflection allowance in stud track, directly below horizontal building framing at non-load bearing framing.
- H. Attach cross studs to studs for attachment of fixtures anchored to walls.
- I. Install framing between studs for attachment of mechanical and electrical items, and to prevent stud rotation.

- J. Touch-up field welds and damaged galvanized surfaces with primer.

3.3 TOLERANCES

- A. Maximum Variation from True Position: 1/4 inch.
- B. Maximum Variation of any Member from Plane: 1/4 inch.

END OF SECTION

**SECTION 055000
METAL FABRICATIONS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Shop fabricated steel items.
- B. Decorative weathering steel panels.

1.2 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- B. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2020.
- C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- D. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates 2018.
- E. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength 2021.
- F. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing 2021.
- G. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- H. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength 2018a.
- I. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination 2020.
- J. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020, with Errata (2022).
- K. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel AC172 2019.
- L. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer 2004.
- M. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic) 2019.
- N. SSPC-SP 2 - Hand Tool Cleaning 2018.

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's data sheets on each ladder safety system product to be used, including installation instructions.
- C. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
 - 1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
 - 2. Design data: Submit drawings and supporting calculations, signed and sealed by a qualified professional structural engineer.
 - a. Include the following, as applicable:
 - 1) Design criteria.
 - 2) Engineering analysis depicting stresses and deflections.
 - 3) Member sizes and gages.
 - 4) Details of connections.
 - 5) Support reactions.
 - 6) Bracing requirements.
- D. Welders' Certificates: Submit certification for welders employed on the project, verifying AWS qualification within the previous 12 months.
- E. Fabricator's Qualification Statement: Provide documentation showing steel fabricator is accredited under IAS AC172.

1.4 QUALITY ASSURANCE

- A. Design load bearing members 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. Fabricator Qualifications: A qualified steel fabricator that is accredited by IAS AC172.

PART 2 PRODUCTS

2.1 MATERIALS - STEEL

- A. Steel Sections: ASTM A36/A36M.
- B. Steel Tubing: ASTM A501/A501M hot-formed structural tubing.
- C. Plates: ASTM A283/A283M.
- D. Pipe: ASTM A53/A53M, Grade B Schedule 40, black finish.
- E. Slotted Channel Framing: ASTM A653/A653M, Grade 33.
- F. Slotted Channel Fittings: ASTM A1011/A1011M.
- G. Bolts, Nuts, and Washers: ASTM A307, Grade A, plain.
- H. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- I. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
- J. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.2 FABRICATION

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

2.3 FABRICATED ITEMS

- A. Ladders: Steel; in compliance with ANSI A14.3; with mounting brackets and attachments; prime paint finish.
 - 1. Side Rails: 3/8 x 2 inches members spaced at 20 inches.
 - 2. Rungs: one inch diameter solid round bar spaced 12 inches on center.
 - 3. Space rungs 7 inches from wall surface.
 - 4. Safety Cage: Provide prefabricated modular welded bolt-on steel safety cage with lockable access.
 - a. Acceptable Manufacturer:
 - 1) National Ladder & Scaffold: www.nationalladder.com.
- B. Bollards: Steel pipe, concrete filled, crowned cap, as detailed; prime paint finish.
- C. Door Frames for Overhead Door Openings: Channel and Angle sections; galvanized finish.
- D. Slotted Channel Framing: Fabricate channels and fittings from structural steel complying with the referenced standards; factory-applied, rust-inhibiting thermoset acrylic enamel finish.

2.4 DECORATIVE WEATHERING STEEL PANELS

- A. At entry canopy, provide weathering steel (Cor-Ten) metal panels.
 - 1. Finish: Corrosion-resistant oxidized protective weathering finish. Coordinate with fabricator for finish processes and maintenance.

2.5 FINISHES - STEEL

- A. Prime paint steel items.
 - 1. Exceptions: Galvanize items to be embedded in concrete and items exposed to exterior.

- B. Prepare surfaces to be primed in accordance with SSPC-SP2.
- C. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- D. Prime Painting: One coat.
- E. Galvanizing of Non-structural Items: Galvanize after fabrication to ASTM A123/A123M requirements.
- F. Weathering Steel: Coordinate with fabricator.

2.6 FABRICATION TOLERANCES

- A. Squareness: 1/8 inch maximum difference in diagonal measurements.
- B. Maximum Offset Between Faces: 1/16 inch.
- C. Maximum Misalignment of Adjacent Members: 1/16 inch.
- D. Maximum Bow: 1/8 inch in 48 inches.
- E. Maximum Deviation From Plane: 1/16 inch in 48 inches.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.
- B. Confirm that the ladder structure to which the ladder safety system is installed is capable of withstanding the loads applied by the system in the event of a fall.

3.2 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Supply setting templates to the appropriate entities for steel items required to be cast into concrete or embedded in masonry.

3.3 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Field weld components as indicated on drawings.
- D. Perform field welding in accordance with AWS D1.1/D1.1M.
- E. Obtain approval prior to site cutting or making adjustments not scheduled.
- F. After erection, prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete.

3.4 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.
- C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION

SECTION 061053
MISCELLANEOUS ROUGH CARPENTRY

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Preservative treated wood materials.
- B. Fire retardant treated wood materials.
- C. Communications and electrical room mounting boards.
- D. Concealed wood blocking, nailers, and supports.
- E. Miscellaneous wood nailers, furring, and grounds.

1.2 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- C. AWPA U1 - Use Category System: User Specification for Treated Wood 2022.
- D. PS 1 - Structural Plywood 2009 (Revised 2019).
- E. PS 20 - American Softwood Lumber Standard 2021.
- F. SPIB (GR) - Grading Rules 2014.

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide technical data on wood preservative materials and application instructions.
- C. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.
- B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, and installation.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
 - 1. If no species is specified, provide species graded by the agency specified; if no grading agency is specified, provide lumber graded by grading agency meeting the specified requirements.
 - 2. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee (www.alsc.org) and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.
 - 3. Lumber of other species or grades is acceptable provided structural and appearance characteristics are equivalent to or better than products specified.

2.2 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- A. Grading Agency: Southern Pine Inspection Bureau, Inc; SPIB (GR).
- B. Sizes: Nominal sizes as indicated on drawings, S4S.
- C. Moisture Content: S-dry or MC19.
- D. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
 - 1. Lumber: S4S, No.2 or Standard Grade.
 - 2. Boards: Standard or No.3.

2.3 CONSTRUCTION PANELS

- A. Communications and Electrical Room Mounting Boards: PS 1, A-D plywood, or medium density fiberboard; 3/4 inch thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.

2.4 ACCESSORIES

- A. Fasteners and Anchors:
 - 1. Metal and Finish: Hot-dipped galvanized steel complying with ASTM A153/A153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
 - 2. Anchors: Toggle bolt type for anchorage to hollow masonry.

2.5 FACTORY WOOD TREATMENT

- A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
 - 1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
 - 2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.
- B. Fire Retardant Treatment:
 - 1. Interior Type A: AWPA U1, Use Category UCFA, Commodity Specification H, low temperature, low hygroscopic type, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
 - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - b. Treat rough carpentry items as indicated.
 - c. Do not use treated wood in applications exposed to weather or where the wood may become wet.
- C. Preservative Treatment:
 - 1. Preservative Pressure Treatment of Lumber Above Grade: AWPA U1, Use Category UC3B, Commodity Specification A using waterborne preservative to 0.10 lb/cu ft retention.
 - a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
 - b. Treat lumber exposed to weather.
 - c. Treat lumber in contact with roofing, flashing, or waterproofing.
 - d. Treat lumber in contact with masonry or concrete.
 - e. Treat lumber less than 18 inches above grade.
 - f. Treat lumber in other locations as indicated.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION - GENERAL

- A. Select material sizes to minimize waste.
- B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
- C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.3 BLOCKING, NAILERS, AND SUPPORTS

- A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.

- B. In framed assemblies that have concealed spaces, provide solid wood fireblocking as required by applicable local code, to close concealed draft openings between floors and between top story and roof/attic space; other material acceptable to code authorities may be used in lieu of solid wood blocking.
- C. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.
- D. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.
- E. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.
- F. Provide the following specific nonstructural framing and blocking:
 - 1. Cabinets and shelf supports.
 - 2. Grab bars.
 - 3. Towel and bath accessories.
 - 4. Wall-mounted door stops.

3.4 INSTALLATION OF CONSTRUCTION PANELS

- A. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches on center on edges and into studs in field of board.
 - 1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
 - 2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
 - 3. Install adjacent boards without gaps.
 - 4. Size and Location: As indicated on drawings.

3.5 CLEANING

- A. Do not leave wood, shavings, sawdust, etc. on the ground or buried in fill.
- B. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION

SECTION 064100
ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Specially fabricated cabinet units.

1.2 REFERENCE STANDARDS

- A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition 2014, with Errata (2016).
- B. BHMA A156.9 - Cabinet Hardware 2020.
- C. NEMA LD 3 - High-Pressure Decorative Laminates 2005.

1.3 ADMINISTRATIVE REQUIREMENTS

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

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
 - 1. Scale of Drawings: 1-1/2 inch to 1 foot, minimum.
 - 2. Provide the information required by AWI/AWMAC/WI (AWS).
- C. Product Data: Provide data for hardware accessories.
- D. Samples: Submit actual samples of architectural cabinet construction, minimum 12 inches square, illustrating proposed cabinet substrate and finish.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.
 - 1. Company with at least one project in the past 5 years with value of woodwork within 20 percent of cost of woodwork for this Project.
 - 2. Accredited participant in the specified certification program prior to the commencement of fabrication and throughout the duration of the project.

1.6 MOCK-UP

- A. Provide mock-up of typical base cabinet, wall cabinet, and countertop, including hardware, finishes, and plumbing accessories.
- B. See Section 014000 - Quality Requirements for additional requirements.
- C. Locate where directed.
- D. Mock-up may remain as part of the Work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect units from moisture damage.

1.8 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 CABINETS

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS), unless noted otherwise.

- B. Plastic Laminate Faced Cabinets: Custom grade.

2.2 LAMINATE MATERIALS

- A. Manufacturers:
 - 1. Formica Corporation: www.formica.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Products:
 - 1. As scheduled.
- C. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications.
- D. Provide specific types as indicated.
 - 1. Horizontal Surfaces: HGS, 0.048 inch nominal thickness, through color, colors as indicated, finish as indicated.
 - 2. Vertical Surfaces: VGS, 0.028 inch nominal thickness, through color, colors as indicated, finish as indicated.
 - 3. Post-Formed Horizontal Surfaces: HGP, 0.039 inch nominal thickness, through color, colors as indicated, finish as indicated.
 - 4. Cabinet Liner: CLS, 0.020 inch nominal thickness, through color, colors as indicated, finish as indicated.
 - 5. Laminate Backer: BKL, 0.020 inch nominal thickness, undecorated; for application to concealed backside of panels faced with high pressure decorative laminate.

2.3 COUNTERTOPS

- A. Countertops are specified in Section 123600.

2.4 ACCESSORIES

- A. Adhesive: Type recommended by fabricator to suit application.
- B. Fasteners: Size and type to suit application.
- C. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel or chrome-plated finish in exposed locations.
- D. Concealed Joint Fasteners: Threaded steel.
- E. Grommets: Standard plastic, painted metal, or rubber grommets for cut-outs, in color to match adjacent surface.

2.5 HARDWARE

- A. Hardware: BHMA A156.9, types as recommended by fabricator for quality grade specified.
- B. Adjustable Shelf Supports: Standard side-mounted system using recessed metal shelf standards or multiple holes for pin supports and coordinated self rests, polished chrome finish, for nominal 1 inch spacing adjustments.
- C. Drawer and Door Pulls: As scheduled.
- D. Cabinet Locks: Keyed cylinder, two keys per lock, master keyed, steel with chrome finish.
- E. Catches: As scheduled.
- F. Drawer Slides:
 - 1. Type: Full extension with overtravel.
 - 2. Static Load Capacity: Extra Heavy Duty grade.
 - 3. Mounting: Bottom mounted.
 - 4. Stops: Integral type.
 - 5. Features: Provide self closing/stay closed type.
- G. Hinges: Concealed (fully mortised) type, steel with polished finish.

2.6 FABRICATION

- A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.

- B. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.
- C. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.
- D. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs.
- E. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

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

3.3 ADJUSTING

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

3.4 CLEANING

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

END OF SECTION

**SECTION 066000
PLASTIC FABRICATIONS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Plastic Fabrications as shown on the Drawings.

1.2 RELATED DOCUMENTS AND SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification sections, apply to this Section.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with conditions of contract and Division 01 specification Section 013000 - Administrative Requirements.
- B. Product Data: Submit manufacturer's product data; include product description, fabrication information, and compliance with specified performance requirements.
- C. Submit product test reports from a qualified independent 3rd party testing agency indicating each type and class of panel system complies with the project performance requirements, based on comprehensive testing of current products. Previously completed test reports will be acceptable if for current manufacturer and indicative of products used on this project.
 - 1. Test reports required are:
 - a. Rate of Burning (ASTM D 635)
 - b. Self-Ignition Temperature (ASTM D 1929)
 - c. Density of Smoke (ASTM D 2843)
 - d. Flame spread and Smoke developed testing (ASTM E 84)
 - e. Room Corner Burn Test (NFPA 286)
 - f. Extent of Burning (UL 94)
 - g. Impact strength (ASTM D 3763)
 - h. Safety glazing impact resistance (ANSI Z97.1-2004)
 - i. UPIITT Test for Combustion Product Toxicity
 - j. Dynamic environmental testing (ASTM standards D 5116 and D 6670)
- D. Building Approvals: Plastic Fabrications are to have been evaluated and must be registered with and comply to requirements of the following jurisdictions:
 - 1. New York Department of Buildings (Product must have an MEA [Materials and Equipment Acceptance] number) for use as Interior Finishes
 - 2. Los Angeles Department of Building and Safety (Product must have a LARR [Los Angeles Research Report] number) for use as Light-transmitting Panels
- E. Shop Drawings: Include plans, elevations, sections, panel dimensions, details, and attachments to other work.
- F. Samples for Verification:
 - 1. Submit minimum 4-inch by 4-inch sample for each type, texture, pattern and color of solid plastic fabrication.
- G. Maintenance Data: Submit manufacturer's care and maintenance data, including care, repair and cleaning instructions. Include in Project closeout documents.

1.4 QUALITY ASSURANCE

- A. Manufacturers Qualifications
 - 1. Materials and systems shall be manufactured by a company continuously and regularly employed in the manufacture of specified materials for a period of at least five (5) consecutive years and which can show evidence of those materials being satisfactorily used on at least six (6) projects of similar size, scope and location. At least three (3) of the projects shall have been successful for use five (5) years or longer.

2. Manufactured panels must be produced from a minimum of 40% post-industrial recycle content. This recycle content must be certified by a recognized 3rd party certification group, such as Scientific Certification Systems (SCS).

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver Plastic Fabrications, systems and specified items in manufacturer's standard protective packaging.
- B. Do not deliver Plastic Fabrications, system, components and accessories to Project site until areas are ready for installation.
- C. Store materials in a flat orientation in a dry place that is not exposed to exterior elements.
- D. Handle materials to prevent damage to finished surfaces. Provide protective coverings to prevent damage or staining following installation for duration of project.
- E. Before installing Plastic Fabrications, permit them to reach room temperature.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install Solid Polymer Fabrications until spaces are enclosed and weatherproof, and ambient temperatures and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.7 WARRANTY

- A. Manufacturer's Special Warranty on Plastic Fabrications: Manufacturer's standard form agreeing to repair or replace units that fail in material or workmanship within the specified warranty period.
- B. Warranty Period: 1 year after the date of substantial completion.
- C. The warranty shall not deprive the owner of other rights or remedies the Owner may have under other provisions of the Contract Documents, and is in addition to and runs concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Manufacturer: 3form, Inc., Salt Lake City, Utah, USA / telephone 801-649-2500
- B. Substitutions: Submit in accordance with Section 016000.

2.2 MATERIALS

- A. Resin Panels: Varia produced from ecoresin Sheet
 1. Engineered polyester resin
 2. Basis of Design Product: The design of Plastic Fabrications is based on Varia produced with ecoresin as provided by 3form, Inc.
- B. Interlayer Materials: Compatible with polyesters and bonding process to create a monolithic sheet of material when complete.
- C. Sheet minimum performance attributes:
 1. Rate of Burning (ASTM D 635). Material must attain CC1 Rating for a nominal thickness of 1.5 mm (0.060 in.) and greater.
 2. Self-Ignition Temperature (ASTM D 1929). Material must have a Self-ignition temperature greater than 650°F.
 3. Density of Smoke (ASTM D 2843). Material must have a smoke density less than 75%.
 4. Flame spread and Smoke developed testing (ASTM E 84). Material must be able to meet a level of Class A (Flame spread less than 25 and smoke less than 450) at thickness of 1".
 5. Room Corner Burn Test (NFPA 286). Material must meet Class A criteria at ¼" thickness as described by the 2003 International Building Code.
 6. Extent of Burning (UL 94). Must submit UL card.
 7. Impact strength. Minimum impact strength test as measured by ASTM D 3763 of 20 ft. lbs. (for durability, shipping, installation, and use).

8. Safety Glazing. Material must attain a Class A impact rating in accordance with ANSI Z97.1-2004 at 1/8" thickness.
9. UPIIT Test for Combustion Product Toxicity: Product must be recorded as "not more toxic than wood".

2.3 FABRICATION

- A. General: Fabricate Plastic Fabrications to designs, sizes and thicknesses indicated and to comply with indicated standards. Sizes, profiles and other characteristics are indicated on the drawings.
- B. Comply with manufacturer's written recommendations for fabrication.
- C. Machining: Acceptable means of machining are listed below. Ensure that material is not chipped or warped by machining operations.
 1. Drilling: Drills specifically designed for use with plastic products.
 2. Milling: Climb cut where possible.
 3. Routing
 4. Tapping
- D. Forming: Form products to shapes indicated using the appropriate method listed below. Comply with manufacturer's written instructions.
 1. Cold Bending
 2. Hot Bending
 3. Thermoforming: Acceptable only on uncoated material.
 4. Drape Forming
 5. Matched Mold Forming
 6. Mechanical Forming
- E. Laminating: Laminate to substrates indicated using adhesives and techniques recommended by manufacturer.

2.4 MISCELLANEOUS MATERIALS

- A. General: Provide products of material, size, and shape required for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaner: Type recommended by manufacturer.
- C. Fasteners: Use screws designed specifically for plastics. Self-threading screws are acceptable for permanent installations. Provide threaded metal inserts for applications requiring frequent disassembly such as light fixtures.
- D. Bonding Cements: May be achieved with solvents or adhesives, suitable for use with product and application.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where installation of Plastic Fabrications will occur, with Installer present, for compliance with manufacturer's requirements. Verify that substrates and conditions are satisfactory for installation and comply with requirements specified.

3.2 INSTALLATION

- A. General: Comply with manufacturer's written instructions for the installation of Plastic Fabrications.
- B. Manufacturer's shop to fabricate items to the greatest degree possible.
- C. Utilize fasteners, adhesives and bonding agents recommended by manufacturer for type of installation indicated. Material that is chipped, warped, hazed or discolored as a result of installation or fabrication methods will be rejected.
- D. Install components plumb, level and rigid, scribed to adjacent finishes, in accordance with approved shop drawings and product data.
- E. Form field joints using manufacturer's recommended procedures. Locate seams in panels so that they are not directly in line with seams in substrates.

3.3 CLEANING AND PROTECTION

- A. Protect surfaces from damage until date of substantial completion. Repair work or replace damaged work, which cannot be repaired to Architect's satisfaction.

END OF SECTION

SECTION 068316
FIBERGLASS REINFORCED PANELING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fiberglass reinforced plastic panels.
- B. Trim.

1.2 REFERENCE STANDARDS

- A. 9 CFR 416.2 - Regulatory Requirements Under the Federal Meat Inspection Act and the Poultry Products Inspection Act, Part 416-Sanitation current edition.
- B. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics 2010 (Reapproved 2018).
- C. ASTM D2583 - Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor 2013a.
- D. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber 2021.
- E. ASTM D5319 - Standard Specification for Glass-Fiber Reinforced Polyester Wall and Ceiling Panels 2017.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store panels flat, indoors, on a clean, dry surface. Remove packaging and allow panels to acclimate to room temperature for 48 hours prior to installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Fiberglass Reinforced Plastic Panels:
 - 1. Crane Composites, Inc: www.cranecomposites.com/#sle.
 - 2. Marlite, Inc: www.marlite.com/#sle.
 - 3. Nudo Products, Inc: www.nudo.com/#sle.
 - 4. Substitutions: See Section 01 6000 - Product Requirements.

2.2 PANEL SYSTEMS

- A. Wall Panels:
 - 1. Panel Size: 4 by 8 feet.
 - 2. Panel Thickness: 0.10 inch.
 - 3. Surface Design: Smooth.
 - 4. Color: As scheduled.
 - 5. Attachment Method: Adhesive only, with trim and sealant in joints.

2.3 MATERIALS

- A. Panels: Fiberglass reinforced plastic (FRP), complying with ASTM D5319.
 - 1. Surface Burning Characteristics: Maximum flame spread index of 25 and smoke developed index of 450; when system tested in accordance with ASTM E84.

2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 3. Scratch Resistance: Barcol hardness score greater than 35, when tested in accordance with ASTM D2583.
 4. Impact Strength: Greater than 6 ft lb force per inch, when tested in accordance with ASTM D256.
 5. Sanitation and Cleanability: Comply with 9 CFR 416.2.
- B. Trim: Vinyl; color coordinating with panel.
 - C. Adhesive: Type recommended by panel manufacturer.
 - D. Sealant: Type recommended by panel manufacturer; white.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions and substrate flatness before starting work.
- B. Verify that substrate conditions are ready to receive the work of this section.
- C. Verify that layout of hangers will not interfere with other work; make adjustments in layout as necessary.

3.2 INSTALLATION - WALLS

- A. Install panels in accordance with manufacturer's instructions.
- B. Cut and drill panels with carbide tipped saw blades, drill bits, or snips.
- C. Apply adhesive to the back side of the panel using trowel as recommended by adhesive manufacturer.
- D. Apply panels to wall with seams plumb and pattern aligned with adjoining panels.
- E. Install panels with manufacturer's recommended gap for panel field and corner joints.
- F. Place trim on panel before fastening edges, as required.
- G. Fill channels in trim with sealant before attaching to panel.
- H. Install trim with adhesive and screws or nails, as required.
- I. Seal gaps at floor, ceiling, and between panels with applicable sealant to prevent moisture intrusion.
- J. Remove excess sealant after paneling is installed and prior to curing.

END OF SECTION

**SECTION 072100
THERMAL INSULATION**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Batt insulation in exterior wall construction.
- B. Fiberglass batt insulation at interior framing.
- C. Mineral fiber batt insulation at sound attenuation and fire safing applications.

1.2 REFERENCE STANDARDS

- A. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing 2017.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- C. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C 2019a.

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer's Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.

1.4 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 APPLICATIONS

- A. Insulation in Metal Framed Walls: Batt insulation with separate vapor retarder.

2.2 BATT INSULATION MATERIALS

- A. Glass Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit.
 - 1. Flame Spread Index: 75 or less, when tested in accordance with ASTM E84.
 - 2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
 - 3. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
 - 4. Formaldehyde Content: Zero.
 - 5. Thermal Resistance: R-value of 19.
 - 6. Facing:
 - a. Unfaced.
 - b. Vinyl facing where indicated.
 - 7. Manufacturers:
 - a. CertainTeed Corporation: www.certainteed.com/#sle.
 - b. Johns Manville: www.jm.com/#sle.
 - c. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- B. Mineral Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit; unfaced flame spread index of 0 (zero) when tested in accordance with ASTM E84.
 - 1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
 - 2. Smoke Developed Index: 0 (zero), when tested in accordance with ASTM E84.

3. Manufacturers:
 - a. Johns Manville: www.jm.com/#sle.
 - b. Knauf Insulation: www.knaufinsulation.com/#sle.
 - c. Thermafiber, Inc: www.thermafiber.com/#sle.
 - d. ROCKWOOL (ROXUL, Inc): www.rockwool.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
- C. Flexible Blanket Insulation: Thin profile insulation that complies with complex shapes, unfaced; flame spread index of 5 (five) and smoke development index of 10 (ten) or less when tested in accordance with ASTM E84.
 1. Color: Gray.
 2. Thickness: 3/8 inch.
 3. Manufacturers:
 - a. Dow Chemical Company; HPI-1000 Insulation Blanket: consumer.dow.com/en-us/industry/ind-building-construction.html/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

2.3 ACCESSORIES

- A. Sheet Vapor Retarder: Black polyethylene film for above grade application, 10 mil, 0.010 inch thick.
- B. Tape: Reinforced polyethylene film with acrylic pressure sensitive adhesive.
 1. Application: Sealing of interior circular penetrations, such as pipes or cables.
 2. Width: Are required for application.
 3. Temperature Resistance: Minus 40 degrees F to 212 degrees F
- C. Flashing Tape: Special polyolefin film with high performance adhesive.
 1. Application: Interior window and door sill flashing tape.
 2. Width: Are required for application.
 3. Temperature Resistance: Minus 40 degrees F to 212 degrees F

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.
- B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.2 BATT INSTALLATION

- A. Install insulation and vapor retarder in accordance with manufacturer's instructions.
- B. Install in exterior wall spaces without gaps or voids. Do not compress insulation.
- C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.
- E. Tape seal butt ends, lapped flanges, and tears or cuts in membrane.
- F. At metal framing, place vapor retarder on cold side of insulation; lap and seal sheet retarder joints over member face.
- G. Tape seal tears or cuts in vapor retarder.
- H. Extend vapor retarder tightly to full perimeter of adjacent window and door frames and other items interrupting the plane of the membrane. Tape seal in place.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.

3.4 PROTECTION

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

END OF SECTION

SECTION 072400
EXTERIOR INSULATION AND FINISH SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Drainage and water-resistive barriers behind insulation board.

1.2 REFERENCE STANDARDS

- A. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus 2019.
- B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019.
- C. ASTM C297/C297M - Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions 2016.
- D. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation 2019.
- E. ASTM C1397 - Standard Practice for Application of Class PB Exterior Insulation and Finish Systems (EIFS) and EIFS with Drainage 2013 (Reapproved 2019).
- F. ASTM D968 - Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive 2022.
- G. ASTM D2247 - Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity 2015 (Reapproved 2020).
- H. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber 2021.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- J. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference 2000 (Reapproved 2016).
- K. ASTM E2273 - Standard Test Method for Determining the Drainage Efficiency of Exterior Insulation and Finish Systems (EIFS) Clad Wall Assemblies 2018.
- L. ASTM G153 - Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials 2013 (Reapproved 2021).
- M. ASTM G155 - Standard Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials 2021.
- N. ICC-ES AC219 - Acceptance Criteria for Exterior Insulation and Finish Systems 2009, with Editorial Revision (2014).
- O. ICC-ES AC235 - Acceptance Criteria for EIFS Clad Drainage Wall Assemblies 2009, with Editorial Revision (2012).
- P. ISO 9001 - Quality Management Systems — Requirements 2015.
- Q. NFPA 259 - Standard Test Method for Potential Heat of Building Materials 2018.
- R. NFPA 268 - Standard Test Method for Determining Ignitibility of Exterior Wall Assemblies Using a Radiant Heat Energy Source 2022.
- S. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components 2019.

1.3 SUBMITTALS

- A. Product Data: Provide data on system materials, product characteristics, performance criteria, and system limitations.
- B. Shop Drawings: Indicate wall joint patterns, joint details, and molding profiles.
- C. Verification Samples: Submit actual samples of selected coating on specified substrate, minimum 12 inches square, illustrating project colors and textures.
- D. Manufacturer's Installation Instructions: Indicate preparation required, installation techniques, and jointing requirements.

1.4 QUALITY ASSURANCE

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

1.5 MOCK-UP

- A. Locate mock-up where directed.
- B. Mock-up may remain as part of the Work.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to project site in manufacturer's original, unopened containers with labels intact. Inspect materials and notify manufacturer of any discrepancies.
- B. Storage: Store materials as directed by manufacturer's written instructions.
 - 1. Protect adhesives and finish materials from freezing, temperatures below 40 degrees F and temperatures in excess of 90 degrees F.
 - 2. Protect Portland cement based materials from moisture and humidity. Store under cover off the ground in a dry location.
 - 3. Protect insulation materials from exposure to sunlight.

1.7 FIELD CONDITIONS

- A. Do not prepare materials or apply EIFS under conditions other than those described in the manufacturer's written instructions.
- B. Do not prepare materials or apply EIFS during inclement weather unless areas of installation are protected. Protect installed EIFS areas from inclement weather until dry.
- C. Do not install coatings or sealants when ambient temperature is below 40 degrees F.
- D. Do not leave installed insulation board exposed to sunlight for extended periods of time.

1.8 WARRANTY

- A. Provide manufacturer's standard material warranty, covering a period of not less than 5 years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers:
 - 1. Dryvit Systems, Inc; Dryvit Outsulation Plus MD EIFS, Class PB with Moisture Drainage: www.dryvit.com/#sle.
 - 2. BASF Wall Systems; Senergy Channeled Adhesive CI Design: www.wallsystems.basf.com/#sle.
 - 3. Master Wall, Inc; Aggregreflex Drainage System: www.masterwall.com/#sle.
 - 4. Parex USA, Inc; Standard WaterMaster EIFS with Moisture Drainage: www.parex.com/#sle.
 - 5. Sto Corp; StoTherm ci: www.stocorp.com/#sle.
 - 6. Substitutions: See Section 016000 - Product Requirements.

2.2 EXTERIOR INSULATION AND FINISH SYSTEM

- A. Exterior Insulation and Finish System: DRAINAGE type; reinforced finish coating on flat-backed insulation board adhesive-applied directly to water-resistive coating over substrate; provide a complete system that

has been tested to show compliance with the following characteristics; include all components of specified system and substrate(s) in tested samples.

- B. Fire Characteristics:
 - 1. Flammability: Pass, when tested in accordance with NFPA 285.
 - 2. Ignitibility: No sustained flaming when tested in accordance with NFPA 268.
 - 3. Fire Resistance: Complies with fire resistance requirements indicated on the drawings as part of an exterior non-load-bearing exterior wall assembly when tested in accordance with NFPA 285.
 - 4. Potential Heat of Foam Plastic Insulation Tested Independently of Assembly: No portion of the assembly having potential heat that exceeds that of the insulation sample tested for flammability (above), when tested in accordance with NFPA 259 with results expressed in Btu per square foot.
- C. Adhesion of Water-Resistive Coating to Substrate: For each combination of coating and substrate, minimum flatwise tensile bond strength of 15 psi, when tested in accordance with ASTM C297/C297M.
- D. Adhesion to Water-Resistive Coating: For each combination of insulation board and substrate, when tested in accordance with ASTM C297/C297M, maximum adhesive failure of 25 percent unless flatwise tensile bond strength exceeds 15 psi in all samples.
- E. Water Penetration Resistance: No water penetration beyond the plane of the base coat/insulation board interface after 15 minutes, when tested in accordance with ASTM E331 at 6.24 psf differential pressure with tracer dye in the water spray; include in tested sample at least two vertical joints and one horizontal joint of same type to be used in construction; disassemble sample if necessary to determine extent of water penetration.
- F. Drainage Efficiency: Average minimum efficiency of 90 percent, when tested in accordance with ASTM E2273 for 75 minutes.
- G. Salt Spray Resistance: No cracking, checking, crazing, erosion, blistering, peeling, delamination, or corrosion of finish coating after 300 hours exposure in accordance with ASTM B117, using at least three samples matching intended assembly, at least 4 by 6 inches in size.
- H. Freeze-Thaw Resistance: No cracking, checking, crazing, erosion, blistering, peeling, delamination, or corrosion of finish coating when viewed under 5x magnification after 10 cycles, when tested in accordance with ICC-ES AC219 or ICC-ES AC235.
- I. Weathering Resistance: No cracking, checking, crazing, erosion, blistering, peeling, delamination, or corrosion of finish coating when viewed under 5x magnification after 2000 hours of accelerated weathering conducted in accordance with ASTM G153 Cycle 1 or ASTM G155 Cycles 1, 5, or 9.
- J. Water Degradation Resistance: No cracking, checking, crazing, erosion, blistering, peeling, delamination, or corrosion of finish coating after 14 days exposure, when tested in accordance with ASTM D2247.
- K. Mildew Resistance: No growth supported on finish coating during 28 day exposure period, when tested in accordance with ASTM D3273.
- L. Abrasion Resistance Of Finish: No cracking, checking or loss of film integrity when tested in accordance with ASTM D968 with 113.5 gallons of sand.

2.3 MATERIALS

- A. Finish Coating Top Coat: Water-based, air curing, acrylic finish with integral color and texture.
 - 1. Texture: As indicated on drawings.
- B. Base Coat: Fiber-reinforced, acrylic or polymer-based product compatible with insulation board and reinforcing mesh.
- C. Reinforcing Mesh: Balanced, open weave glass fiber fabric, treated for compatibility and improved bond with coating, weight, strength, and number of layers as required to meet required system impact rating.
- D. Expanded Polystyrene (EPS) Board Insulation: Complies with ASTM C578.
 - 1. Board Size: 24 by 48 inches.
 - 2. Board Size Tolerance: Plus/minus 1/16 inch from square and dimension.
 - 3. Board Thickness: As indicated on drawings.
 - 4. Board Edges: Square.
 - 5. Type and Thermal Resistance, R-value (RSI-value): Type XI, 3.1 (0.55) per 1 inch thickness at 75 degrees F mean temperature using ASTM C177 test method.

6. Type and Board Density: Type XI, 0.70 pcf (12 kg/cu m), minimum.
 7. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/450, when tested in accordance with ASTM E84.
- E. Water-Resistive Barrier Coating: Fluid-applied air and water barrier membrane; applied to sheathing; furnished or approved by EIFS manufacturer.

2.4 ACCESSORY MATERIALS

- A. Insulation Adhesive: Type required by EIFS manufacturer for project substrate.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 INSTALLATION - GENERAL

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

3.4 INSTALLATION - WATER-RESISTIVE BARRIER

- A. Apply barrier coating as recommended by coating manufacturer; prime substrate as required before application.
- B. Seal substrate transitions and intersections with other materials to form continuous water-resistive barrier on exterior of sheathing, using method recommended by manufacturer.
- C. At door and window rough openings and other wall penetrations, seal water-resistive barrier and flexible flashings to rough opening before installation of metal flashings, sills, or frames, using method recommended by manufacturer.
- D. Lap flexible flashing or flashing tape at least 2 inches on each side of joint or transition.

3.5 INSTALLATION - INSULATION

- A. Install in accordance with manufacturer's instructions.
- B. Install back wrap reinforcing mesh at all openings and terminations that are not to be protected with trim.
- C. On wall surfaces, install boards horizontally. On horizontal surfaces, install boards [] .
- D. Place boards in a method to maximize tight joints. Stagger vertical joints and interlock at corners. Butt edges and ends tight to adjacent board and to protrusions. Achieve a continuous flush insulation surface, with no gaps in excess of 1/16 inch.
- E. Fill gaps greater than 1/16 inch with strips or shims cut from the same insulation material.
- F. Rasp irregularities off surface of installed insulation board.

3.6 INSTALLATION - CLASS PB FINISH

- A. Base Coat: Apply in thickness as necessary to fully embed reinforcing mesh, wrinkle free, including back-wrap at terminations of EIFS. Install reinforcing fabric as recommended by EIFS manufacturer.
1. Lap reinforcing mesh edges and ends a minimum of 2-1/2 inches.
 2. Allow base coat to dry a minimum of 24 hours before next coating application.

- B. Install expansion joints at floor lines as recommended by EIFS manufacturer.
- C. Apply finish coat after base coat has dried not less than 24 hours, embed finish aggregate, and finish to a uniform texture and color.
- D. Finish Coat Thickness: As recommended by manufacturer.
- E. Seal control and expansion joints within the field of exterior finish and insulation system, using procedures recommended by sealant and finish system manufacturers.

3.7 CLEANING

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

3.8 PROTECTION

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

END OF SECTION

SECTION 072700
AIR BARRIERS - CARLISLE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fire-resistant fluid-applied STPE air barrier.
- B. Self-adhered composite membrane air barrier

1.2 REFERENCE STANDARDS

- A. ASTM C920 - Standard Specification for Elastomeric Joint Sealants 2018.
- B. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension 2016 (Reapproved 2021).
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- D. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022.
- E. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials 2021a.
- F. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components 2019.

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for membrane, surface conditioner, flexible flashings, joint cover sheet, and joint and crack sealants.
- C. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.
- D. Certificate: Certify that products meet or exceed specified requirements.
- E. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention, and acceptable installation temperatures.
- F. Manufacturer's qualification statement.
- G. Installer's qualification statement.
- H. Testing firm's qualification statement.
- I. Warranty:
 - 1. Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
 - 2. Submit installer's certification that installation complies with warranty conditions for the waterproofing membrane.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.
- C. Testing Firm Qualifications: Company specializing in performing work of the type specified and approved by manufacturer.

1.5 MOCK-UPS

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Construct mock-up consisting of 100 sq ft of horizontal waterproofed panel; to represent finished work including internal and external corners, drainage panel, base flashings, control joints, expansion joints, counterflashings, and protective cover.

- C. Locate where directed.
- D. Mock-up may remain as part of this Work.

1.6 FIELD CONDITIONS

- A. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application.

1.7 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 5-year manufacturer warranty for air barrier failing to resist penetration of air. Complete forms in Owner's name and register with manufacturer.
 - 1. Exceptions are where such failures are the result of building structural failures; hairline cracking of concrete due to temperature change or shrinkage is not considered a structural failure.
- C. Extended Correction Period: Correct defective work within 5-year period commencing on Date of Substantial Completion. Remove and replace materials concealing air barrier at no cost to Owner.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Air Barriers:
 - 1. Carlisle Coatings & Waterproofing: www.carlisleccw.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.

2.2 PRODUCT TYPES

- A. Self-Adhered Composite Membrane Air Barrier:
 - 1. Vertical Surfaces: Apply directly to exterior sheathing substrate.
 - 2. Apply strips and flashing at appropriate locations.

2.3 MATERIALS

- A. Fire-Resistant Fluid-Applied STPE Air Barrier: Fluid-applied, vapor-permeable air and water resistive barrier for above-grade wall assemblies; high-solids, single-component, moisture curing STPE with low VOC and fire-retardant composition.
 - 1. Product:
 - a. Carlisle Coatings & Waterproofing Inc; Fire Resist Barrithane VP.
 - 2. Cured Thickness on Sheathing: 13 to 22 mil, 0.013 to 0.022 inch, comb gauge test method.
 - 3. Cured Thickness on CMU: 26 to 44 mil, 0.026 to 0.044 inch, comb gauge test method.
 - 4. Suitable for installation over masonry, concrete, and exterior gypsum sheathing substrates.
 - 5. Application Temperature: 15 degrees F, minimum.
 - 6. Water Vapor Permeance: 5.1 perm at 40 mil, 0.040 inch thickness, measured in accordance with ASTM E96/E96M using Procedure A, Desiccant Method.
 - 7. Air Permeance on CMU Substrate: 0.0026 cfm/sq ft maximum film leakage when tested at 1.57 psf pressure difference in accordance with ASTM E2178.
 - 8. Comply with NFPA 285 wall assembly requirements.
 - 9. Surface Burning: For 50 mil, 0.050 inch thick membrane, flame spread index (FSI) of 20 or less, and smoke developed index (SDI) of 250 or less, when tested in accordance with ASTM E84
 - 10. Elongation at Break: 400 percent, minimum, measured in accordance with ASTM D412.
 - 11. Reinforcing Fabric: Woven, synthetic polymer fabric for use in sheathing joints.
 - a. Width: 4 inches, nominal.
 - b. Weight: 3 oz/sq yd, minimum.
 - c. Product:
 - 1) Carlisle Coatings & Waterproofing Inc; DCH Reinforcing Fabric.
 - 12. Adhesives, Sealants, Tapes, and Accessories: As indicated below or by air barrier manufacturer in accordance with requirements.
- B. Self-Adhered Composite Membrane Air Barrier: Membrane consisting of rubberized-asphalt adhesive laminated to poly film with removable silicone-coated plastic release film.

1. Product:
 - a. Carlisle Coatings & Waterproofing Inc; CCW-705.
2. Thickness: 40 mil, 0.040 inch, nominal.
3. Width: 36 inches, nominal.
4. Suitable for above-grade installation over exterior gypsum sheathing, concrete masonry unit (CMU), and concrete substrates.
5. Service Temperature: Range of minus 25 to 149 degrees F.
6. Application Temperature: 40 degrees F, minimum.
7. Water Vapor Permeance: 0.10 perm, measured in accordance with ASTM E96/E96M using Procedure B, Water Method.
8. Air Permeance: 0.00 cfm/sq ft nominal leakage when tested at 1.57 psf pressure difference in accordance with ASTM E2178.
9. Elongation at Break: 300 percent, measured in accordance with ASTM D412.
10. Strips: Rubberized-asphalt adhesive laminated to poly film with removable silicone-coated plastic release film for use as wall flashing at window and door openings and joints, in addition to air barrier system details.
 - a. Width: 12 inches, nominal.
 - b. Product:
 - 1) Carlisle Coatings & Waterproofing Inc; CCW-705 Strips.
11. Flashing: Self-adhering rubberized-asphalt membrane laminated to HDPE film with removable silicone-coated plastic release film for use as through-wall flashing.
 - a. Width: 36 inches, nominal.
 - b. Product:
 - 1) Carlisle Coatings & Waterproofing Inc; CCW-705-TWF.
12. Adhesives, Sealants, Tapes, and Accessories: As indicated below or by air barrier manufacturer in accordance with requirements.

2.4 ACCESSORIES

- A. Seaming Materials: As recommended by membrane manufacturer.
- B. Membrane Sealant: As recommended by membrane manufacturer.
- C. Adhesives: As recommended by membrane manufacturer.
- D. Thinner and Cleaner: As recommended by adhesive manufacturer, compatible with sheet membrane.
- E. Sealant for Cracks and Joints In Substrates: Resilient elastomeric joint sealant compatible with substrates and waterproofing materials, as recommended by membrane manufacturer.
- F. Backer Rods: Closed-cell polyethylene foam rod, as recommended by membrane manufacturer.
- G. Primer/Adhesive: High-tack, water-based contact adhesive.
 1. Product:
 - a. Carlisle Coatings & Waterproofing Inc; CCW-702 WB.
- H. Liquid Flashing and Detail Sealant: High solids, single-component STPE based compound complying with ASTM C920 Type S, Grade NS, Class 25, Use NT.
 1. Product:
 - a. Carlisle Coatings & Waterproofing Inc; BarriBond: www.carlisleccw.com/#sle.
- I. Self-Adhering Flashing: Flashing with aluminum foil facer coated with asphalt-free butyl adhesive and laminated with poly release liner.
 1. Used for over faced gypsum sheathing substrates.
 2. Width: 2 inches, nominal.
 3. Thickness: 30 mil, 0.030 inch.
 4. Product:
 - a. Carlisle Coatings & Waterproofing Inc; Aluma-Grip 701.
- J. Inside/Outside Corners: Preformed inside or outside corners of 60 mil, 0.060 inch uncured Elastoform Flashing with preapplied adhesive for 88 mil, 0.088 inch total thickness.
 1. Size: 7 by 9 inches, nominal; may be installed as either inside or outside corner.
 2. Product:

- a. Carlisle Coatings & Waterproofing Inc; Sure-Seal Pressure-Sensitive Inside/Outside Corners.
- K. Termination Bar: Corrosion resistant 6063-T6 extruded aluminum bar with prepunched holes at 6 inches on center and 1 inch from each end, used to secure and seal flashing terminations.
 1. Size: 1 inch wide by 10 feet long, with serrated backside.
 2. Product:
 - a. Carlisle Coatings & Waterproofing Inc; Sure-Seal Termination Bar.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify substrate surfaces are free of frozen matter, dampness, loose particles, cracks, pits, projections, penetrations, or foreign matter detrimental to adhesion or application of air barrier system.
- C. Verify that substrate surfaces are smooth, free of honeycomb or pitting detrimental to full contact bond of air barrier materials.
- D. Verify that items penetrating surfaces to receive air barrier are securely installed.
- E. Where existing conditions are responsibility of another installer, notify Architect of unsatisfactory conditions.
- F. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove projections, protruding fasteners, and loose or foreign matter that may interfere with proper installation.
- B. Remove mortar droppings on brick ties, shelf angles, brick shelves, or other horizontal obstructions.
- C. Clean and prime substrate surfaces to receive adhesives and sealants in accordance with manufacturer's installation instructions.

3.3 INSTALLATION

- A. Install materials in accordance with manufacturer's installation instructions.
- B. Air Barriers: Install continuous airtight barrier over surfaces indicated, with sealed seams and with sealed joints to adjacent surfaces.
- C. Apply sealants and adhesives within recommended temperature range in accordance with manufacturer's installation instructions.
- D. Self-Adhered Sheets:
 1. Prepare substrate in accordance with sheet manufacturer's installation instructions; fill and tape joints in substrate and between dissimilar materials.
 2. Overlap sheets shingle fashion to shed water and seal laps airtight, 3 inches, minimum.
 3. Overlap sheets onto each side of transitions such as joints, angle changes, and substrate changes, 3 inches, minimum.
 4. Overlap sheets onto adjacent membrane systems such as foundation or roofing waterproofing, 6 inches, minimum.
 5. Once sheets are in place, press firmly onto substrate with resilient hand roller; ensure that laps are firmly adhered with no gaps or fishmouths.
 6. Use same material, or other material approved by sheet manufacturer, to seal to adjacent substrates, and as flashing.
 7. At wide joints, install extra flexible membrane to allow for joint movement.
- E. Fluid-Applied Coatings or Membranes:
 1. Prepare substrate in accordance with manufacturer's installation instructions; treat joints in substrate and between dissimilar materials as indicated.
 2. Use flashing to seal to adjacent construction and to bridge joints in coating substrate.
- F. Openings and Penetrations in Exterior Air Barriers:
 1. Install flashing over sills, covering entire sill frame member, extending at least 5 inches onto air barrier and at least 6 inches up jambs; mechanically fasten stretched edges.

2. At openings with frames having nailing flanges, seal head and jamb flanges using a continuous bead of sealant compressed by flange and cover flanges with sealing tape at least 4 inches wide; do not seal sill flange.
3. At openings with nonflanged frames, seal air barrier to each side of framing at opening using flashing at least 9 inches wide, and covering entire depth of framing.
4. At head of openings, install flashing under air barrier extending at least 2 inches beyond face of jambs; seal air barrier to flashing.
5. At interior face of openings, seal gap between window/door frame and rough framing using joint sealant over backer rod.
6. Service and Other Penetrations: Form flashing around penetrating item and seal to air barrier surface.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Owner will provide testing services, and Contractor to provide temporary construction and materials for testing.
- C. Do not cover installed air barriers until required inspections have been completed.
- D. Obtain approval of installation procedures from air barrier manufacturer based on a mock-up installed in place, prior to proceeding with remainder of installation.
- E. Take digital photographs of each portion of installation prior to covering up air barriers.

3.5 PROTECTION

- A. Do not permit traffic over unprotected or uncovered membrane.

END OF SECTION

SECTION 07 41 13 - STANDING-SEAM METAL ROOF PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes standing-seam metal roof panels.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site
 1. Meet with Owner, Architect, Owner's insurer if applicable, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of roof accessories and roof-mounted equipment.
 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
 4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
 5. Review structural loading limitations of deck during and after roofing.
 6. Review flashings, special details, drainage, penetrations, equipment curbs, and condition of other construction that affect metal panels.
 7. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
 8. Review temporary protection requirements for metal panel systems during and after installation.
 9. Review procedures for repair of metal panels damaged after installation.
 10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.4 ACTION SUBMITTALS

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

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
 - B. Shop Drawings:
 1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
 2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 3 inches per 12 inches.
 - C. Calculations:
 1. Include calculations with registered engineer seal, verifying roof panel and attachment method resist wind pressures imposed on it pursuant to applicable building codes.
 - D. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.
 1. Include similar Samples of trim and accessories involving color selection.
 - E. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
 1. Metal Panels: 12 inches long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.
- 1.5 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For Manufacturer and Installer.
 - B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
 - C. Field quality-control reports.
 - D. Sample Warranties: For special warranties.
- 1.6 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For metal panels to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in architectural sheet metal products.
- B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 - 1. Build mockup of typical roof area and eave, including fascia, and soffit as shown on Drawings; approximately 48 inches square by full thickness, including attachments, underlayment, and accessories.
 - 2. Build mockups for typical roof area only, including accessories.
 - a. Size: 48 inches by 48 inches.
 - 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. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

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

1.9 FIELD CONDITIONS

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

1.10 COORDINATION

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

1.11 WARRANTY

- A. Special Galvalume Substrate Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, or perforating.
 - b. Deterioration of metals and other materials beyond normal weathering.
 - 2. Warranty Period: 20 years and 6 months from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, chipping, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.
- C. Special Watertightness Warranty: Manufacturer's no dollar limit form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain watertight, including leaks, within specified warranty period.
1. Warranty Period: 20 years from date of Substantial Completion.
 2. Shop drawings must be provided to, reviewed, and approved by panel manufacturer prior to panel system installation.
 3. Inspections by panel system manufacturer technical representative are required. Perform first inspection when underlayment and flashing are in place and second inspection when the roof is complete.
- D. Special Installer Warranty: Furnish a written warranty signed by the Panel Applicator guaranteeing materials and workmanship for watertightness of the roofing system, flashings, penetrations, and against all leaks.
1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 29 percent.
- B. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592:
1. Wind Loads: As indicated on Drawings.
 2. Other Design Loads: As indicated on Drawings
 3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- C. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E 1680 and ASTM E 283 at the following test-pressure difference:
1. Test-Pressure Difference: 6.24 lbf/sq. ft.
- D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 1646 and ASTM E 331 at the following test-pressure difference:
1. Test-Pressure Difference: 15 lbf/sq. ft.

- E. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
 - 1. Uplift Rating: UL 90.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F ambient; 180 deg F, material surfaces
- G. Energy Conservation Requirements: Thermal Resistance 'R' for the specified roof insulation system shall include the continuous insulation (ci) above roof deck.
 - 1. Total Thermal Resistance R Value, continuous insulation (ci) above-deck: R(25)

2.2 STANDING-SEAM METAL ROOF PANELS

- A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
 - 1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.
 - 2. Aluminum Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1637.
- B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and panel striations between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and snapping panels together.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Berridge Manufacturing Company; Cee-lock or comparable product as approved by the architect:
 - 2. Metallic-Coated Steel Sheet: Aluminum-zinc alloy-coated steel sheet complying with ASTM A 792/A 792M, Class AZ50 coating designation;

structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

- a. Nominal Thickness: 0.024 inch.
 - b. Exterior Finish: Two-coat fluoropolymer
 - c. Painted materials shall have a removable plastic film to protect the paint during roll forming, shipping and handling.
 - d. Color: As selected by Architect from manufacturer's full range
3. Clips: Continuous Cee-Rib with Vinyl Weatherseal Insert to accommodate thermal movement.
- a. Material: 0.024-inch nominal thickness, aluminum-zinc alloy-coated steel sheet.
4. Panel Coverage: 16.5 inches.
5. Panel Height: 1.5 inches.

2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 40 mils thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.
1. Thermal Stability: Stable after testing at 240 deg F; ASTM D 1970.
 2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D 1970.
 3. Adhesion Properties: Adhesion to plywood @ 75°F, 39 lbf/ft per ASTM D1970.
 4. Manufacturers: Subject to compliance with metal roofing manufacturers requirements and approved materials.
 - a. Grace
 - b. Soprema

2.4 INSULATION

- A. Polyisocyanurate: Rigid board with glass fiber reinforced facers (GRF) on both sides, meeting or exceeding the requirements of ASTM C 1289, type II, Class 1.
1. Compressive Strength: Grade 2, 20 psi.
 2. Density: 2 lb per cubic foot minimum.

2.5 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C 645; cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 coating designation or

ASTM A 792/A 792M, Class AZ50 coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
 - 1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
 - 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Gutters: Formed from same material as roof panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36 inches o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match metal roof panels.
- E. Downspouts: Formed from same material as roof panels. Fabricate in 10-foot long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Finish downspouts to match gutters.
- F. Downspout Boots: Premanufactured aluminum downspout boots are to be constructed from 1/8" thick aluminum 6063-T52. Manufacturer's standard powder coat and primer finish total dry film thickness of 2-4 mils.
 - 1. Kinetic Architectural Products. Distributed by Liz Cromwell, 405-810-0111, admin@walcousa.com.
- G. Roof Curbs: Fabricated from same material as roof panels, 0.024 inch nominal thickness; galvalume or stainless steel; supply an integral full-length cricket for curbs wider than 24 inches supported by a structural metal deck. Fabricate curb flashing from 0.024 inch. On open framing, provide roof underlayment and decking at and about roof curb per roofing manufacturer's requirements. Maintain a minimum of 1/2 of roofing panel width on each side of roof curb, and start panels a minimum of 9 inches up slope of roof curb, flashing roofing panels to roof curb per roofing manufacturer's requirements.. Fabricate curb

and subframing to withstand indicated loads of size and height of roof top equipment. Where required insulate roof curbs with rigid insulation.

- H. Panel Fasteners: Zinc-coated steel, corrosion resisting steel, zinc cast head, or nylon capped steel, type and size as approved for the applicable loading requirements.
- I. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 - 1. Joint Sealant: Silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.

2.6 FABRICATION

- A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using factory set, non-adjustable, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
 - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 - 2. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
 - 3. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

- a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.7 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Steel Panels and Accessories:
 1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat applied by panel manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.75 ± 0.05 mil over 0.2 ± 0.05 mil primer coat, to provide a total dry film thickness of 0.95 ± 0.10 mil. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.35 mil.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
 1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
 2. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.

- a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

3.3 UNDERLAYMENT INSTALLATION

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 36 inches. Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days or as directed by the underlayment product manufacturer.
 1. Apply over the entire roof surface.
- B. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 076200 "Sheet Metal Flashing and Trim."

3.4 METAL PANEL INSTALLATION

- A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 1. Shim or otherwise plumb substrates receiving metal panels to be level to 1/4 inch in 20 ft.
 2. Flash and seal metal panels at perimeter of all openings. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.

3. Locate and space fastenings in uniform vertical and horizontal alignment.
 4. Install flashing and trim as metal panel work proceeds.
 5. Panels should be continuous without end laps.
 6. Align bottoms of metal panels and fasten.
 7. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners:
1. Steel Panels: Use stainless-steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
- C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.
- D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
1. Install clips to supports with self-tapping fasteners.
 2. Install pressure plates, if required, at locations indicated in manufacturer's written installation instructions.
 3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied vinyl weatherseal.
- F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.
- G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectoral Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded

- back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
- H. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.
- I. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.
1. Provide elbows at base of downspouts to direct water away from building.
 2. Connect downspouts to underground drainage system indicated.
- J. Roof Curbs: Install flashing around bases where they meet metal roof panels.
- K. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.5 ERECTION TOLERANCES

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

3.6 FIELD QUALITY CONTROL

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

3.7 CLEANING AND PROTECTION

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

END OF SECTION 074113.16

**SECTION 074213
METAL WALL PANELS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Manufactured metal panels for walls and soffits, with accessory components.

1.2 REFERENCE STANDARDS

- A. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document) 2015.

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate dimensions, layout, joints, construction details, and methods of anchorage.
- C. Samples: Submit two samples of wall panel, 12 inch by 12 inch in size illustrating finish color, sheen, and texture.
- D. Manufacturer's Qualification Statement.
- E. Installer's Qualification Statement.

1.4 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 installing products of the type specified in this section with minimum three years of documented experience.

1.5 MOCK-UP

- A. Construct mock-up, 8 feet long by 12 feet wide; include panel system, attachments to building frame, associated vapor retarder and air seal materials, weep drainage system, sealants and seals, related insulation in mock-up.
- B. Locate where directed by Architect.
- C. Mock-up may remain as part of the Work.

1.6 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.

1.7 WARRANTY

- A. Correct defective work within a five year period after Date of Substantial Completion for degradation of panel finish, including color fading caused by exposure to weather.
- B. Correct defective work within a five year period after Date of Substantial Completion, including defects in water tightness and integrity of seals.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Metal Wall Panels - Concealed Fasteners; Metal Soffit Panels:
 - 1. ATAS International, Inc: www.atas.com/#sle.
 - 2. Berridge Manufacturing Company: www.berridge.com/#sle.
 - 3. Centria: www.centria.com/#sle.
 - 4. Dri-Design: www.dri-design.com.

5. Petersen Aluminum Corporation: www.pac-clad.com/#sle.
6. Substitutions: See Section 016000 - Product Requirements.

2.2 MANUFACTURED METAL PANELS

- A. Wall Panel System: Factory fabricated prefinished metal panel system, site assembled.
 1. Provide exterior 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. Design Pressure: In accordance with applicable codes.
 4. Maximum Allowable Deflection of Panel: $L/180$ for length(L) of span.
 5. 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.
 6. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within panel system.
 7. Fabrication: Formed true to shape, accurate in size, square, and free from distortion or defects; pieces of longest practical lengths.
 8. Corners: Factory-fabricated in one continuous piece with minimum 2 inch returns.
 9. Provide continuity of air barrier and vapor retarder seal at building enclosure elements in accordance with materials specified in Section 072500.
- B. Exterior Wall Panels:
 1. Profile: Vertical and horizontal, as indicated; style as indicated.
 - a. Perforated panels where indicated.
 2. Side Seams: Double-interlocked, tight-fitting, sealed with continuous bead of sealant.
 3. Material: Precoated aluminum sheet, 20 gage, 0.032 inch minimum thickness.
 4. Panel Width: As indicated.
 5. Color: As selected by Architect from manufacturer's full line.
 - a. Including pre-weathered (COR-TEN) finishing.
- C. Soffit Panels:
 1. Profile: Flush.
 2. Material: Precoated aluminum sheet, 20 gage, 0.032 inch minimum thickness.
 3. Color: As selected by Architect from manufacturer's standard line.
- D. Subgirt Framing Assembly:
 1. 16 gage, 0.0598 inch thick formed non-precoated steel sheet.
 2. Profile as indicated; to attach panel system to building.
- E. Trim: Same material, thickness and finish as exterior sheets; brake formed to required profiles.

2.3 MATERIALS

- A. Precoated Aluminum Sheet: ASTM B209 (ASTM B209M), 3105 alloy, O temper, smooth surface texture; continuous-coil-coated on exposed surfaces with specified finish coating and on panel back with specified panel back coating.
- B. Select materials with surface flatness, smoothness, and lack of surface blemishes where exposed to view in finished system.

2.4 FINISHES

- A. Exposed Surface Finish: Panel manufacturer's standard polyvinylidene fluoride (PVDF) coating, top coat over epoxy primer.
- B. Panel Backside Finish: Panel manufacturer's standard siliconized polyester wash coat.
- C. Custom Fluoropolymer Coating System: Polyvinylidene fluoride (PVDF) multi-coat thermoplastic fluoropolymer coating system, including minimum 70 percent PVDF color topcoat and minimum total dry film thickness (DFT) of 0.9 mil; color and gloss as indicated on drawings.

2.5 ACCESSORIES

- A. Gaskets: Manufacturer's standard type suitable for use with system, permanently resilient; ultraviolet and ozone resistant.
- B. Concealed Sealants: Non-curing butyl sealant or tape sealant.
- C. Fasteners: Manufacturer's standard type to suit application; with soft neoprene washers, steel, hot dip galvanized.
 - 1. Metal-to-Metal Fasteners: Self-drilling, self-tapping screws.
- D. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils ()thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
 - 1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F.
 - 2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F.
 - 3. Products: Subject to compliance with requirements, provide one of the following:
 - a. Carlisle Coatings & Waterproofing; CCW WIP 300HT.
 - b. GCP Applied Technologies; Grace Ice and Water Shield HT.
 - c. Henry Company; Blueskin PE200 HT.
- E. Field Touch-up Paint: As recommended by panel manufacturer.
- F. Bituminous Paint: Asphalt base.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that building framing members are ready to receive panels.
- B. Verify that water-resistive barrier has been installed over substrate completely and correctly.

3.2 PREPARATION

- A. Install subgirts perpendicular to panel length, securely fastened to substrates and shimmed and leveled to uniform plane. Space at intervals indicated.

3.3 INSTALLATION

- A. Install panels on walls and soffits in accordance with manufacturer's instructions.
- B. Protect surfaces in contact with cementitious materials with bituminous paint. Allow to dry prior to installation.
- C. Fasten panels to structural supports; aligned, level, and plumb.
- D. Locate joints over supports.
- E. Provide expansion joints where indicated.
- F. Use concealed fasteners unless otherwise approved by Architect.
- G. Seal and place gaskets to prevent weather penetration. Maintain neat appearance.

3.4 TOLERANCES

- A. Maximum Offset From True Alignment Between Adjacent Members Butting or In Line: 1/16 inch.
- B. Maximum Variation from Plane or Location Indicated on Drawings: 1/4 inch.

3.5 CLEANING

- A. Remove site cuttings from finish surfaces.
- B. Remove protective material from wall panel surfaces.
- C. Clean and wash prefinished surfaces with mild soap and water; rinse with clean water.
- D. Upon completion of installation, thoroughly clean prefinished aluminum surfaces in accordance with AAMA 609 & 610.

END OF SECTION

SECTION 075423
THERMOPLASTIC POLYOLEFIN (TPO) MEMBRANE ROOFING - CARLISLE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Adhered system with thermoplastic polyolefin (TPO) roofing membrane.
- B. Insulation, flat and tapered.
- C. Deck sheathing and cover boards.
- D. Roofing cant strips, cant strips, stack boots, stack boots, roofing expansion joints, roofing expansion joints, walkway pads, and walkway pads.

1.2 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.
- B. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing 2017.
- C. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board 2022.
- D. ASTM D6878/D6878M - Standard Specification for Thermoplastic Polyolefin-Based Sheet Roofing 2021.
- E. ASTM E1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces 2011 (Reapproved 2019).
- F. FM DS 1-28 - Wind Design 2016.
- G. FM DS 1-29 - Roof Deck Securement and Above-Deck Roof Components 2016, with Editorial Revision (2020).
- H. NRCA (RM) - The NRCA Roofing Manual 2022.
- I. UL 790 - Standard for Standard Test Methods for Fire Tests of Roof Coverings Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week before starting work of this section.
 - 1. Review preparation and installation procedures and coordinating and scheduling required with related work.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's written information listed below.
 - 1. Product data indicating membrane materials, flashing materials and insulation.
 - 2. Preparation instructions and recommendations.
 - 3. Storage and handling requirements.
- C. Shop Drawings: Indicate joint or termination detail conditions, conditions of interface with other materials, and paver layout.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Manufacturer's Field Reports: Indicate procedures followed, ambient temperatures, humidity, wind velocity during application, and supplementary instructions given.
- F. Manufacturer's Installation Instructions: Indicate membrane seaming precautions and perimeter conditions requiring special attention.
- G. Specimen Warranty: For approval.
- H. Warranty:
 - 1. Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

2. Submit installer's certification that installation complies with all warranty conditions for the waterproof membrane.
 - I. Manufacturer's Qualification Statement.
 - J. Installer's Qualification Statement.
- 1.5 QUALITY ASSURANCE
- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum twenty (20) years of documented experience.
 - B. Installer Qualifications: Company specializing in performing the work of this section:
 1. With minimum five (5) years documented experience.
 2. Approved by membrane manufacturer.
 3. Extend manufacturer's No Dollar Limit guarantee.
- 1.6 MOCK-UPS
- A. See Section 014000 - Quality Requirements for additional requirements.
 - B. Provide mock-up for evaluation of surface preparation, installation methods, and workmanship. mock-up.
 - C. Locate where directed.
 - D. Mock-up may remain as part of the Work.
- 1.7 DELIVERY, STORAGE, AND HANDLING
- A. Deliver products in manufacturer's original containers, dry, undamaged, with seals and labels intact.
 - B. Protect products in weather protected environment, clear of ground and moisture.
 - C. Protect foam insulation from direct exposure to sunlight.
 - D. Provide Safety Data Sheets (SDS) at the project site at all times during transportation, storage, and installation of materials.
 - E. Comply with requirements from Owner to prevent overloading or disturbance of the structure when loading materials onto the roof.
- 1.8 FIELD CONDITIONS
- A. Do not apply roofing membrane during unsuitable weather. Refer to manufacturer's written instructions.
 - B. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
 - C. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.
 - D. Proceed with work so new roofing materials are not subject to construction traffic as work progresses.
 - E. Do not allow grease, oil, fats, or other contaminants to come into direct contact with membrane.
- 1.9 WARRANTY
- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
 - B. Material Warranty: Provide membrane manufacturer's warranty agreeing to replace material that shows manufacturing defects within 10 years after installation.
 - C. System Warranty: Provide manufacturer's system warranty agreeing to repair or replace roofing that leaks or is damaged due to wind or other natural causes.
 1. Warranty Term: 20 years.
 2. For repair and replacement include costs of both material and labor in warranty.
 3. Include accidental punctures according to the manufacturer's standard warranty terms.
 4. Include hail damage according to the manufacturer's standard warranty terms.
 5. Exceptions NOT Permitted:
 - a. Damage due to roof traffic.
 - b. Damage due to wind of speed greater than 56 mph but less than 90 mph.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Carlisle SynTec Systems: www.carlisle-syntec.com/#sle.
- B. Substitutions: Not permitted.

2.2 ROOFING APPLICATIONS

- A. TPO Membrane Roofing: One ply membrane, fully adhered, over insulation.
- B. Roofing Assembly Performance Requirements and Design Criteria:
 - 1. Solar Reflectance Index (SRI): 78, minimum, calculated in accordance with ASTM E1980.
 - a. Field applied coating may not be used to achieve specified SRI.
 - 2. Roof Covering External Fire Resistance Classification: Class A when tested per UL 790.
 - 3. Wind Uplift:
 - a. Designed to withstand wind uplift forces calculated with ASCE 7.
 - 4. Drainage: No standing water within 48 hours after precipitation.

2.3 ROOFING MEMBRANE AND ASSOCIATED MATERIALS

- A. Single Source Responsibility: Provide and install products from single source.
- B. Membrane:
 - 1. Material: Thermoplastic Polyolefin (TPO) complying with ASTM D6878/D6878M.
 - 2. Reinforcing: Internal fabric.
 - 3. Thickness: 115 mils (0.115 inch), minimum.
 - 4. Sheet Width: Factory fabricated into largest sheets possible.
 - 5. Color: White.
 - 6. Color: To be selected by Architect from manufacturer's full color range.
 - 7. Products:
 - a. Carlisle Sure-Weld FleeceBACK TPO.
- C. Seaming Materials: As recommended by membrane manufacturer.
- D. Flexible Flashing Material: Same material as membrane.
- E. Base Flashing: Provide waterproof, fully adhered base flashing system at all penetrations, plane transitions, and terminations.

2.4 DECK SHEATHING AND COVER BOARDS

- A. Deck Sheathing: Glass mat faced gypsum panels, ASTM C1177/C1177M, fire resistant type, 1/2 inch thick.
 - 1. Products:
 - a. GP Dens-Deck Prime, distributed by Carlisle.
- B. Cover Board: Polyisocyanurate (ISO) thermal board, complying with ASTM C1289; Type II - Faced with dark coated-glass facer on one side and light coated-glass facer on other surface of core foam, Class 4 with thickness of 1/2 inch, and Grade 1 with 109 psi, maximum, compressive strength.
 - 1. Product: Carlisle SecurShield HD Polyiso.

2.5 INSULATION

- A. Polyisocyanurate (ISO) Board Insulation: Complies with ASTM C1289, Type II, Class 1 - Faced with glass-reinforced felt on both surfaces of core foam.
 - 1. Tapered Board: Slope as indicated; minimum thickness 1/2 inch; fabricate of fewest layers possible.
 - 2. Grade and Compressive Strength: Grade 2, 20 psi, minimum.
 - 3. Board Thickness: 1/2 inch.
 - 4. Product: Carlisle InsulBase.

2.6 ACCESSORIES

- A. Prefabricated Roofing Expansion Joint Flashing: Sheet butyl over closed-cell foam backing seamed to galvanized steel flanges.

- B. Prefabricated Flashing Accessories:
 - 1. Corners and Seams: Same material as membrane, in manufacturer's standard thicknesses.
 - 2. Penetrations: Same material as membrane, with manufacturer's standard cut-outs, rigid inserts, clamping rings, and flanges.
 - 3. Sealant Pockets: Same material as membrane, with manufacturer's standard accessories, in manufacturer's standard configuration.
 - 4. Pressure Sensitive Cover Strips: 6 inches wide, 45 mil, 0.045 inch thick, non-reinforced TPO membrane laminated to 35 mil, 0.035 inch thick cured synthetic rubber with pressure sensitive adhesive.
 - 5. Walkway Rolls:
 - a. Carlisle SynTec Systems; Sure-Flex Heat Weldable Walkway Rolls: 80 mils (0.080 inch) thick; gray membrane.
 - 6. Contour Rib: Used to have membrane appear as standing seam metal roofing, with profile of 1-1/4 inches tall, 2-1/8 inches wide including welding flanges, and vertical profile that is 3/8 inch thick.
 - a. Length: 120 inches, nominal.
 - b. Color: As selected by Architect.
 - c. Product: Carlisle Sure-Weld TPO Contour Rib Profile.
 - 7. Miscellaneous Flashing: Non-reinforced TPO membrane; 80 mil, 0.080 inch thick, in manufacturer's standard lengths and widths.
- C. Insulation Adhesive: Two-component polyurethane, expanding foam.
- D. Insulation Joint Tape: Glass fiber reinforced type as recommended by insulation manufacturer, compatible with roofing materials; 6 inches wide; self adhering.
- E. Insulation Fasteners: Appropriate for purpose intended and approved by roofing manufacturer.
 - 1. Length as required for thickness of insulation material and penetration of deck substrate, with metal washers.
- F. Membrane Adhesive: As recommended by membrane manufacturer.
 - 1. Carlisle SynTec Systems; Sure-Weld Bonding Adhesive.
- G. Surface Conditioner for Adhesives: Compatible with membrane and adhesives.
- H. Strip Reglet Devices: Galvanized steel, maximum possible lengths per location, with attachment flanges.
- I. Sealants: As recommended by membrane manufacturer.
- J. Cleaner: Manufacturer's standard, clear, solvent-based cleaner.
 - 1. Product: Carlisle Weathered Membrane Cleaner.
- K. Edgings and Terminations: Manufacturer's standard edge and termination accessories.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces and site conditions are ready to receive work.
- B. Verify deck is supported and secure.
- C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.
- D. Verify deck surfaces are dry and free of snow or ice.
- E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips are in place.

3.2 PREPARATION, GENERAL

- A. Clean substrate thoroughly prior to roof application.
- B. Do not begin work until other work that requires foot or equipment traffic on roof is complete.

3.3 METAL DECK PREPARATION

- A. Install deck sheathing on metal deck:
 - 1. Lay with long side at right angle to flutes; stagger end joints; provide support at ends.
 - 2. Cut sheathing cleanly and accurately at roof breaks and protrusions to provide smooth surface.
 - 3. Tape joints.

4. Mechanically fasten sheathing to roof deck, in accordance with Factory Mutual recommendations and roofing manufacturer's instructions.
 - a. Over entire roof area, fasten sheathing using 6 fasteners with washers per sheathing board.

3.4 INSTALLATION - GENERAL

- A. Perform work in accordance with manufacturer's instructions and NRCA (RM) applicable requirements.
- B. Do not apply roofing membrane during unsuitable weather.
- C. Do not apply roofing membrane when ambient temperature is outside the temperature range recommended by manufacturer.
- D. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
- E. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.
- F. Coordinate the work with installation of associated counterflashings installed by other sections as the work of this section proceeds.
- G. When substrate preparation is responsibility of another installer, notify Architect of unsatisfactory conditions before proceeding.

3.5 INSULATION APPLICATION

- A. Attachment of Insulation:
 1. Embed first layer of insulation in full bed of adhesive in accordance with roofing and insulation manufacturers' instructions.
 2. Mechanically fasten subsequent layer of insulation to deck in accordance with roofing manufacturer's instructions and Factory Mutual requirements.
- B. Lay subsequent layers of insulation with joints staggered minimum 6 inch from joints of preceding layer.
- C. On metal deck, place boards parallel to flutes with insulation board edges bearing on deck flutes.
- D. Lay boards with edges in moderate contact without forcing, and gap between boards no greater than 1/4 inch. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
- E. Tape joints of insulation in accordance with roofing and insulation manufacturers' instructions.
- F. Do not apply more insulation than can be completely waterproofed in the same day.

3.6 MEMBRANE APPLICATION

- A. Roll out membrane, free from wrinkles or tears. Place sheet into place without stretching.
- B. Shingle joints on sloped substrate in direction of drainage.
- C. Fully Adhered Application: Apply adhesive at manufacturer's recommended rate. Fully embed membrane in adhesive except in areas directly over or within 3 inches of expansion joints. Fully adhere one roll before proceeding to adjacent rolls.
- D. Seam Welding:
 1. Seam Welding: Overlap edges and ends and seal seams by heat welding, minimum 2 inches.
 2. Cover seams with manufacturer's recommended joint covers.
 3. Probe seams once welds have thoroughly cooled, in approximately 30 minutes.
 4. Repair deficient seams within the same day.
 5. Seal cut edges of reinforced membrane after seam probe is complete.
- E. At intersections with vertical surfaces:
 1. Extend membrane over cant strips and up a minimum of 4 inches onto vertical surfaces.
 2. Fully adhere flexible flashing over membrane and up to nailing strips.
- F. Install roofing expansion joints where indicated. Make joints watertight.
- G. Install prefabricated joint components in accordance with manufacturer's instructions.
- H. Coordinate installation of roof drains and sumps and related flashings. Locate all field splices away from low areas and roof drains. Lap upslope sheet over downslope sheet.
- I. Install walkway pads at areas of concentrated traffic and as shown on Drawings. Space pad joints to permit drainage.

- J. Daily Seal: Install daily seal per manufacturers instructions at the end of each work day. Prevent infiltration of water at incomplete flashings, terminations, and at unfinished membrane edges.

3.7 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for general requirements for field quality control and inspection.
- B. Require site attendance of roofing and insulation material manufacturers daily during installation of this Work.

3.8 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Remove wrappings, empty containers, paper, and other debris from the roof daily. Dispose of debris in compliance with local, State, and Federal regulations.
- C. Remove bituminous markings from finished surfaces.
- D. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and conform to their documented instructions.
- E. Repair or replace defaced or damaged finishes caused by work of this section.

3.9 PROTECTION

- A. Protect installed roofing and flashings from construction operations.
- B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION

SECTION 076200
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fabricated sheet metal items, including flashings and counterflashings.
- B. Sealants for joints within sheet metal fabrications.

1.2 REFERENCE STANDARDS

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix) 2020, with Errata (2022).
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- C. ASTM C920 - Standard Specification for Elastomeric Joint Sealants 2018.
- D. ASTM D226/D226M - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing 2017.
- E. ASTM D4586/D4586M - Standard Specification for Asphalt Roof Cement, Asbestos-Free 2007 (Reapproved 2018).
- F. CDA A4050 - Copper in Architecture - Handbook current edition.
- G. SMACNA (ASMM) - Architectural Sheet Metal Manual 2012.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week before starting work of this section.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
- C. Color Chart: Manufacturer's standard prefinished product charts showing actual physical coating for prefinished items.

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with SMACNA (ASMM) and CDA A4050 requirements and standard details, except as otherwise indicated.
- B. Fabricator and Installer Qualifications: Company specializing in sheet metal work with five years of documented experience.
- C. Provide products that have been tested to resist wind uplift as required by ANSI/SPRI ES-1.

1.6 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 SHEET MATERIALS

- A. Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24 gage, (0.0239 inch) thick base metal.
- B. Pre-Finished Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24 gage, (0.0239) inch thick base metal, shop pre-coated with PVDF coating.

1. PVDF (Polyvinylidene Fluoride) Coating: Superior Performance Organic Finish, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system.
2. Color: As selected by Architect from manufacturer's standard colors.

2.2 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Form pieces in longest possible lengths.
- C. Hem exposed edges on underside 1/2 inch; miter and seam corners.
- D. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
- E. Fabricate corners from one piece with minimum 18 inch long legs; seam for rigidity, seal with sealant.
- F. Fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip.
- G. Fabricate flashings to allow toe to extend 2 inches over roofing gravel. Return and brake edges.

2.3 ACCESSORIES

- A. Fasteners: Galvanized steel, with soft neoprene washers.
- B. Underlayment: ASTM D226/D226M, organic roofing felt, Type I (No. 15).
- C. Primer: Zinc chromate type.
- D. Concealed Sealants: Non-curing butyl sealant.
- E. Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.
- F. Plastic Cement: ASTM D4586/D4586M, Type I.
- G. Reglets: Surface mounted type, galvanized steel; face and ends covered with plastic tape.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Install starter and edge strips, and cleats before starting installation.
- B. Install surface mounted reglets true to lines and levels, and seal top of reglets with sealant.
- C. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil.

3.3 INSTALLATION

- A. Comply with drawing details.
- B. Insert flashings into reglets to form tight fit; secure in place with lead wedges; pack remaining spaces with lead wool; seal flashings into reglets with sealant.
- C. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted..
- D. Apply plastic cement compound between metal flashings and felt flashings.
- E. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- F. Seal metal joints watertight.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for field inspection requirements.
- B. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

END OF SECTION

SECTION 077100 ROOF SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Manufactured roof specialties, including copings.
- B. Roof control joint covers.
- C. Roof membrane vents.

1.2 RELATED REQUIREMENTS

1.3 REFERENCE STANDARDS

- A. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix) 2021.
- B. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix) 2020, with Errata (2022).
- C. ANSI/SPRI/FM 4435/ES-1 - Test Standard for Edge Systems Used with Low Slope Roofing Systems 2017.
- D. NRCA (RM) - The NRCA Roofing Manual 2022.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on shape of components, materials and finishes, anchor types and locations.
- C. Shop Drawings: Indicate configuration and dimension of components, adjacent construction, required clearances and tolerances, and other affected work.
- D. Samples: Submit two appropriately sized samples of coping and fascia.
- E. Manufacturer's Installation Instructions: Indicate special procedures, fasteners, supporting members, and perimeter conditions requiring special attention.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Roof Edge Flashings and Copings:
 - 1. Architectural Products Co: www.archprod.com/#sle.
 - 2. ATAS International, Inc: www.atas.com/#sle.
 - 3. Metal-Era Inc: www.metalera.com/#sle.
 - 4. OMG Roofing Products: www.omgroofing.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.
- B. Control and Expansion Joint Covers:
 - 1. GAF: www.gaf.com/#sle.
 - 2. Johns Manville: www.jm.com/#sle.
 - 3. MM Systems Corp: www.mmsystemscorp.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.

2.2 COMPONENTS

- A. Copings: Factory fabricated to sizes required; mitered, welded corners; concealed fasteners.
 - 1. Configuration: Concealed continuous hold down cleat at both legs; internal splice piece at joints of same material, thickness and finish as cap; concealed stainless steel fasteners.
 - 2. Pull-Off Resistance: Tested in accordance with ANSI/SPRI/FM 4435/ES-1 using test method RE-3 to positive and negative design wind pressure as defined by applicable local building code.
 - 3. Material: Formed steel sheet, galvanized, 24 gage, 0.024 inch thick, minimum.

4. Finish: 70 percent polyvinylidene fluoride.
 5. Color: To be selected by Architect from manufacturer's standard range.
- B. Control Joint Covers: Composite construction of 2 inch wide flexible EPDM flashing of white color with closed cell urethane foam backing, each edge seamed to aluminum sheet metal flanges, designed for nominal joint width of 1 inch. Include special formed corners, tees, intersections, and wall flashings, each sealed watertight.
- C. Roofing Vents: Formed aluminum with watertight construction to allow construction below roof membrane to breathe; with attachment flanges.
1. Finish: Mill finish.

2.3 FINISHES

- A. Baked Enamel: Pigmented Organic Coating System, AAMA 2603; polyester baked enamel finish system; color as indicated.
- B. PVDF (Polyvinylidene Fluoride) Coating: Superior Performance Organic Finish, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system; color as indicated.

2.4 ACCESSORIES

- A. Sealant for Joints in Linear Components: As recommended by component manufacturer.
- B. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils ()thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F.
 2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F.
 3. Products: Subject to compliance with requirements, provide one of the following:
 - a. Carlisle Coatings & Waterproofing; CCW WIP 300HT.
 - b. Grace Construction Products, a unit of W. R. Grace & Co.; Ince and Water Shield HT.
 - c. Henry Company; Blueskin PE200 HT.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that deck, curbs, roof membrane, base flashing, and other items affecting work of this Section are in place and positioned correctly.
1. Refer to Section 077200 for information on roofing related accessories.

3.2 INSTALLATION

- A. Install components in accordance with manufacturer's instructions and NRCA (RM) applicable requirements.
- B. Seal joints within components when required by component manufacturer.
- C. Anchor components securely.
- D. Comply with NRCA (RM) drawing details as noted:
- E. Coordinate installation of components of this section with installation of roofing membrane and base flashings.
- F. Coordinate installation of sealants and roofing cement with work of this section to ensure water tightness.
- G. Coordinate installation of flashing flanges into reglets.

END OF SECTION

SECTION 077200
ROOF ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Curbs.
- B. Equipment rails.
- C. Roof penetrations mounting curbs.
- D. Snow guards.

1.2 REFERENCE STANDARDS

- A. 29 CFR 1910.23 - Ladders current edition.
- B. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- C. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- E. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used.
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
 - 4. Maintenance requirements.
- C. Shop Drawings: Submit detailed layout developed for this project and provide dimensioned location and number for each type of roof accessory.
 - 1. Non-penetrating Rooftop Supports: Submit design calculations for loadings and spacings.
 - 2. Snow Guards: Submit design calculations for loadings and spacings based on manufacturer testing.
 - 3. Submit shop drawings sealed and signed by a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
- D. Certificate: For smoke hatches, provide certificate of approval from authority having jurisdiction.
- E. Warranty Documentation:
 - 1. Submit manufacturer warranty.
 - 2. Ensure that forms have been completed in Owner's name and registered with manufacturer.
 - 3. Submit documentation that roof accessories are acceptable to roofing manufacturer, and do not limit the roofing warranty.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store products under cover and elevated above grade.

1.5 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

2.1 ROOF CURBS

- A. Manufacturers:
 - 1. AES Industries Inc: www.aescurb.com/#sle.
 - 2. The Pate Company: www.patecurbs.com/#sle.
 - 3. LMCurbs; Roof Curbs: www.lmcurbs.com/#sle.
 - 4. Roof Products & Systems (RPS): www.rpscurbs.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.
- B. Roof Curbs Mounting Assemblies: Factory fabricated hollow sheet metal construction, internally reinforced, and capable of supporting superimposed live and dead loads and designated equipment load with fully mitered and sealed corner joints welded or mechanically fastened, and integral counterflashing with top and edges formed to shed water.
 - 1. Applications: Roof curbs used for roof penetrations/openings as indicated on drawings.
 - 2. Roof Curb Mounting Substrate: Curb substrate consists of flat roof deck sheathing with insulation.
 - 3. Sheet Metal Material:
 - a. Galvanized Steel: Hot-dip zinc coated steel sheet complying with ASTM A653/A653M, SS Grade 33; G60 coating designation; 18 gage, 0.048 inch thick.
 - 1) Finish: Factory primed.
 - 2) Color: As selected by Architect from manufacturer's standard line of colors.
 - 4. Roofing Cants: Provide integral sheet metal roofing cants dimensioned to begin slope at top of roofing system at 1:1 slope; minimum cant height 4 inches.
 - 5. Provide layouts and configurations indicated on drawings.
- C. Curbs Adjacent to Roof Openings: Provide curb on each side of opening, with top of curb horizontal for equipment mounting.
 - 1. Provide preservative treated wood nailers along top of curb.
 - 2. Insulate inside curbs with 1-1/2 inch thick fiberglass insulation.
 - 3. Height Above Finished Roof Surface: 8 inches, minimum.
- D. Equipment Rail Curbs: Straight curbs on each side of equipment, with top of curbs horizontal and level with each other for equipment mounting.
- E. Pipe, Duct, or Conduit Mounting Curbs: Vertical posts, minimum 8 inches square unless otherwise indicated.

2.2 NON-PENETRATING ROOFTOP SUPPORTS/ASSEMBLIES

- A. Non-Penetrating Rooftop Support/Assemblies: Manufacturer-engineered and factory-fabricated, with pedestal bases that rest on top of roofing membrane, and not requiring any attachment to roof structure and not penetrating roofing assembly.
 - 1. Design Loadings and Configurations: As required by applicable codes.
 - 2. Support Spacing and Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - 3. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
 - 4. Hardware, Bolts, Nuts, and Washers: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A153/A153M.
- B. Pipe Supports: Provide attachment fixtures complying with MSS SP-58 and as indicated.
 - 1. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
 - 2. See relevant piping system specification section for additional requirements.

2.3 SNOW GUARDS

- A. Fence Type Snow Guard: Continuous snow guard; manufacturer's standard pipe, bar, channel, or solid rod, set in brackets or posts, with optional plates and metal trim to match roof.
 - 1. Brackets: Zinc plated steel.

2. Clamps for Standing Seam Roof: Aluminum clamps attached to standing seams of roof panels; for attachment of fence type snow guard.
 - a. Seam Profile: Selected by Architect from manufacturer's standard range; match profile of metal roof.
3. Manufacturers:
 - a. Metal Roof Innovations, Ltd. S-5! Attachment Solutions; ColorGard: www.s-5.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using methods recommended by manufacturer for achieving acceptable results for applicable substrate under project conditions.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions, in manner that maintains roofing system weather-tight integrity.

3.4 CLEANING

- A. Clean installed work to like-new condition.

3.5 PROTECTION

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

END OF SECTION

SECTION 078400 FIRESTOPPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Firestopping of all joints and penetrations in fire resistance rated and smoke resistant assemblies, and other openings indicated.

1.2 REFERENCE STANDARDS

- A. UL (FRD) - Fire Resistance Directory Current Edition.

1.3 SUBMITTALS

- A. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.
- B. Product Data: Provide data on product characteristics, performance ratings, and limitations.
- C. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Certificate from authority having jurisdiction indicating approval of materials used.
- F. Installer Qualification: Submit qualification statements for installing mechanics.

1.4 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
 - 1. Listing in UL (FRD) will be considered as constituting an acceptable test report.
 - 2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.
 - 3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Installer Qualifications: Company specializing in performing the work of this section and:
 - 1. Trained by manufacturer.
 - 2. Verification of minimum three years documented experience installing work of this type.
 - 3. Verification of at least five satisfactorily completed projects of comparable size and type.
 - 4. Licensed by local authorities having jurisdiction (AHJ).

1.5 FIELD CONDITIONS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation; maintain minimum temperature before, during, and for three days after installation of materials.
- B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.1 FIRESTOPPING - GENERAL REQUIREMENTS

- A. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

2.2 FIRESTOPPING SYSTEMS

- A. Firestopping: Any material meeting requirements of approved assembly.

2.3 MATERIALS

- A. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.
- B. Fire Ratings: Refer to drawings for required systems and ratings.
- C. Elastomeric Silicone Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.
 - 1. Manufacturers:
 - a. A/DFire Protection Systems Inc: www.adfire.com.
 - b. 3M Fire Protection Products: www.3m.com/firestop.
 - c. Hilti, Inc: www.us.hilti.com.
 - d. Specified Technologies, Inc: www.stifirestop.com.
 - e. Substitutions: See Section 016000 - Product Requirements.
- D. Foam Firestopping: Single component silicone foam compound.
 - 1. Manufacturers:
 - a. 3M Fire Protection Products: www.3m.com/firestop.
 - b. Hilti, Inc: www.us.hilti.com.
 - c. Specified Technologies, Inc: www.stifirestop.com.
 - d. Substitutions: See Section 016000 - Product Requirements.
- E. Fibered Compound Firestopping: Formulated compound mixed with incombustible non-asbestos fibers.
 - 1. Manufacturers:
 - a. A/DFire Protection Systems Inc: www.adfire.com.
 - b. USG: www.usg.com.
 - c. Substitutions: See Section 016000 - Product Requirements.
- F. Fiber Firestopping: Mineral fiber insulation used in conjunction with elastomeric surface sealer forming airtight bond to opening.
 - 1. Manufacturers:
 - a. A/DFire Protection Systems Inc: www.adfire.com.
 - b. Pecora Corporation: www.pecora.com.
 - c. Thermafiber, Inc: www.thermafiber.com.
 - d. Substitutions: See Section 016000 - Product Requirements.
- G. Firestop Devices - Wrap Type: Mechanical device with incombustible filler and sheet stainless steel jacket, intended to be installed after penetrating item has been installed.
 - 1. Manufacturers:
 - a. RectorSeal: www.rectorseal.com.
 - b. 3M Fire Protection Products: www.3m.com/firestop.
 - c. Hilti, Inc: www.us.hilti.com.
 - d. Specified Technologies, Inc: www.stifirestop.com.
 - e. Substitutions: See Section 016000 - Product Requirements.
- H. Intumescent Putty: Compound that expands on exposure to surface heat gain.
 - 1. Manufacturers:
 - a. RectorSeal: www.rectorseal.com.
 - b. 3M Fire Protection Products: www.3m.com/firestop.
 - c. Hilti, Inc: www.us.hilti.com.
 - d. Specified Technologies, Inc: www.stifirestop.com.
 - e. Substitutions: See Section 016000 - Product Requirements.
- I. Reusable Firestopping: Removable intumescent compressible shapes, pillows, or blocks specifically tested in removable configuration.
 - 1. Manufacturers:
 - a. RectorSeal: www.rectorseal.com.
 - b. Hilti, Inc: www.us.hilti.com.
 - c. Nelson FireStop Products: www.nelsonfirestop.com.
 - d. Specified Technologies, Inc: www.stifirestop.com.
 - e. Substitutions: See Section 016000 - Product Requirements.

- J. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.
 - 1. Use only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.
- C. Install backing materials to prevent liquid material from leakage.

3.3 INSTALLATION

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

3.4 FIELD QUALITY CONTROL

- A. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

3.5 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.6 PROTECTION

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

END OF SECTION

SECTION 079005 JOINT SEALERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Sealants and joint backing at the juncture of all dis-similar materials.
- B. Pre-compressed foam sealers.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with other sections referencing this section.

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating sealant chemical characteristics.
- C. Samples: Submit one sample for each Designation and color of joint sealant required. Samples shall be installed in 1/2 inch wide joints formed between two 6 inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Compatibility and Adhesion Test Reports: Submit reports from joint sealant manufacturer indicating:
 - 1. Materials forming joint substrates and joint sealant backings have been tested for compatibility and adhesion with joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- E. Manufacturer's Installation Instructions: Indicate special procedures.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Applicator Qualifications: Company specializing in performing the work of this section with minimum three years experience.
- C. Do not apply sealants if ambient or substrate temperatures are below 40 degrees and rising.

1.5 FIELD CONDITIONS

- A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.6 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective workmanship within a five-year period after Date of Substantial Completion.
- C. Correct defective materials for 5 years for urethane sealants and 20 years for silicone sealants.
- D. Warranty: Include coverage for installed sealants and accessories which fail to achieve airtight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Silicone Sealants:
 - 1. Bostik Inc: www.bostik-us.com.
 - 2. Master Builders Solutions: www.master-builders-solutions.com.
 - 3. Momentive Performance Materials, Inc (formerly GE Silicones): www.momentive.com.
 - 4. Pecora Corporation: www.pecora.com.
 - 5. Tremco Global Sealants: www.tremcosealants.com.
 - 6. Substitutions: See Section 016000 - Product Requirements.

- B. Polyurethane Sealants:
 - 1. Bostik Inc: www.bostik-us.com.
 - 2. Master Builders Solutions: www.master-builders-solutions.com.
 - 3. Pecora Corporation: www.pecora.com.
 - 4. Substitutions: See Section 016000 - Product Requirements.
- C. Acrylic Sealants (ASTM C920):
 - 1. Tremco Global Sealants: www.tremcosealants.com.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- D. Acrylic Emulsion Latex Sealants:
 - 1. Bostik Inc: www.bostik-us.com.
 - 2. Master Builders Solutions: www.master-builders-solutions.com.
 - 3. Pecora Corporation: www.pecora.com.
 - 4. Tremco Global Sealants: www.tremcosealants.com.
 - 5. Substitutions: See Section 016000 - Product Requirements.
- E. Preformed Compressible Foam Sealers:
 - 1. EMSEAL Joint Systems, Ltd: www.emseal.com.
 - 2. Hohmann & Barnard: www.h-b.com.
 - 3. Dayton Superior Corporation: www.daytonsuperior.com.
 - 4. Tremco Global Sealants: www.tremcosealants.com.
 - 5. Substitutions: See Section 016000 - Product Requirements.

2.2 SEALANTS

- A. Designation AL-A - Acoustical Sealant: Butyl or acrylic sealant; ASTM C 920, Grade NS, Class 12-1/2, Uses M and A; single component, solvent release curing, non-skinning.
 - 1. Product: BA-98 manufactured by Pecora.
- B. Designation AL - Acrylic Sealant: ASTM C 920, Grade NS, Class 12-1/2, Uses NT, M, A, O; single component, solvent curing, non-staining, non-bleeding, non-sagging.
 - 1. Color: Standard colors matching finished surfaces.
 - 2. Product: MasterSeal NP 520 manufactured by Master Builders Solutions.
 - 3. Movement Capability: Plus and minus 12-1/2 percent.
 - 4. Service Temperature Range: -13 to 180 degrees F.
 - 5. Shore A Hardness Range: 25 to 50.
 - 6. Applications: Use for:
- C. Designation U-MC - Non-sag Polyurethane Sealant: ASTM C 920, Grade NS, Class 25, Uses NT, I, M, A, G, O; single component, chemical curing, non-staining, non bleeding, capable of continuous water immersion, non-sagging Designation.
 - 1. Color: Standard colors matching finished surfaces.
 - 2. Product: MasterSeal NP 2 manufactured by Master Builders Solutions.
 - 3. Movement Capability: Plus and minus 25 percent.
 - 4. Service Temperature Range: -40 to 180 degrees F.
 - 5. Shore A Hardness Range: 20 to 35.
- D. Designation U-SL - Self-Leveling Polyurethane Sealant: ASTM C 920, Grade P, Class 25, Uses T, I, M, A, O; single component, chemical curing, non staining, non bleeding, capable of continuous water immersion, self-leveling Designation.
 - 1. Color: Color as selected.
 - 2. Product: MasterSeal SL 2 manufactured by Master Builders Solutions.
 - 3. Movement Capability: Plus and minus 25 percent.
 - 4. Service Temperature Range: -40 to 180 degrees F.
 - 5. Shore A Hardness Range: 20 to 35.
- E. Designation S-GP - Silicone Sealant: ASTM C 920, Grade NS, Class 25, Uses NT, A, G, M, O; single component, solvent curing, non-sagging, non-staining, fungus resistant, non-bleeding.
 - 1. Color: Standard colors matching finished surfaces.
 - 2. Product: 795 manufactured by Dow Corning.

3. Movement Capability: Plus and minus 25 percent.
 4. Service Temperature Range: -65 to 180 degrees F.
 5. Shore A Hardness Range: 15 to 35.
- F. Designation S-S - Silicone Sealant: ASTM C 920, Grane NS, Class 25, Uses NG, A, G, M, O; single component, non-sagging, non-staining, sanitary.
1. Color: Standard colors matching finished surfaces.
 2. Product: 786 manufactured by Dow Corning.
 3. Service Temperature Range: -65 to 180 degrees F.
 4. Shore A Hardness Range: 15 to 35.
 5. Pre-Formed Elastomeric Foam Seal (PF): Protectowrap Triple Guard energy Sill Sealer.

2.3 ACCESSORIES

- A. Primer: Non-staining Designation, recommended by sealant manufacturer to suit application.
- B. Joint Backing: Round foam rod compatible with sealant; ASTM D 1667, closed cell PVC; oversized 30 to 50 percent larger than joint width.
- C. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.
- B. Verify that joint backing and release tapes are compatible with sealant.

3.2 PREPARATION

- A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.
- C. Clean and prime joints in accordance with manufacturer's instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- D. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
- E. Protect elements surrounding the work of this section from damage or disfigurement.

3.3 INSTALLATION

- A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Perform installation in accordance with ASTM C1193.
- C. Perform acoustical sealant application work in accordance with ASTM C919 and USG manual.
- D. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer, except where specific dimensions are indicated.
- E. Install bond breaker where joint backing is not used.
- F. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
- G. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- H. Tool joints concave.
- I. Pre-compressed Foam Sealant: Do not stretch; avoid joints except at corners, ends, and intersections; install with face 1/8 to 1/4 inch below adjoining surface.

3.4 CLEANING

- A. Clean adjacent soiled surfaces.

3.5 PROTECTION

- A. Protect sealants until cured.

3.6 SCHEDULE

- A. Exterior Joints for Which No Other Sealant Designation is Indicated: Designation S-GP.
- B. Control and Expansion Joints in Paving: Designation U-SL.
- C. Interior Wall Expansion Joints: Designation U-MC.
- D. Exterior Wall Expansion Joints: Designation S-GP.
- E. Control, Expansion, and Soft Joints in Masonry, and Between Masonry and Adjacent Work: Designation S-GP.
- F. Lap Joints in Exterior Sheet Metal Work: Designation S-GP.
- G. Joints Between Exterior Metal Frames and Adjacent Work: Designation S-GP.
- H. Under Exterior Door Thresholds: Designation S-GP.
- I. Interior Joints for Which No Other Sealant is Indicated: Designation AL.
- J. Control and Expansion Joints in Interior Concrete Slabs and Floors: Designation U-SL.
- K. Joints Between Plumbing Fixtures and Walls and Floors, and Between Countertops and Walls: Designation S-S.
- L. Between Slab and Sill Receivers at Aluminum Storefront: Bituminous Mastic.

END OF SECTION

SECTION 081113
HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Hollow metal frames for wood doors.
- B. Thermally insulated hollow metal doors with frames.

1.2 ABBREVIATIONS AND ACRONYMS

- A. ANSI - American National Standards Institute.
- B. ASCE - American Society of Civil Engineers.
- C. HMMA - Hollow Metal Manufacturers Association.
- D. NAAMM - National Association of Architectural Metal Manufacturers.
- E. NFPA - National Fire Protection Association.
- F. SDI - Steel Door Institute.
- G. UL - Underwriters Laboratories.

1.3 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design 2010.
- B. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors 2018.
- C. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames 2020.
- D. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100) 2017.
- E. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames 2020.
- F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- G. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable 2021a.
- H. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength 2018a.
- I. BHMA A156.115 - Hardware Preparation in Steel Doors and Steel Frames 2016.
- J. ICC A117.1 - Accessible and Usable Buildings and Facilities 2017.
- K. NAAMM HMMA 830 - Hardware Selection for Hollow Metal Doors and Frames 2002.
- L. NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames 2011.
- M. NAAMM HMMA 840 - Guide Specifications For Receipt, Storage and Installation of Hollow Metal Doors and Frames 2017.
- N. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames 2014.
- O. NFPA 80 - Standard for Fire Doors and Other Opening Protectives 2022.
- P. SDI 117 - Manufacturing Tolerances for Standard Steel Doors and Frames 2019.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced standards/guidelines.
- C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.

- D. Samples: Submit two samples of metal, 2 inch by 2 inch in size showing factory finishes, colors, and surface texture.
- E. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.
- F. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.
- G. Manufacturer's Qualification Statement.
- H. Installer's Qualification Statement.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Provide hollow metal doors and frames from SDI Certified manufacturer: www.steeldoor.org/sdicertified.php.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.
- C. Maintain at project site copies of reference standards relating to installation of products specified.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
- B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Hollow Metal Doors and Frames:
 - 1. Ceco Door, an Assa Abloy Group company: www.assaabloydss.com/#sle.
 - 2. Curries, an Assa Abloy Group company: www.assaabloydss.com/#sle.
 - 3. Republic Doors, an Allegion brand: www.republicdoor.com/#sle.
 - 4. Steelcraft, an Allegion brand: www.allegion.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.

2.2 DESIGN CRITERIA

- A. Requirements for Hollow Metal Doors and Frames:
 - 1. Steel used for fabrication of doors and frames shall comply with one or more of the following requirements; Galvannealed steel conforming to ASTM A653/A653M, cold-rolled steel conforming to ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel conforming to ASTM A1011/A1011M, Commercial Steel (CS) Type B for each.
 - 2. Accessibility: Comply with ICC A117.1 and ADA Standards.
 - 3. Exterior Door Top Closures: Flush end closure channel, with top and door faces aligned.
 - 4. Door Edge Profile: Manufacturers standard for application indicated.
 - 5. Typical Door Face Sheets: Flush.
 - 6. Hardware Preparations, Selections and Locations: Comply with NAAMM HMMA 830 and NAAMM HMMA 831 or BHMA A156.115 and ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
- B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.3 HOLLOW METAL DOORS

- A. Door Finish: Factory primed and field finished.
- B. Exterior Doors: Thermally insulated.
 - 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).

- a. Level 3 - Extra Heavy-duty.
 - b. Physical Performance Level A 1 000 000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 2 - Seamless.
 - d. Door Face Metal Thickness: 16 gage, 0.053 inch, minimum.
 - e. Zinc Coating: A60/ZF180 galvanized coating; ASTM A653/A653M.
2. Door Thickness: 1-3/4 inch, nominal.

2.4 HOLLOW METAL FRAMES

- A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.
- B. Frame Finish: Factory primed and field finished.
- C. Exterior Door Frames: Full profile/continuously welded type.
 1. Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvanized) in accordance with ASTM A653/A653M, with A40/ZF120 coating.
 2. Frame Metal Thickness: 16 gage, 0.053 inch, minimum.
 3. Frame Finish: Factory primed and field finished.
 4. Weatherstripping: Separate, see Section 087100.
- D. Interior Door Frames, Non-Fire Rated: Full profile/continuously welded type.
 1. Frame Metal Thickness: 18 gage, 0.042 inch, minimum.
 2. Frame Finish: Factory primed and field finished.
- E. Door Frames, Fire-Rated: Full profile/continuously welded type.
 1. Fire Rating: Same as door, labeled.
 2. Frame Metal Thickness: 18 gage, 0.042 inch, minimum.
- F. Mullions for Pairs of Doors: Fixed, with profile similar to jambs.
- G. Provide mortar guard boxes for hardware cut-outs in frames to be installed in masonry or to be grouted.
- H. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inch high to fill opening without cutting masonry units.
- I. Frames Wider than 48 inches: Reinforce with steel channel fitted tightly into frame head, flush with top.

2.5 FINISHES

- A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

2.6 ACCESSORIES

- A. Mechanical Fasteners for Concealed Metal-to-Metal Connections: Self-drilling, self-tapping, steel with electroplated zinc finish.
- B. Grout for Frames: Portland cement grout with maximum 4 inch slump for hand troweling; thinner pumpable grout is prohibited.
- C. Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.
- D. Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Verify that finished walls are in plane to ensure proper door alignment.

3.2 PREPARATION

- A. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.
- B. Coat inside of other frames with bituminous coating to a thickness of 1/16 inch.

3.3 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
- B. Install fire rated units in accordance with NFPA 80.
- C. Coordinate frame anchor placement with wall construction.
- D. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.
- E. Install door hardware as specified in Section 087100.
 - 1. Comply with recommended practice for hardware placement of doors and frames in accordance with ANSI/SDI A250.6 or NAAMM HMMA 861.

3.4 TOLERANCES

- A. Clearances Between Door and Frame: Comply with related requirements of specified frame standards or custom guidelines indicated in accordance with SDI 117 or NAAMM HMMA 861.
- B. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.5 ADJUSTING

- A. Adjust for smooth and balanced door movement.

END OF SECTION

**SECTION 081416
FLUSH WOOD DOORS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Flush wood doors; flush configuration; fire-rated and non-rated.

1.2 REFERENCE STANDARDS

- A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition 2014, with Errata (2016).
- B. NFPA 80 - Standard for Fire Doors and Other Opening Protectives 2022.
- C. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies Current Edition, Including All Revisions.

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.
- C. Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling, blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.
- D. Samples: Submit two samples of door construction, 8 by 10 inch in size cut from top corner of door.
- E. Certificate: Submit labels and certificates required by quality assurance and quality control programs.
- F. Test Reports: Show compliance with specified requirements for the following:
 - 1. Bullet resistant doors and frames.
- G. Manufacturer's Installation Instructions: Indicate special installation instructions.
- H. Warranty, executed in Owner's name.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section, with not less than three years of documented experience.
 - 1. Company with at least one project within the past 5 years with value of woodwork within 20 percent of cost of woodwork for this project.
- B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Package, deliver and store doors in accordance with specified quality standard.
- B. Accept doors on site in manufacturer's packaging. Inspect for damage.
- C. Protect doors with resilient packaging sealed with heat shrunk plastic. Do not store in damp or wet areas; or in areas where sunlight might bleach veneer. Seal top and bottom edges with tinted sealer if stored more than one week. Break seal on site to permit ventilation.

1.6 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Interior Doors: Provide manufacturer's warranty for the life of the installation.
- C. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Wood Veneer Faced Doors:
 - 1. Eggers Industries: www.eggersindustries.com/#sle.
 - 2. Graham Wood Doors: www.grahamdoors.com/#sle.

3. Marshfield DoorSystems, Inc: www.marshfielddoors.com/#sle.
4. VT Industries, Inc: www.vtindustries.com/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

2.2 DOORS AND PANELS

- A. Doors: Refer to drawings for locations and additional requirements.
 1. Quality Standard: Custom Grade, Extra Heavy Duty performance, in accordance with AWI/AWMAC/WI (AWS), unless noted otherwise.
 2. Wood Veneer Faced Doors: 5-ply unless otherwise indicated.
- B. Interior Doors: 1-3/4 inches thick unless otherwise indicated; flush construction.
 1. Provide solid core doors at each location.
 2. Fire Rated Doors: Tested to ratings indicated on drawings in accordance with UL 10C - Positive Pressure; Underwriters Laboratories Inc (UL) or Intertek/Warnock Hersey (WHI) labeled without any visible seals when door is open.
 3. Wood veneer facing for field transparent finish as indicated on drawings.

2.3 DOOR AND PANEL CORES

- A. Non-Rated Solid Core and 20 Minute Rated Doors: Type particleboard core (PC), plies and faces as indicated.
- B. Fire-Rated Doors: Mineral core type, with fire resistant composite core (FD), plies and faces as indicated above; with core blocking as required to provide adequate anchorage of hardware without through-bolting.
- C. Bullet Resistant Doors: Equivalent to type, with bonded particleboard core (PC); rating; plies and faces as indicated above.

2.4 DOOR FACINGS

- A. Veneer Facing for Transparent Finish: White birch, veneer grade in accordance with quality standard indicated, plain sliced (flat cut), with book match between leaves of veneer, running match of spliced veneer leaves assembled on door or panel face.
 1. Vertical Edges: Any option allowed by quality standard for grade.
 2. "Running Match" each pair of doors and doors in close proximity to each other.
 3. "Pair Match" each pair of doors; "Set Match" pairs of doors within 10 feet of each other when doors are closed.
- B. Facing Adhesive: Type I - waterproof.

2.5 DOOR CONSTRUCTION

- A. Fabricate doors in accordance with door quality standard specified.
- B. Cores Constructed with stiles and rails:
 1. Provide solid blocks at lock edge and top of door for closer for hardware reinforcement.
 2. Provide solid blocking for other throughbolted hardware.
- C. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.
- D. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.
- E. Provide edge clearances in accordance with the quality standard specified.

2.6 FACTORY FINISHING - WOOD VENEER DOORS

- A. Finish work in accordance with AWI/AWMAC/WI (AWS), Section 5 - Finishing for grade specified and as follows:
 1. Transparent:
 - a. System - 11, Polyurethane, Catalyzed.
 - b. Stain: As selected by Architect.
 - c. Sheen: As scheduled.
- B. Factory finish doors in accordance with approved sample.

- C. Seal door top edge with color sealer to match door facing.

2.7 ACCESSORIES

- A. Hollow Metal Door Frames: As specified in Section 081113.
- B. Door Hardware: As specified in Section 087100.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.

3.2 INSTALLATION

- A. Install doors in accordance with manufacturer's instructions and specified quality standard.
 - 1. Install fire-rated doors in accordance with NFPA 80 requirements.
- B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.
- C. Use machine tools to cut or drill for hardware.
- D. Coordinate installation of doors with installation of frames and hardware.

3.3 TOLERANCES

- A. Conform to specified quality standard for fit and clearance tolerances.
- B. Conform to specified quality standard for telegraphing, warp, and squareness.

3.4 ADJUSTING

- A. Adjust doors for smooth and balanced door movement.
- B. Adjust closers for full closure.

END OF SECTION

SECTION 083323 OVERHEAD COILING DOORS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Overhead coiling doors, operating hardware, non-fire-rated and exterior; electrically operated.

1.2 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 2020.
- D. ITS (DIR) - Directory of Listed Products current edition.
- E. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts 2008 (Reaffirmed 2020).
- F. UL (DIR) - Online Certifications Directory Current Edition.
- G. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems Current Edition, Including All Revisions.

1.3 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: Submit two slats, 2 x6 inch in size illustrating shape, color and finish texture.
- E. Manufacturer's Installation Instructions: Indicate installation sequence and procedures, adjustment and alignment procedures.
- F. Manufacturer's Qualification Statement.
- G. Installer's Qualification Statement.
- H. Maintenance Data: Indicate lubrication requirements and frequency and periodic adjustments required.

1.4 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 testing firm acceptable to authorities having jurisdiction as suitable for purpose specified.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Overhead Coiling Doors:
 - 1. Clopay Building Products: www.clopaydoor.com/#sle.
 - 2. The Cookson Company: www.cooksondoor.com/#sle.
 - 3. [_____].
 - 4. Substitutions: See Section 016000 - Product Requirements.

2.2 COILING DOORS

- A. Exterior Coiling Doors: Steel slat curtain.

1. Capable of withstanding positive and negative wind loads of 20 psf, without undue deflection or damage to components.
 2. Single thickness slats.
 3. Nominal Slat Size: 2 inches wide x required length.
 4. Finish: Galvanized.
 5. Guide, Angles: Galvanized steel.
 6. Hood Enclosure: Manufacturer's standard; primed steel.
 7. Electric operation.
 8. Mounting: Within framed opening.
- B. Non-Fire-Rated Interior Coiling Doors: Steel slat curtain.
1. Single thickness slats.
 2. Nominal Slat Size: 2 inches wide x required length.
 3. Finish: Primed.
 4. Hood Enclosure: Manufacturer's standard; primed steel.
 5. Electric operation.
 6. Mounting: Within framed opening.

2.3 MATERIALS AND COMPONENTS

- A. Curtain Construction: Interlocking slats.
1. Slat Ends: Alternate slats fitted with end locks to act as wearing surface in guides and to prevent lateral movement.
 2. Curtain Bottom: Fitted with angles to provide reinforcement and positive contact in closed position.
 3. Weatherstripping: Moisture and rot proof, resilient type, located at jamb edges, bottom of curtain, and where curtain enters hood enclosure of exterior doors.
- B. Steel Slats: Minimum thickness, 0.028-inch; ASTM A653/A653M galvanized steel sheet.
1. Galvanizing: Minimum G90 coating.
- 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.
1. Prime paint.

2.4 ELECTRIC OPERATION

- A. Operator, Controls, Actuators, and Safeties: Comply with UL 325; provide products listed by ITS (DIR), UL (DIR), or testing agency acceptable to authorities having jurisdiction.
1. Provide interlock switches on motor operated units.
 2. Provide tamperproof operation cycle counter.
- B. Electric Operators:
1. Mounting: Side mounted.
 2. Motor Enclosure:
 - a. Exterior Coiling Doors: NEMA MG 1, Type 4; open drip proof.
 3. Motor Rating: 1/2 hp; continuous duty.
 4. Motor Voltage: 120 volts, single phase, 60 Hz.
 5. Motor Controller: NEMA ICS 2, full voltage, reversing magnetic motor starter.
 6. Controller Enclosure: NEMA 250, Type 1.
 7. Opening Speed: 12 inches per second.
 8. Brake: Adjustable friction clutch type, activated by motor controller.
 9. Manual override in case of power failure.
- C. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated; enclose terminal lugs in terminal box sized to conform to NFPA 70.
- D. Control Station: Provide standard three button (Open-Close-Stop) momentary-contact control device for each operator conforming to UL 325.
1. Surface mounted, at interior door jamb.

2. Entrapment Protection Devices: Provide sensing devices and safety mechanisms conforming to 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.
- E. 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

3.1 EXAMINATION

- A. Verify that opening sizes, tolerances and conditions are acceptable.

3.2 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.

3.3 TOLERANCES

- A. Maintain dimensional tolerances and alignment with adjacent work.
- B. Maximum Variation From Plumb: 1/16 inch.
- C. Maximum Variation From Level: 1/16 inch.
- D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 ft straight edge.

3.4 ADJUSTING

- A. Adjust operating assemblies for smooth and noiseless operation.

3.5 CLEANING

- A. Clean installed components.
- B. Remove labels and visible markings.

END OF SECTION

SECTION 084229
AUTOMATIC ENTRANCES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Sliding type packaged power-operated door assemblies.
- B. Controllers, actuators and safety devices.

1.2 DEFINITIONS

- A. AAADM: American Association of Automatic Door Manufacturers.

1.3 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design 2010.
- B. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen 2004 (Reapproved 2012).
- C. BHMA A156.10 - Power Operated Pedestrian Doors 2017.
- D. ITS (DIR) - Directory of Listed Products current edition.
- E. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. NFPA 101 - Life Safety Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- 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.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Shop Drawings:
 - 1. Indicate layout and dimensions; head, jamb, and sill conditions; elevations; components, anchorage, recesses, materials, and finishes, electrical characteristics and connection requirements.
 - 2. Identify installation tolerances required, assembly conditions, routing of service lines and conduit, and locations of operating components and boxes.
- C. Product Data: Include system components, sizes, features, and finishes.
- D. Samples: Submit two samples of exposed to view hardware, carpet with frame, and attachment hardware.
- E. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention, and manufacturer's hardware and component templates.
- F. Manufacturer's qualification statement.
- G. Installer's qualification statement.
- H. Maintenance Contract.
- I. Project Record Documents: Record actual locations of concealed equipment, services, and conduit.
- J. Maintenance Data: Include manufacturer's parts list and maintenance instructions for each type of hardware and operating component.
- K. Executed warranty.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience, and a member of AAADM.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years documented experience and approved by manufacturer.

1.6 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide two-year manufacturer warranty for materials and workmanship. Complete forms in Owner's name and register with manufacturer.
- C. Extended Correction Period: Correct defective work within five-year period commencing on Date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Sliding Automatic Entrance Door Assemblies:
 - 1. ASSA ABLOY Entrance Solutions: www.besam-usa.com/#sle.
 - 2. DORMA USA, Inc: www.dorma.com/#sle.
 - 3. Horton Automatics, a division of Overhead Door Corporation: www.hortondoors.com/#sle.
 - 4. Stanley Access Technologies: www.stanleyaccess.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.
- B. All-Glass Sliding Automatic Entrance Door Assemblies:
 - 1. ASSA ABLOY Entrance Solutions: www.besam-usa.com/#sle.
 - 2. DORMA USA, Inc: www.dorma.com/#sle.
 - 3. Horton Automatics, a division of Overhead Door Corporation: www.hortondoors.com/#sle.
 - 4. Stanley Access Technologies: www.stanleyaccess.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.

2.2 POWER OPERATED DOORS

- A. Power Operated Doors: Provide products that comply with NFPA 101 and requirements of authorities having jurisdiction; provide equipment selected for actual door weight and for light pedestrian traffic, unless otherwise indicated.
 - 1. Sliding and Folding Door Operators: In the event of power failure, provide for manual open, close, and break-away operation of door leaves.
 - 2. Packaged Door Assemblies: Provide components by single manufacturer, factory-assembled, including doors, frames, operators, actuators, and safeties.
 - a. Finish exposed equipment components to match door and frame finish.
 - 3. Air Leakage: Maximum of 1.0 cu ft/min/sq ft of wall area, when tested in accordance with ASTM E283 at 1.57 lbs/sq ft pressure differential across assembly.
 - 4. Exterior and Vestibule Doors: Provide equipment suitable for operating temperature range of minus 20 to plus 140 degrees F ambient.
- B. Sliding and Folding Doors with Full Power Operators: Comply with BHMA A156.10; safeties required; provide break-away operation unless otherwise indicated; in the event of break-away operation, interrupt power operation.
 - 1. Comply with UL 325; acceptable evidence of compliance includes UL (DIR) or ITS (DIR) listing or test report by testing agency acceptable to authorities having jurisdiction.
 - 2. Force Required to Swing Break-Away Panel: 50 pound-force, maximum, measured at 1 inch from the latch edge of the door at any point in the closing cycle.

2.3 AUTOMATIC ENTRANCE DOOR ASSEMBLIES

- A. Comply with ADA Standards for egress requirements.
- B. Framing Members: Provide manufacturer's standard extruded aluminum framing, reinforced as required to support imposed loads.
 - 1. Nominal Sizes:
 - a. Single Slide and Bi-Parting Sliding Doors: 1-3/4 inch wide by 4-1/2 inch deep.
 - 2. Concealed Fastening: Provide concealed fastening pocket in framing, with continuous flush insert cover extending full length of each framing member.

- C. Door and Sidelight Construction: Heavy duty interlocked extruded aluminum tubular stile and rail sections, through-rod bolted construction with steel corner support at hinge stile of carrier-suspended swinging panels or mechanically fastened corners with welded reinforcing brackets to reduce sag in sliding or breakout mode.
 - 1. Door Thickness: 1-3/4 inch, nominal.
 - 2. Stile Design:
 - a. Medium stile, 3-1/2 inch, nominal width.
 - 3. Top Rail Height: 4 inch, nominal.
 - 4. Bottom Rail Height: 4 inch, nominal.
 - 5. Glazing Stops: Manufacturer's standard snap-on extruded aluminum square stops with preformed resilient glazing gaskets.
 - 6. Glazing Stop Width: Manufacturers standard.
 - 7. Glazing Thickness: 1/4 inch.
- D. Sliding Automatic Door: Single leaf track-mounted, electric operation, extruded aluminum glazed door, with frame, and operator concealed overhead.
 - 1. Operation: Power open, power boost operation.
 - 2. Exterior-Side Actuator/Safety: Motion sensor.
 - 3. Interior-Side Actuator/Safety: Motion sensor.
 - 4. Door and Frame Finish: Anodized, natural.
- E. All-Glass Sliding Automatic Door: Bi-parting double leaf track-mounted, electric operation, all-glass door with extruded aluminum top and bottom rails and operator concealed overhead.
 - 1. Operation: Power open, spring close operation.
 - 2. Exterior-Side Actuator/Safety: Motion sensor.
 - 3. Interior-Side Actuator/Safety: Motion sensor.
 - 4. Hold Open: Toggle switch at inside head of doors; this is not a fire-rated door.
 - 5. Rail and Frame Finish: Anodized, natural.

2.4 CONTROLLERS, ACTUATORS, AND SAFETIES

- A. Controller: Provide microprocessor operated controller for each door.
- B. Comply with BHMA A156.10 for actuator and safety types and zones.
- C. Photo-Electric Actuator/Safety: Horizontal multiple ray device, with aluminum housing for light source and relay units.

2.5 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.
- B. Disconnect Switch: Factory mount disconnect switch in control panel.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work and dimensions are as indicated on shop drawings.
- B. Verify that electric power is available and is of the correct characteristics.

3.2 INSTALLATION

- A. Install equipment in accordance with manufacturer's instructions.
- B. Provide for thermal expansion and contraction of door and frame units and live and dead loads that may be transmitted to operating equipment.
- C. Provide for dimensional distortion of components during operation.
- D. Install pneumatic lines and door power units in a manner to prevent condensation or freezing.
- E. Coordinate installation of components with related and adjacent work; level and plumb.

3.3 ADJUSTING

- A. Adjust door equipment for correct function and smooth operation.

3.4 CLEANING

- A. Remove temporary protection, clean exposed surfaces.

3.5 CLOSEOUT ACTIVITIES

- A. Demonstrate operation, operating components, adjustment features, and lubrication requirements.

3.6 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements relating to maintenance service.
- B. Provide a separate maintenance contract for specified maintenance service.
- C. Provide service and maintenance of operating equipment for one year from Date of Substantial Completion, at no extra charge to Owner.

END OF SECTION

SECTION 084313
ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Aluminum-framed storefront, with vision glass.
- B. Aluminum doors.
- C. Weatherstripping.

1.2 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. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.
- G. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2014.
- H. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric) 2014.
- I. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2021.
- J. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) 2021.
- K. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen 2004 (Reapproved 2012).
- L. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference 2014 (Reapproved 2021).
- M. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference 2000 (Reapproved 2016).
- N. ASTM 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.

1.3 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.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, 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.
- D. Samples: Submit two samples 8 by 8 inches in size illustrating finished aluminum surface, glass, glazing materials.
- E. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.

- F. Delegated-Design Submittal: For aluminum-framed storefronts, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for review by Engineer of Record.
 - 1. Include recommendation of alternative framing system if required.
- G. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.
- H. Field Quality Control Submittals: Report of field testing for water penetration and air leakage.
- I. Designer's Qualification Statement.
- J. Manufacturer's Qualification Statement.
- K. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

- A. Designer Qualifications: Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State in which the Project is located.
- B. 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.

1.6 MOCK-UP

- A. Provide mock-up of each finish required for Architect's approval.
- B. See Section 014000 - Quality Requirements for additional requirements.
- C. Locate mock-ups where directed. Mock-ups to be full-size unless Architect approves smaller models. Alternatively, when a mock-up is not practical, the first piece of an element or connection can be used to determine acceptability.
 - 1. Construct mock-up 1 storefront bay wide by 1 story.
- D. Notify Architect one week in advance of dates and times when mock-ups will be available for review.
- E. Build mock-ups using member sizes and materials indicated for final work.
- F. Obtain Architect's written approval of mock-ups before starting fabrication.
- G. Retain and maintain mock-ups during construction in an undisturbed condition as a standard for judging completed work.
- H. Approved mock-ups in an undisturbed condition at Date of Substantial Completion may become part of completed work.

1.7 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.

1.8 FIELD CONDITIONS

- A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.9 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.
- C. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.
- D. Provide 10 year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Aluminum-Framed Storefront and Doors:
 - 1. Arcadia: www.arcadiainc.com.
 - 2. EFCO Corporation: www.efcocorp.com/#sle.
 - 3. Kawneer North America: www.kawneer.com/#sle.
 - 4. Oldcastle BuildingEnvelope: www.oldcastlebe.com/#sle.
 - 5. Tubelite, Inc: www.tubeliteinc.com/#sle.
 - 6. United States Aluminum Corp: www.usalum.com/#sle.
 - 7. YKK AP America Inc: www.ykkap.com/#sle.
 - 8. Substitutions: See Section 016000 - Product Requirements.

2.2 STOREFRONT

- A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
 - 1. Glazing Rabbet: For 1 inch insulating glazing.
 - 2. Glazing Position: Front-set.
 - 3. Vertical Mullion Dimensions: 2 inches wide by depth per product selection.
 - 4. Finish: Class I natural anodized.
 - a. Factory finish all surfaces that will be exposed in completed assemblies.
 - 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 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.
- B. Performance Requirements:
 - 1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
 - a. Design Wind Loads: Comply with requirements of ASCE 7.
 - b. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.
 - 2. Water Penetration Resistance on Manufactured Assembly: No uncontrolled water on interior face, when tested in accordance with ASTM E331 at pressure differential of 8 psf.
 - 3. Air Leakage Laboratory Test: Maximum of 0.06 cu ft/min sq ft of wall area, when tested in accordance with ASTM E283 at 6.27 psf pressure differential across assembly.

2.3 COMPONENTS

- A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
 - 1. Framing members for interior applications need not be thermally broken.
 - 2. Glazing Stops: Flush.
- B. Glazing: As specified in Section 088000.

- C. Swing Doors: Glazed aluminum.
 - 1. Thickness: 1-3/4 inches.
 - 2. Top Rail: 4 inches wide.
 - 3. Vertical Stiles: 4-1/2 inches wide.
 - 4. Bottom Rail: 10 inches wide.
 - 5. Glazing Stops: Square.
 - 6. Finish: Same as storefront.

2.4 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M).
- B. Sheet Aluminum: ASTM B209 (ASTM B209M).
- C. Fasteners: Stainless steel.
- D. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.
- E. Glazing Accessories: As specified in Section 088000.

2.5 FINISHES

- A. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils thick.
- B. Touch-Up Materials: As recommended by coating manufacturer for field application.

2.6 HARDWARE

- A. For each door, include weatherstripping, sill sweep strip, and threshold.
- B. Other Door Hardware: As specified in 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.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify dimensions, tolerances, and method of attachment with other work.
- B. Verify that wall openings and adjoining air and vapor seal materials are ready to receive work of this section.

3.2 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. Set thresholds in bed of sealant and secure.
- J. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.3 TOLERANCES

- A. Maximum Variation from Plumb: 0.06 inch per 3 feet non-cumulative or 0.06 inch per 10 feet, whichever is less.
- B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

3.4 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. Water-Spray Test: Provide water spray quality test of installed storefront components in accordance with AAMA 501.2 during construction process and before installation of interior finishes.
 - 1. Perform a minimum of two tests in each designated area as indicated on drawings.
 - 2. Conduct tests in each area prior to 10 percent and 50 percent completion of this work.
- D. Provide field testing of installed storefront system by independent laboratory in accordance with AAMA 503 during construction process and before installation of interior finishes.
 - 1. Perform a minimum of two tests in each designated area as indicated on drawings.
 - 2. Conduct tests in each area prior to 10 percent and 50 percent completion of this work.
 - 3. Field test for water penetration in accordance with ASTM E1105 with uniform static air pressure difference (Procedure A) not less than 4.18 psf.
 - a. Maximum allowable rate of water penetration in 15-minute test is 0.5 ounce that is not contained in an area with provisions to drain to exterior, or collected on surface of interior horizontal framing member.

3.5 ADJUSTING

- A. Adjust operating hardware for smooth operation.

3.6 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.

3.7 PROTECTION

- A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION

SECTION 085653
SECURITY WINDOWS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Security transaction windows with pass-through device.

1.2 REFERENCE STANDARDS

- A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum 2020.
- B. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2021.
- C. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) 2021.
- D. ASTM F588 - Standard Test Methods for Measuring the Forced Entry Resistance of Window Assemblies, Excluding Glazing Impact 2017.
- E. ASTM F1233 - Standard Test Method for Security Glazing Materials And Systems 2021.
- F. SSPC-Paint 33 - Coal Tar Mastic Coating, Cold-Applied 2006, with Editorial Revision (2015).
- G. UL 752 - Standard for Bullet-Resisting Equipment Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Furnish anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, to be embedded into concrete or masonry, with setting diagrams and installation, to applicable installer in time for installation.
- B. Preinstallation Meeting: Prior to start of installation arrange a meeting on site to familiarize installer and installers of related work with requirements relating to this work.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's published data showing materials, construction details, dimensions of components, and finishes.
- C. Shop Drawings: Drawings prepared specifically for this project, showing plans, elevations, sections, details of construction, anchorage to other work, hardware, and glazing.
 - 1. For new work show required opening dimensions and allowance for field deviation.
- D. Test Reports: Test reports for specific window model and glazing to be furnished, showing compliance with specified requirements; window and glazing may be tested separately, provided window test sample adequately simulates the glazing to be used.
 - 1. Include testing agency qualifications.
 - 2. Reports for thermal requirements may be based on calculations, in accordance with the specified standard.
- E. Samples:
 - 1. Actual sections of frame members, at least 12 inch long, showing finish, weatherstripping, and fasteners.
 - 2. Samples of each type of hardware and operator.
- F. Coordination Drawings: For each window opening, show locations and details of items necessary to anchor windows that must be installed by others, in sufficient detail that installer of those items can do so correctly without reference to the actual window itself.
- G. Manufacturer's Qualification Statement.
- H. Installer's Qualification Statement.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Firm with at least 5 years experience in the manufacture of windows of the type specified and able to provide test reports showing that their standard manufactured products meet the specified requirements; custom designed products not acceptable.
- B. Testing Agency Qualifications: Independent testing agency able to show experience in conducting tests of the type specified.
- C. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.6 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Provide manufacturer's warranty agreeing to repair or replace windows and window components that fail within three years after Date of Substantial Completion due to, but not limited to, the following:
 - 1. Structural failure, failure of welds, and deterioration of metals and finishes beyond that expected under detention use and normal weathering.
 - 2. Failure of glazing due to excessive deflection of supporting members under wind load.
 - 3. Faulty operation of ventilators, hardware, and operators.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Security Transaction Windows with Pass-Through Device:
 - 1. Quikserv: www.quikserv.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.

2.2 ASSEMBLIES

- A. Security and Detention Windows:
 - 1. Dimensions, profiles, features, and performance specified and indicated on drawings are required; do not deviate unless specifically approved by Architect under substitution procedures; see Section 016000.
 - 2. Design to fit openings indicated on drawings; design to accommodate deviation of actual construction from dimensions indicated on drawings.
 - 3. Fabricate frames and sash with corners mitered or coped full depth with concealed welded joints.
 - 4. Design anchorages to provide performance equivalent to that required for window unit; provide anchorages at least equivalent to those by which the tested units were anchored to the test frame.
 - 5. Design interface between frame and adjacent construction so that gap between them has at least the equivalent performance as specified for window; coordinate with anchorage requirements; custom testing is not required.
 - 6. Separate dissimilar metals to prevent corrosion by galvanic action by painting contact surfaces with primer or with sealant or tape recommended by manufacturer for the purpose.
 - 7. Weld components before finishing and in concealed locations, to greatest extent possible; minimize distortion and discoloration of finish; remove residue of welding; grind exposed welds smooth and finish to match.
 - 8. Label units to indicate which side is which, such as inside/outside or secure/non-secure; use labels that are removable after installation but durable enough not to be lost during delivery, storage, handling, and installation.

2.3 SECURITY TRANSACTION WINDOWS

- A. Security Transaction Windows:
 - 1. Location: Built within interior wall, as indicated on drawings.
 - 2. Type of Use: Walk-up.
 - 3. Forced Entry Resistance: Tested to meet ASTM F588, Grade 10 for window type and ASTM F1233, Class Achieved 1.0 for security glazing.
 - 4. Ballistic Resistance: Tested to meet UL 752, Level 1.

5. Window Type: Sliding, single horizontal.
 - a. Mounting: Projected from the wall surface.
 - b. Window Size: As indicated on drawings.
 - c. Size of Counter Space: Manufacturer's standard size.
 - d. Material: Aluminum.
 - 1) Finish: Natural anodized.
6. Glazing: Single (monolithic), clear, and forced entry resistant.
 - a. Tempered safety glazing.

2.4 ASSEMBLY COMPONENTS

- A. Aluminum Framing: ASTM B221 (ASTM B221M) extrusions of alloy and temper selected by manufacturer for strength, corrosion resistance, and finish required; not less than 1/8 inch thick at any location of frame and sash members.
- B. Frame Anchors: Mild steel plates, shapes, or bars, concealed in completed construction; provide anchorage devices as necessary to securely fasten windows to adjacent construction; use security fasteners for exposed anchors.
 1. Provide minimum of two anchors per side of window plus one additional anchor for each 18 inches or fraction thereof more than 36 inches in height or width.
- C. Glazing Seals: Factory installed; molded EPDM or neoprene compressible gaskets and compression strips.
- D. Security Fasteners: Operable only by tools produced by fastener manufacturer or manufacturer's licensee; head style appropriate to installation conditions, strength, and finish of materials being fastened; use countersunk heads wherever possible.
- E. Bituminous Paint: Cold-applied asbestos-free asphalt mastic, complying with SSPC-Paint 33; 30 mils, 0.030 inch minimum thickness per coat.

2.5 FINISHES

- A. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils thick.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that window openings are ready for installation of windows.
- B. Verify that correct embedded anchors are in place and in proper location; repair or replace anchors as required to achieve satisfactory installation.
- C. Notify Architect if conditions are not suitable for installation of windows; do not proceed until conditions are satisfactory.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions and drawing details.
- B. Install windows in correct orientation (inside/outside or secure/non-secure).
- C. Anchor windows securely in manner so as to achieve performance specified.
- D. Separate metal members from concrete and masonry using bituminous paint.
- E. Set sill members and sill flashing in continuous bead of sealant.

3.3 ADJUSTING

- A. Adjust operating components for smooth operation while also providing tight fit at contact points and a secure enclosure; lubricate operating hardware.

3.4 CLEANING

- A. Clean exposed surfaces promptly after installation without damaging finishes.
- B. Remove and replace defective work.

3.5 CLOSEOUT ACTIVITIES

- A. Demonstrate operation and maintenance to designated Owner personnel.

END OF SECTION

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes commercial door hardware for the following:
 - 1. Swinging doors.
 - 2. Sliding doors.
 - 3. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
 - 1. Mechanical door hardware.
 - 2. Electromechanical door hardware.
 - 3. Automatic operators.
 - 4. Cylinders specified for doors in other sections.
- C. Related Sections:
 - 1. Division 08 Section "Hollow Metal Doors and Frames".
 - 2. Division 08 Section "Flush Wood Doors".
 - 3. Division 08 Section "Aluminum-Framed Entrances and Storefronts".
 - 4. Division 08 Section "Automatic Door Operators".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ICC/IBC - International Building Code.
 - 3. NFPA 70 - National Electrical Code.
 - 4. NFPA 80 - Fire Doors and Windows.
 - 5. NFPA 101 - Life Safety Code.
 - 6. NFPA 105 - Installation of Smoke Door Assemblies.
 - 7. UL/ULC and CSA C22.2 - Standards for Automatic Door Operators Used on Fire and Smoke Barrier Doors and Systems of Doors.
 - 8. State Building Codes, Local Amendments.

- E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:

1. ANSI/BHMA Certified Product Standards - A156 Series.
2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
3. ANSI/UL 294 - Access Control System Units.
4. UL 305 - Panic Hardware.
5. ANSI/UL 437- Key Locks.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Warranty information for each product.
 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
 - a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.
 - c. Wiring instructions for each electronic component scheduled herein.
 2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Proof of Certification: Provide copy of manufacturer(s) official certification or accreditation document indicating proof of status as a qualified and authorized provider of the primary Integrated Wiegand Access Control Products.
- E. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- F. Informational Submittals:
1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- G. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

1.4 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).
- C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

- D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.
- E. Integrated Wiegand, Wireless, and IP-Enabled Access Control Products Supplier Qualifications: Integrated access control products and accessories are required to be supplied and installed through current members of the ASSA ABLOY "Authorized Channel Partner" (ACP) and "Certified Integrator" (CI) programs. Suppliers are to be factory trained, certified prior to project bid, and a direct purchaser of the specified product. Installers are to be factory trained, certified prior to project bid, and are responsible for commissioning, servicing, and warranting the installed equipment specified for the project.
- F. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
 2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
- G. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.
- H. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
1. Function of building, purpose of each area and degree of security required.
 2. Plans for existing and future key system expansion.
 3. Requirements for key control storage and software.
 4. Installation of permanent keys, cylinder cores and software.
 5. Address and requirements for delivery of keys.
- I. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.

2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
 3. Review sequence of operation narratives for each unique access controlled opening.
 4. Review and finalize construction schedule and verify availability of materials.
 5. Review the required inspecting, testing, commissioning, and demonstration procedures
- J. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.
- C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship

within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
 2. Faulty operation of the hardware.
 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 4. Electrical component defects and failures within the systems operation.
- C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.
- D. Special Warranty Periods:
1. Ten years for mortise locks and latches.
 2. Five years for exit hardware.
 3. Twenty five years for manual overhead door closer bodies.
 4. Five years for motorized electric latch retraction exit devices.
 5. Two years for electromechanical door hardware, unless noted otherwise.

1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.
- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.

2.2 HANGING DEVICES

- A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
1. Quantity: Provide the following hinge quantity:

- a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
 - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
 4. Hinge Options: Comply with the following:
 - a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.
 5. Manufacturers:
 - a. McKinney (MK).
- B. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 certified continuous geared hinge. with minimum 0.120-inch thick extruded 6063-T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.
1. Manufacturers:
 - a. Pemko (PE).

2.3 POWER TRANSFER DEVICES

- A. Electrified Quick Connect Transfer Hinges: Provide electrified transfer hinges with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets with a 1-year warranty. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.
 1. Manufacturers:

- a. McKinney (MK) - QC (# wires) Option.
- B. Electrified Quick Connect Continuous Geared Transfer Hinges: Provide electrified transfer continuous geared hinges with a removable service panel cutout accessible without de-mounting door from the frame. Furnish with Molex™ standardized plug connectors with sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.
1. Manufacturers:
 - a. Pemko (PE) - SER-QC (# wires) Option.
- C. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.
1. Provide one each of the following tools as part of the base bid contract:
 - a. McKinney (MK) - Electrical Connecting Kit: QC-R001.
 - b. McKinney (MK) - Connector Hand Tool: QC-R003.
 2. Manufacturers:
 - a. McKinney (MK) - QC-C Series.
- 2.4 DOOR OPERATING TRIM
- A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.
1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
 2. Furnish dust proof strikes for bottom bolts.
 3. Surface bolts to be minimum 8” in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
 4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
 5. Manufacturers:
 - a. Rockwood (RO).

- B. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.
 - 1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
 - 2. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
 - 3. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
 - 4. Manufacturers:
 - a. Rockwood (RO).

2.5 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.
- B. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.
- C. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:
 - 1. Threaded mortise cylinders with rings and cams to suit hardware application.
 - 2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 - 3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
 - 4. Tubular deadlocks and other auxiliary locks.
 - 5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
 - 6. Keyway: Manufacturer's Standard.
- D. Patented Cylinders: ANSI/BHMA A156.5, Grade 1 Certified Products Directory (CPD) listed cylinders employing a utility patented and restricted keyway requiring the use of a patented key. Cylinders are to be protected from unauthorized manufacture and distribution by manufacturer's United States patents. Cylinders are to be factory keyed with owner having the ability for on-site original key cutting.
 - 1. Patented key systems shall not be established with products that have an expired patent. Expired systems shall only be specified and supplied to support existing systems.
 - 2. Manufacturers:
 - a. Corbin Russwin (RU) - Access 3 AP.
 - b. No Substitution.

- E. Keying System: Each type of lock and cylinders to be factory keyed.
 - 1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
 - 2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
 - 3. Existing System: Field verify and key cylinders to match Owner's existing system.
- F. Key Quantity: Provide the following minimum number of keys:
 - 1. Change Keys per Cylinder: Three (3).
 - 2. Master Keys (per Master Key Level/Group): Five (5).
 - 3. Construction Keys (where required): Ten (10).
- G. Construction Keying: Provide construction master keyed cylinders.
- H. Key Registration List (Bitting List):
 - 1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
 - 2. Provide transcript list in writing or electronic file as directed by the Owner.

2.6 KEY CONTROL

- A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.
 - 1. Manufacturers:
 - a. Lund Equipment (LU).

2.7 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.
 - 1. Where specified, provide status indicators with highly reflective color and wording for "locked/unlocked" or "vacant/occupied" with custom wording options if required. Indicator to be located above the cylinder with the inside thumb-turn not blocking the visibility of the indicator status. Indicator window size to be a minimum of 2.1" x 0.6" with a curved design allowing a 180 degree viewing angle with protective covering to prevent tampering.
 - 2. Manufacturers:

- a. Corbin Russwin Hardware (RU) - ML2000 Series.
- b. No Substitution.

2.8 ELECTROMECHANICAL LOCKING DEVICES

- A. Electromechanical Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed, subject to same compliance standards and requirements as mechanical mortise locksets, electrified locksets to be of type and design as specified below and in the hardware sets.
 - 1. Electrified Lock Options: Where indicated in the Hardware Sets, provide electrified options including: outside door lock/unlock trim control, latchbolt and lock/unlock status monitoring, deadbolt monitoring, and request-to-exit signaling. Support end-of-line resistors contained within the lock case. Unless otherwise indicated, provide electrified locksets standard as fail secure.
 - 2. Energy Efficient Design: Provide lock bodies which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.
 - 3. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ML20900 Series.
 - b. No Substitution.

2.1 INTEGRATED WIRED OUTPUT LOCKING DEVICES – MULTI-CLASS READER

- A. Integrated Wired Output Multi-Class Mortise Locks: Wiegand or Open Supervised Device Protocol (OSDP) output ANSI A156.13, Grade 1, mortise lockset with integrated card reader with or without keypad option, request-to-exit signaling, door position status switch, and latchbolt monitoring in one complete unit. Hard wired, solenoid driven locking/unlocking control of the lever handle trim, 3/4" deadlocking anti-friction latch, and 1" case-hardened steel deadbolt. Lock is U.L listed and labeled for use on up to 3 hour fire rated openings. Available with or without keyed high security cylinder override.
 - 1. Open architecture, hard wired platform supports centralized control of locking units with new or existing Wiegand or OSDP compatible access control systems. Latchbolt monitoring and door position switch act in conjunction to report door-in-frame (DPS) and door latched (door closed and latched) conditions.
 - 2. Integrated reader supports the following credentials:
 - a. 125kHz proximity credentials: HID, AWID, Indala, and EM4102.
 - b. 13.56 MHz proximity credentials: HID Secure Identity Object™ (SIO) on iCLASS Seos, HID iCLASS, HID iCLASS SE/SR, MIFARE Classic, DESFire EV1 and EV2.
 - c. 2.4 GHz credentials: Secure Identity Object™ (SIO) on Mobile IDs (Bluetooth Smart)

- d. ISO14443A/B (PIV-compatible Transparent FASC-N read) available with pivCLASS variant
 - e. NFC-enabled mobile phones
 - f. PIN code only or PIN + credential with keypad option.
3. 12VDC external power supply required for reader and lock, with optional 24VDC lock solenoid. Fail safe or fail secure options.
 4. Energy Efficient Design: Provide lock bodies which have a holding current draw of 500mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.
 5. Support end-of-line resistors contained within the lock case.
 6. Installation requires only one cable run from the lock to the access control panel without requirements for additional proprietary lock panel interface boards or modules.
 7. Installation to include manufacturer's access control panel interface board or module where required for Wiegand or OSDP output protocol.
 8. Manufacturers:
 - a. Corbin Russwin (RU) – ML2000 SN Series.
 - b. No Substitution.

2.2 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
 3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
 4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.
- B. Standards: Comply with the following:
 1. Strikes for Mortise Locks and Latches: BHMA A156.13.
 2. Strikes for Bored Locks and Latches: BHMA A156.2.
 3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
 4. Dustproof Strikes: BHMA A156.16.

2.3 CONVENTIONAL EXIT DEVICES

- A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
 2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
 3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
 4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
 5. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
 - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
 - b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.
 6. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
 7. Rail Sizing: Provide exit device rails factory sized for proper door width application.
 8. Through Bolt Installation: For exit devices and trim.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.
1. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.
 - b. No Substitution.
- C. Extruded Aluminum Removable Mullions: ANSI/BHMA A156.3 anodized, removable mullions with malleable-iron top and bottom retainers. Mullions to be provided standard with stabilizers and imbedded weatherstrip.
1. Manufacturers:
 - a. Same as exit device manufacturer.

- D. Tube Steel Removable Mullions: ANSI/BHMA A156.3 removable steel mullions with malleable-iron top and bottom retainers and a primed paint finish.
1. Provide keyed removable feature where specified in the Hardware Sets.
 2. Provide stabilizers and mounting brackets as required.
 3. Provide electrical quick connection wiring options as specified in the hardware sets.
 4. Manufacturers:
 - a. Same as exit device manufacturer.

2.4 ELECTROMECHANICAL EXIT DEVICES

- A. Electromechanical Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices subject to same compliance standards and requirements as mechanical exit devices. Electrified exit devices to be of type and design as specified below and in the hardware sets.
1. Energy Efficient Design: Provide devices which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.
 2. Where conventional power supplies are not sufficient, include any specific controllers required to provide the proper inrush current.
 3. Motorized Electric Latch Retraction: Devices with an electric latch retraction feature must use motors which have a maximum current draw of 600mA. Solenoid driven latch retraction is not acceptable.
 4. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ED5000 Series.
 - b. No Substitution.

2.5 INTEGRATED WIRED OUTPUT EXIT DEVICES - MULTI-CLASS READER

- A. Integrated Wired Output Multi-Class Exit Hardware: Wiegand output ANSI 156.3 Grade 1 rim, mortise, and vertical rod exit device hardware with integrated card reader with or without keypad option, latchbolt and touchbar monitoring, and request-to-exit signaling, in one complete unit. Hard wired, solenoid driven locking/unlocking control of the lever handle exit trim with 3/4" throw latch bolt. U.L listed and labeled for either panic or "fire exit hardware" for use on up to 3 hour fire rated openings. Available with or without keyed high security cylinder override.
1. Open architecture, hard wired platform supports centralized control of locking units with new or existing Wiegand or OSDP compatible access control systems. Inside push bar

(request-to-exit) signaling and door position (open/closed status) monitoring (via separately connected DPS).

2. Integrated reader supports the following credentials:
 - a. 125kHz proximity credentials: HID, AWID, Indala, and EM4102.
 - b. 13.56 MHz proximity credentials: HID Secure Identity Object™ (SIO) on iCLASS Seos, HID iCLASS, HID iCLASS SE/SR, MIFARE Classic, DESFire EV1 and EV2.
 - c. 2.4 GHz credentials: Secure Identity Object™ (SIO) on Mobile IDs (Bluetooth Smart)
 - d. ISO14443A/B (PIV-compatible Transparent FASC-N read) available with pivCLASS variant
 - e. NFC-enabled mobile phones
 - f. PIN code only or PIN + credential with keypad option
3. 12VDC external power supply required for reader. 24VDC required for solenoid operated exit trim. Fail safe or fail secure options.
4. Installation requires only one cable run from the exit hardware to the access control panel without requirements for additional proprietary lock panel interface boards or modules.
5. Competitor Alternates Allowed Option: Installation to include manufacturer's access control panel interface board or module where required for Wiegand or OSDP output protocol.
6. Manufacturers:
 - a. Corbin Russwin (RU) – ED5000 SN Series.
 - b. No Substitution.

2.6 DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.

6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

B. Door Closers, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.

1. Manufacturers:

- a. Norton Rixson (NO) - 9500 Series.
- b. No Substitution.

C. Door Closers, Surface Mounted (Unitrol): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted closers with door stop mechanism to absorb dead stop shock on arm and top hinge. Hold-open arms to have a spring loaded mechanism in addition to shock absorber assembly. Arms to be provided with rigid steel main arm and secondary arm lengths proportional to the door width.

1. Manufacturers:

- a. Norton Rixson (NO) - Unitrol Series.
- b. No Substitution.

2.7 ELECTROMECHANICAL DOOR OPERATORS

A. General: Provide low energy operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for compliance with UL 325. Coordinate operator mechanisms with door operation, hinges, and activation devices.

1. Fire-Rated Doors: Provide door operators for fire-rated door assemblies that comply with NFPA 80 for fire-rated door components and are listed and labeled by a qualified testing agency.

B. Standard: Certified ANSI/BHMA A156.19.

C. Performance Requirements:

1. Opening Force if Power Fails: Not more than 15 lbf required to release a latch if provided, not more than 30 lbf required to manually set door in motion, and not more than 15 lbf required to fully open door.
2. Entrapment Protection: Not more than 15 lbf required to prevent stopped door from closing or opening.

D. Configuration: Surface mounted or in-ground as required. Door operators to control single swinging and pair of swinging doors.

- E. Operation: Power opening and spring closing operation capable of meeting ANSI A117.1 accessibility guideline. Provide time delay for door to remain open before initiating closing cycle as required by ANSI/BHMA A156.19.
- F. Features: Operator units to have full feature adjustments for door opening and closing force and speed, backcheck, motor assist acceleration from 0 to 30 seconds, time delay, vestibule interface delay, obstruction recycle, and hold open time from 0 up to 30 seconds.
- G. Provide outputs and relays on board the operator to allow for coordination of exit device latch retraction, electric strikes, magnetic locks, card readers, safety and motion sensors and specified auxiliary contacts.
- H. Brackets and Reinforcements: Manufacturer's standard, fabricated from aluminum with nonferrous shims for aligning system components.
- I. Wireless Interface: Operator units shall have a wireless interface via a mobile device for ease of installation and setup.
- J. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Norton Rixson (NO) - 6300 Series.

2.8 ARCHITECTURAL TRIM

A. Door Protective Trim

- 1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
- 2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
- 3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
- 4. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:
 - a. Stainless Steel: 300 grade, 050-inch thick.
- 5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
- 6. Manufacturers:

- a. Rockwood (RO).

2.9 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.
- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
 1. Manufacturers:
 - a. Rockwood (RO).

2.10 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
 1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Manufacturers:
 1. Pemko (PE).

2.11 ELECTRONIC ACCESSORIES

- A. Intelligent Switching Power Supplies: Provide power supplies with single, dual or multi-voltage configurations at 12 and/or 24VDC. Power Supply shall have battery backup function with an integrated battery charging circuit. The power supply shall have a standard, integrated Fire Alarm Interface (FAI). The power supply shall provide capability for secondary voltage, power distribution, direct lock control and network monitoring through add on modules. The power supply shall be expandable up to 16 individually protected outputs. Output modules shall provide individually protected, continuous outputs and/or individually protected, relay controlled outputs. Network modules shall provide remote monitoring functions such as status reporting, fault reporting and information logging.
 - 1. Manufacturers:
 - a. Securitron (SU) - AQL Series.

2.12 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.13 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
 - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. DHI TDH-007-20: Installation Guide for Doors and Hardware.
 - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 - 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.5 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.6 DOOR HARDWARE SETS

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.
 - 1. Quantities listed are for each pair of doors, or for each single door.
 - 2. The supplier is responsible for handing and sizing all products.
 - 3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.

Hardware Sets

Set: 1.0

Doors: 161

2 Continuous Hinge	DFM95SLI-HD1 SER12		PE	087100
1 Mullion	CR808 8'	695	RU	087100
1 Rim Exit Device, Exit Only	ED4200 EO MELR	613E	RU	087100
1 Rim Exit Device, Nightlatch	ED4200 K157ET MELR ACP	613E	RU	087100
2 Pull	RM3131-12 Mtg-Type 1XHD	US10BE	RO	087100
2 Automatic Opener	6331	690	NO	087100
1 Threshold	2715D		PE	087100
2 Sweep	345DNB		PE	087100
1 ElectroLynx Harness	QC-C1500		MK	087100

2 ElectroLynx Harness	QC-C***P Per Door Size, as Req'd		MK 087100
1 Door Switch	503		NO 087100
1 Door Switch Post	500	690	NO 087100

Notes: Exit devices with electric latch retraction for use with the automatic operators. The operators are to be wired to simultaneously open both doors when the door switch is pushed. Locate the pedestal with door switch as indicated by the owner / architect on the exterior of the opening. Locate the 503 on the interior side of the opening. Balance of weatherstrip by the aluminum door supplier.

Set: 2.0

Doors: 123B, 124, 156B

5 Hinge, Full Mortise	TA2314 NRP 4-1/2" x 4-1/2"	US32D	MK 087100
1 Hinge, Full Mortise	TA2314 QC12 4-1/2" x 4-1/2"	US32D	MK 087100
2 Flush Bolt	555	US26D	RO 087100
1 Dust Proof Strike	570	US26D	RO 087100
1 Access Control Mort Lock	ML20606 x SN200-SEC 109W BIPS ACP	626	RU 087100
2 Surface Closer	UNI9500 SN-134 x Mtg Plates / Brackets as Req'd	689	NO 087100
1 Threshold	252x3AFG		PE 087100
1 Gasketing	290APK		PE 087100
1 Rain Guard	346C		PE 087100
2 Door Bottom	217APK		PE 087100
1 ElectroLynx Harness	QC-C1500		MK 087100
1 ElectroLynx Harness	QC-C***P Per Door Size, as Req'd		MK 087100
1 Power Supply	AQL as Req'd		SU 087100

Notes: Electrified lock on active leaf for access control. Lock includes credential reader, door position switch, request to exit, and can be wired to the security contractor's control panel. Door is normally closed, latched and secured. Valid credential for ingress, free egress at all times. Co-ordinate with security and electrical.

Set: 3.0

Doors: 140, 171

5 Hinge, Full Mortise	TA2314 NRP 4-1/2" x 4-1/2"	US32D	MK 087100
1 Hinge, Full Mortise	TA2314 QC12 4-1/2" x 4-1/2"	US32D	MK 087100
1 Exit Device (exit only)	ED5200 EO	630	RU 087100

1 Access Control Rim Exit	ED5200N 1099605ET-SN200 BIPS 24AD ACP	630	RU	087100
2 Surface Closer	UNI9500 SN-134 x Mtg Plates / Brackets as Req'd	689	NO	087100
2 Kick Plate	K1050 10" x Width Req'd CSK	US32D	RO	087100
1 Threshold	252x3AFG		PE	087100
1 Gasketing	290APK		PE	087100
1 Rain Guard	346C		PE	087100
1 Gasketing	5110BL 120"		PE	087100
2 Door Bottom	217APK		PE	087100
1 ElectroLynx Harness	QC-C1500		MK	087100
1 ElectroLynx Harness	QC-C***P Per Door Size, as Req'd		MK	087100
1 Power Supply	AQL as Req'd		SU	087100

Notes: Exit device with electrified trim on one leaf for access control. Device includes credential reader, door position switch, request to exit, and can be wired to the security contractor's control panel. Door is normally closed, latched and secured. Valid credential for ingress, free egress at all times. Co-ordinate with security and electrical. Exit only device on other leaf for egress.

Set: 4.0

Doors: 132B

2 Hinge, Full Mortise	TA2314 NRP 4-1/2" x 4-1/2"	US32D	MK	087100
1 Hinge, Full Mortise	TA2314 QC12 4-1/2" x 4-1/2"	US32D	MK	087100
1 Access Control Mort Lock	ML20606 x SN200-SEC 109W BIPS ACP	626	RU	087100
1 Surface Closer	UNI9500 SN-134 x Mtg Plates / Brackets as Req'd	689	NO	087100
1 Kick Plate	K1050 10" x Width Req'd CSK	US32D	RO	087100
1 Threshold	252x3AFG		PE	087100
1 Gasketing	290APK		PE	087100
1 Rain Guard	346C		PE	087100
1 Door Bottom	217APK		PE	087100
1 ElectroLynx Harness	QC-C1500		MK	087100
1 ElectroLynx Harness	QC-C***P Per Door Size, as Req'd		MK	087100
1 Power Supply	AQL as Req'd		SU	087100

Notes: Electrified lock for access control. Lock includes credential reader, door position switch, request to exit, and can be wired to the security contractor's control panel. Door is normally closed, latched and secured. Valid credential for ingress, free egress at all times. Co-ordinate with security and electrical.

Set: 5.0

Doors: 167

2 Hinge, Full Mortise, Hvy Wt	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK	087100
1 Hinge, Full Mortise, Hvy Wt	T4A3386 QC12 4-1/2" x 4-1/2"	US32D	MK	087100
1 Access Control Rim Exit	ED5200N 1099605ET-SN200 BIPS 24AD ACP	630	RU	087100
1 Surface Closer	UNI9500 SN-134 x Mtg Plates / Brackets as Req'd	689	NO	087100
1 Kick Plate	K1050 10" x Width Req'd CSK	US32D	RO	087100
1 Threshold	252x3AFG		PE	087100
1 Gasketing	290APK		PE	087100
1 Rain Guard	346C		PE	087100
1 Door Bottom	217APK		PE	087100
1 ElectroLynx Harness	QC-C1500		MK	087100
1 ElectroLynx Harness	QC-C***P Per Door Size, as Req'd		MK	087100
1 Power Supply	AQL as Req'd		SU	087100

Notes: Exit device with electrified trim for access control. Device includes credential reader, door position switch, request to exit, and can be wired to the security contractor's control panel. Door is normally closed, latched and secured. Valid credential for ingress, free egress at all times. Co-ordinate with security and electrical.

Set: 6.0

Doors: 122A

5 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK	087100
1 Hinge, Full Mortise	TA2714 QC12 4-1/2" x 4-1/2"	US26D	MK	087100
2 Flush Bolt	555	US26D	RO	087100
1 Dust Proof Strike	570	US26D	RO	087100
1 Fail Safe Lock	ML20914-SAF 109W ACP	626	RU	087100
2 Surface Closer	9500 SN-134 x Mtg Plates / Brackets as Req'd	689	NO	087100
2 Door Stop	Wall 409 or Floor RM850 as Req'd	US32D	RO	087100
2 Silencer	608-RKW		RO	087100
1 ElectroLynx Harness	QC-C003		MK	087100
1 ElectroLynx Harness	QC-C1500		MK	087100
1 Power Supply	AQL as Req'd		SU	087100

Notes: Fail safe electrified lock for access control credential readers for ingress and egress. 2 credential readers, door position switch, request to exit by security contractor. Door is normally closed, latched and

secured. Valid credential for ingress and egress. Wire locks to the alarm system to release and allow free egress in case of an emergency. Co-ordinate with security and electrical.

Set: 7.0

Doors: 163

5 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK	087100
1 Hinge, Full Mortise	TA2714 QC12 4-1/2" x 4-1/2"	US26D	MK	087100
1 Exit Device (exit only)	ED5200 EO	630	RU	087100
1 Access Control Rim Exit	ED5200N 1099605ET-SN200 BIPS 24AD ACP	630	RU	087100
2 Surface Closer	UNI9500 SN-134 x Mtg Plates / Brackets as Req'd	689	NO	087100
2 Kick Plate	K1050 10" x Width Req'd CSK	US32D	RO	087100
2 Silencer	608-RKW		RO	087100
1 ElectroLynx Harness	QC-C1500		MK	087100
1 ElectroLynx Harness	QC-C***P Per Door Size, as Req'd		MK	087100
1 Power Supply	AQL as Req'd		SU	087100

Notes: Exit device with electrified trim on one leaf for access control. Device includes credential reader, door position switch, request to exit, and can be wired to the security contractor's control panel. Door is normally closed, latched and secured. Valid credential for ingress, free egress at all times. Co-ordinate with security and electrical. Exit only device on other leaf for egress.

Set: 8.0

Doors: 165

5 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK	087100
1 Hinge, Full Mortise, Hvy Wt	T4A3786 QC12 4-1/2" x 4-1/2"	US26D	MK	087100
1 Exit Device (exit only)	ED5200 EO	630	RU	087100
1 Access Control Rim Exit	ED5200N 1099605ET-SN200 BIPS 24AD ACP	630	RU	087100
2 Surface Closer	UNI9500 SN-134 x Mtg Plates / Brackets as Req'd	689	NO	087100
2 Kick Plate	K1050 10" x Width Req'd CSK	US32D	RO	087100
2 Silencer	608-RKW		RO	087100
1 ElectroLynx Harness	QC-C1500		MK	087100
1 ElectroLynx Harness	QC-C***P Per Door Size, as Req'd		MK	087100
1 Power Supply	AQL as Req'd		SU	087100

Notes: Exit device with electrified trim on one leaf for access control. Device includes credential reader, door position switch, request to exit, and can be wired to the security contractor's control panel. Door is normally closed, latched and secured. Valid credential for ingress, free egress at all times. Co-ordinate with security and electrical. Exit only device on other leaf for egress.

Set: 9.0

Doors: 112, 113A, 113B, 122B

6 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK	087100
1 Mullion	CR910KM ACP		RU	087100
2 Rim Exit Device, Classroom	ED5200 109955ET ACP	630	RU	087100
2 Surface Closer	9500 SN-134 x Mtg Plates / Brackets as Req'd	689	NO	087100
2 Kick Plate	K1050 10" x Width Req'd CSK	US32D	RO	087100
2 Door Stop	Wall 409 or Floor RM850 as Req'd	US32D	RO	087100
2 Silencer	608-RKW		RO	087100

Set: 10.0

Doors: 135, 137B, 138, 139

2 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK	087100
1 Hinge, Full Mortise, Hvy Wt	T4A3786 QC12 4-1/2" x 4-1/2"	US26D	MK	087100
1 Fail Safe Lock	ML20914-SAF 109W ACP	626	RU	087100
1 Surface Closer	9500 SN-134 x Mtg Plates / Brackets as Req'd	689	NO	087100
1 Door Stop	Wall 409 or Floor RM850 as Req'd	US32D	RO	087100
3 Silencer	608-RKW		RO	087100
1 ElectroLynx Harness	QC-C1500		MK	087100
1 ElectroLynx Harness	QC-C***P Per Door Size, as Req'd		MK	087100
1 Power Supply	AQL as Req'd		SU	087100

Notes: Fail safe electrified lock for access control credential readers for ingress and egress. 2 credential readers, door position switch, request to exit by security contractor. Door is normally closed, latched and secured. Valid credential for ingress and egress. Wire locks to the alarm system to release and allow free egress in case of an emergency. Co-ordinate with security and electrical.

Set: 11.0

Doors: 113C, 124B, 131, 132A, 133, 136, 141, 142, 143, 145A, 146, 147, 148, 149, 151, 156A, 157

2 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK	087100
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1 Hinge, Full Mortise	TA2714 QC12 4-1/2" x 4-1/2"	US26D	MK	087100
1 Access Control Mort Lock	ML20606 x SN200-SEC 109W BIPS ACP	626	RU	087100
1 Surface Closer	9500 SN-134 x Mtg Plates / Brackets as Req'd	689	NO	087100
1 Door Stop	Wall 409 or Floor RM850 as Req'd	US32D	RO	087100
3 Silencer	608-RKW		RO	087100
1 ElectroLynx Harness	QC-C1500		MK	087100
1 ElectroLynx Harness	QC-C***P Per Door Size, as Req'd		MK	087100
1 Power Supply	AQL as Req'd		SU	087100

Notes: Electrified lock for access control. Lock includes credential reader, door position switch, request to exit, and can be wired to the security contractor's control panel. Door is normally closed, latched and secured. Valid credential for ingress, free egress at all times. Co-ordinate with security and electrical.

Set: 12.0

Doors: [144](#), [145B](#), [150A](#)

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK	087100
1 Storeroom Lock	ML2057 109W ACP	626	RU	087100
1 Surface Closer	9500 SN-134 x Mtg Plates / Brackets as Req'd	689	NO	087100
1 Door Stop	Wall 409 or Floor RM850 as Req'd	US32D	RO	087100
3 Silencer	608-RKW		RO	087100

Set: 13.0

Doors: [105](#), [115](#), [116](#)

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK	087100
1 Storeroom Lock	ML2057 109W ACP	626	RU	087100
1 Door Stop	Wall 409 or Floor RM850 as Req'd	US32D	RO	087100
3 Silencer	608-RKW		RO	087100

Set: 14.0

Doors: [114](#), [121](#)

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK	087100
1 Entrance Lock	ML2053 109W ACP	626	RU	087100
1 Door Stop	Wall 409 or Floor RM850 as Req'd	US32D	RO	087100
3 Silencer	608-RKW		RO	087100

Set: 15.0

Doors: 107, 108, 152

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK	087100
1 Privacy Lock	ML2030 109W V10	626	RU	087100
1 Surface Closer	9500 SN-134 x Mtg Plates / Brackets as Req'd	689	NO	087100
1 Kick Plate	K1050 10" x Width Req'd CSK	US32D	RO	087100
1 Door Stop	Wall 409 or Floor RM850 as Req'd	US32D	RO	087100
3 Silencer	608-RKW		RO	087100

Set: 16.0

Doors: 125, 126

3 Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK	087100
1 Push Plate	70C-RKW	US32D	RO	087100
1 Door Pull	RM3341-12 Mtg-Type 1XHD	US32D- 316	RO	087100
1 Surface Closer	9500 SN-134 x Mtg Plates / Brackets as Req'd	689	NO	087100
1 Kick Plate	K1050 10" x Width Req'd CSK	US32D	RO	087100
3 Silencer	608-RKW		RO	087100

Set: 17.0

Doors: 123A, 137A

1 Cylinder	ACP as Req'd for Hardware by Others	626	RU	087100
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Notes: Balance of hardware by the overhead door supplier. Verify type of cylinder required.

Set: 18.0

Doors: 101A, 101B, 101C, 101D, 164

2 Cylinder	ACP as Req'd for Hardware by Others	626	RU	087100
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Notes: Balance of hardware by the aluminum sliding door supplier. Verify type and quantity of cylinders required.

Set: 19.0

Doors: 104, 106

1 Case Open Frame	No Hardware Req'd	OT
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Set: 20.0

Doors: C117, C118, C119

1 All Hardware by the	Cooler Door Supplier	OT
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END OF SECTION 087100

**SECTION 088000
GLAZING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Insulating glass units.
- B. Glazing units.
- C. Decorative glass.
- D. Glazing compounds and accessories.

1.2 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials Current Edition.
- B. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test 2015 (Reaffirmed 2020).
- C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.
- D. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers 2005 (Reapproved 2019).
- E. ASTM C920 - Standard Specification for Elastomeric Joint Sealants 2018.
- F. ASTM C1036 - Standard Specification for Flat Glass 2021.
- G. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass 2018.
- H. ASTM C1193 - Standard Guide for Use of Joint Sealants 2016.
- I. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass 2021a.
- J. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings 2016.
- K. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation 2019.
- L. GANA (GM) - GANA Glazing Manual 2008.
- M. GANA (SM) - GANA Sealant Manual 2008.
- N. NFRC 100 - Procedure for Determining Fenestration Product U-factors 2020.
- O. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence 2020.
- P. NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems 2020.

1.3 ADMINISTRATIVE REQUIREMENTS

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

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data on Insulating Glass Unit and Glazing Unit Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- C. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
- D. Samples: Submit two samples of glass units, showing coloration.
- E. Certificate: Certify that products of this section meet or exceed specified requirements.
- F. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with GANA (GM) for glazing installation methods. Maintain one copy on site.

- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
- C. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years documented experience.

1.6 MOCK-UPS

1.7 FIELD CONDITIONS

- A. Do not install glazing when ambient temperature is less than 40 degrees F.
- B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.8 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Insulating Glass Units: Provide a five (5) year manufacturer warranty to include coverage for seal failure, interpane dusting or misting, including providing products to replace failed units.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Glass Fabricators:
 - 1. Cardinal Glass Industries: www.cardinalcorp.com/#sle.
 - 2. GGI - General Glass International: www.generalglass.com/#sle.
 - 3. Trulite Glass & Aluminum Solutions, LLC: www.trulite.com/#sle.
 - 4. Viracon, Inc: www.viracon.com/#sle.
 - 5. Vitro Architectural Glass: www.vitroglazings.com.
 - 6. Substitutions: Refer to Section 016000 - Product Requirements.

2.2 PERFORMANCE REQUIREMENTS - EXTERIOR GLAZING ASSEMBLIES

- A. Provide type and thickness of exterior glazing assemblies to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of glass.
 - 1. Design Pressure: Calculated in accordance with ASCE 7.
 - 2. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
 - 3. Provide glass edge support system sufficiently stiff to limit the lateral deflection of supported glass edges to less than 1/175 of their lengths under specified design load.
 - 4. Glass thicknesses listed are minimum.
- B. Vapor Retarder and Air Barrier Seals: Provide completed assemblies that maintain continuity of building enclosure vapor retarder and air barrier.
 - 1. In conjunction with vapor retarder and joint sealer materials described in other sections.
- C. Thermal and Optical Performance: Provide exterior glazing products with performance properties as indicated. Performance properties are in accordance with manufacturer's published data as determined with the following procedures and/or test methods:
 - 1. Center of Glass U-Value: Comply with NFRC 100 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
 - 2. Center of Glass Solar Heat Gain Coefficient (SHGC): Comply with NFRC 200 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
 - 3. Solar Optical Properties: Comply with NFRC 300 test method.

2.3 GLASS MATERIALS

- A. Float Glass: Provide float glass based glazing unless noted otherwise.
 - 1. Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality-Q3.
 - 2. Heat-Strengthened and Fully Tempered Types: ASTM C1048, Kind HS and FT where required by code.

3. Fully Tempered Safety Glass: Complies with ANSI Z97.1 and 16 CFR 1201 criteria.

2.4 DECORATIVE

- A. Clear textured glass.
 1. Basis-of-Design Product: Nathan Allan Glass Studios; Stream: www.nathanallan.com.

2.5 INSULATING GLASS UNITS

- A. Manufacturers:
 1. Fabricator certified by glass manufacturer for type of glass, coating, and treatment involved and capable of providing specified warranty.
 2. AGC Glass North America, Inc: www.agc-yourglass.com/#sle.
 3. Cardinal Glass Industries: www.cardinalcorp.com/#sle.
 4. Guardian Glass, LLC: www.guardianglass.com/#sle.
 5. Pilkington North America Inc: www.pilkington.com/na/#sle.Pilkington North America Inc: www.pilkington.com/na/#sle.
 6. Viracon, Apogee Enterprises, Inc: www.viracon.com/#sle.
 7. Vitro Architectural Glass (formerly PPG Glass): www.vitroglazings.com/#sle.
 8. Substitutions: Refer to Section 016000 - Product Requirements.
- B. Insulating Glass Units: Types as indicated.
 1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
 2. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
 3. Metal Edge Spacers: Aluminum, bent and soldered corners.
 4. Spacer Color: Black.
 5. Edge Seal:
 - a. Single-Sealed System: Provide silicone, polysulfide, or polyurethane sealant as seal applied around perimeter.
 6. Purge interpane space with dry air, hermetically sealed.
- C. Insulating Glass Units: Vision glass, double glazed.
 1. Applications: Exterior glazing unless otherwise indicated.
 2. Space between lites filled with air.
 3. Outboard Lite: Fully tempered float glass, 1/4 inch thick, minimum.
 - a. Tint: As selected by Architect or as scheduled.
 - b. Coating: Low-E (passive type), on #2 surface.
 4. Inboard Lite: Heat-strengthened float glass, 1/4 inch thick, minimum.
 - a. Tint: Clear.
 5. Total Thickness: 1 inch.
 6. Thermal Transmittance (U-Value), Winter - Center of Glass: [____], nominal.
 7. Visible Light Transmittance (VLT): [____] percent, nominal.
 8. Solar Heat Gain Coefficient (SHGC): [____], nominal.
 9. Visible Light Reflectance, Outside: [____] percent, nominal.

2.6 GLAZING COMPOUNDS

- A. Polysulfide Sealant: Two component; chemical curing, non-sagging type; ASTM C920 Type M, Grade NS, Class 25, Uses M, A, and G; with cured Shore A hardness range of 15 to 25; color as selected.
- B. Silicone Sealant: Single component; neutral curing; capable of water immersion without loss of properties; non-bleeding, non-staining; ASTM C920 Type S, Grade NS, Class 25, Uses M, A, and G; with cured Shore A hardness range of 15 to 25; color as selected.

2.7 ACCESSORIES

- A. Setting Blocks: Silicone, with 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1 inch for each square foot of glazing or minimum 4 inch by width of glazing rabbet space minus 1/16 inch by height to suit glazing method and pane weight and area.

- B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness; ASTM C864 Option II. Minimum 3 inch long by one half the height of the glazing stop by thickness to suit application, self adhesive on one face.
- C. Glazing Splines: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; color black.
- D. Glazing Clips: Manufacturer's standard type.

2.8 SOURCE QUALITY CONTROL

- A. Provide shop inspection and testing for insulating glass.

PART 3 EXECUTION

3.1 VERIFICATION OF CONDITIONS

- A. Verify that openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.
- B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and support framing is ready to receive glazing system.
- C. Verify that sealing between joints of glass framing members has been completed effectively.
- D. Proceed with glazing system installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean contact surfaces with appropriate solvent and wipe dry within maximum of 24 hours before glazing. Remove coatings that are not tightly bonded to substrates.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- C. Prime surfaces scheduled to receive sealant where required for proper sealant adhesion.

3.3 INSTALLATION, GENERAL

- A. Install glazing in compliance with written instructions of glass, gaskets, and other glazing material manufacturers, unless more stringent requirements are indicated, including those in glazing referenced standards.
- B. Install glazing sealants in accordance with ASTM C1193, GANA (SM), and manufacturer's instructions.
- C. Set glass lites of system with uniform pattern, draw, bow, and similar characteristics.
- D. Set glass lites in proper orientation so that coatings face exterior or interior as indicated.
- E. Prevent glass from contact with any contaminating substances that may be the result of construction operations such as, and not limited to the following; weld splatter, fire-safing, plastering, mortar droppings, etc.

3.4 INSTALLATION - DRY GLAZING METHOD (GASKET GLAZING)

- A. Application - Exterior and/or Interior Glazed: Set glazing infills from either the exterior or the interior of the building.
- B. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
- C. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.
- D. Install removable stops without displacing glazing gasket; exert pressure for full continuous contact.

3.5 INSTALLATION - WET GLAZING METHOD (COMPOUND AND COMPOUND)

- A. Application - Interior Glazed: Set glazing infills from the interior of the building.
- B. Install glazing resting on setting blocks. Install applied stop and center pane by use of spacer shims at 24 inch centers, kept 1/4 inch below sight line.
- C. Locate and secure glazing pane using glazers' clips.
- D. Fill gaps between glazing and stops with glazing compound until flush with sight line. Tool surface to straight line.

3.6 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Glass and Glazing product manufacturers to provide field surveillance of the installation of their products.
- C. Monitor and report installation procedures and unacceptable conditions.

3.7 CLEANING

- A. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.
- B. Remove non-permanent labels immediately after glazing installation is complete.
- C. Clean glass and adjacent surfaces after sealants are fully cured.
- D. Clean glass on both exposed surfaces not more than 4 days prior to Date of Substantial Completion in accordance with glass manufacturer's written recommendations.

3.8 PROTECTION

- A. After installation, mark pane with an 'X' by using removable plastic tape or paste; do not mark heat absorbing or reflective glass units.
- B. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

END OF SECTION

SECTION 088300
MIRRORS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Glass mirrors.
 - 1. Tempered safety glass.

1.2 REFERENCE STANDARDS

- A. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass 2018.
- B. ASTM C1193 - Standard Guide for Use of Joint Sealants 2016.
- C. GANA (GM) - GANA Glazing Manual 2008.

1.3 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.
- C. Product Data on Glazing Compounds: Submit chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
- D. Manufacturer's Certificate: Certify that mirrors, meets or exceeds specified requirements.
- E. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with GANA (GM) for glazing installation methods.
- B. Fabricate, store, transport, receive, install, and clean mirrors in accordance with recommendations of GANA (TIPS).

1.5 FIELD CONDITIONS

- A. Do not install mirrors when ambient temperature is less than 50 degrees F.
- B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.6 WARRANTY

- A. See Section 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

2.1 MANUFACTURERS

- A. Mirrors:
 - 1. Binswanger Mirror/ACI Distribution: www.binswangerglass.com/#sle.
 - 2. Lenoir Mirror Co: www.lenoirmirror.com/#sle.
 - 3. Trulite Glass and Aluminum Solutions: www.trulite.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.

2.2 MATERIALS

- A. Mirror Design Criteria: Select materials and/or provide supports as required to limit mirror material deflection to 1/200, or to the flexure limit of glass, with full recovery of glazing materials, whichever is less.
- B. Mirror Glass: Clear, tempered safety glass; ASTM C1048, with copper and silver coatings, and protective overcoating.
 - 1. Thickness: 1/4 inch.

2. Edges: Bevelled.
3. Size: As noted on drawings.

2.3 ACCESSORIES

- A. Setting Blocks: Neoprene, 80 to 90 Shore A durometer hardness.
- B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness.
- C. Glazing Tape: Preformed butyl compound; 10 to 15 Shore A durometer hardness; on release paper.
- D. Glazing Clips: Manufacturer's standard type.
- E. Mirror Attachment Accessories: Stainless steel clips.
- F. Mirror Adhesive: Silicone pre-polymer based, chemically compatible with mirror coating and wall substrate.
 1. Application Temperature: Minus 35 to 140 degrees F at contact surfaces.
- 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 with 90 degree mitered corners.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that openings for mirrored glazing are correctly sized and within tolerance.
- B. Verify that surfaces of mirror frames or recesses are clean, free of obstructions, and ready for installation of mirrors.

3.2 PREPARATION

- A. Clean contact surfaces with solvent and wipe dry.
- B. Seal porous mirror frames or recesses with substrate compatible primer or sealer. Prime surfaces scheduled to receive sealant.
- C. Prepare installation in accordance with ASTM C1193 for solvent release sealants, and install sealant in accordance with manufacturer's instructions.

3.3 INSTALLATION

- A. Install mirrors in accordance with GANA (TIPS) and manufacturers 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.

3.4 CLEANING

- A. Remove wet glazing materials from finish surfaces.
- B. Remove labels after work is complete.
- C. Clean mirrors and adjacent surfaces.

END OF SECTION

SECTION 092116
GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Performance criteria for gypsum board assemblies.
- B. Metal stud wall framing.
- C. Metal channel ceiling framing.
- D. Acoustic insulation.
- E. Gypsum sheathing.
- F. Gypsum wallboard.
- G. Joint treatment and accessories.
- H. Acoustic (sound-dampening) wall and ceiling board.
- I. Bullet resistant sheathing and wallboard.

1.2 REFERENCE STANDARDS

- A. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members 2016, with Supplement (2018).
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- C. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board 2017 (Reapproved 2022).
- D. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members 2018.
- E. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing 2017.
- F. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products 2020.
- G. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board 2020.
- H. 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.
- I. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base 2019.
- J. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing 2017.
- K. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel 2018.
- L. ASTM C1280 - Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing 2018.
- M. ASTM C1396/C1396M - Standard Specification for Gypsum Board 2017.
- N. ASTM C1629/C1629M - Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels 2019.
- O. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber 2021.
- P. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- Q. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements 2009 (Reapproved 2016).
- R. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials 2020.
- S. ASTM E413 - Classification for Rating Sound Insulation 2022.
- T. GA-216 - Application and Finishing of Gypsum Panel Products 2021.
- U. UL 752 - Standard for Bullet-Resisting Equipment Current Edition, Including All Revisions.

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate special details associated with acoustic seals.
- C. Product Data: Provide data on metal framing, gypsum board, accessories, and joint finishing system.
- D. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.
- E. Test Reports: For stud framing products that do not comply with ASTM C645 or ASTM C754, provide independent laboratory reports showing maximum stud heights at required spacings and deflections.
- F. Test Reports: Bullet resistant sheathing and wallboard.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing gypsum board installation and finishing, with minimum three years of experience.

PART 2 PRODUCTS

2.1 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
- B. Interior Partitions: Provide completed assemblies with the following characteristics:
 - 1. Acoustic Attenuation: STC of 45-49 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
- C. Shaft Walls at HVAC Shafts: Provide completed assemblies with the following characteristics:
 - 1. Air Pressure Within Shaft: Sustained loads of 5 lbf/sq ft with maximum mid-span deflection of L/240.
 - 2. Acoustic Attenuation: STC of 35-39 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.
- D. Fire Rated Assemblies: Provide completed assemblies complying with applicable code.

2.2 METAL FRAMING MATERIALS

- A. Manufacturers - Metal Framing, Connectors, and Accessories:
 - 1. Clarkwestern Dietrich Building Systems LLC: www.clarkdietrich.com/#sle.
 - 2. Marino: www.marinoware.com/#sle.
 - 3. Phillips Manufacturing Co: www.phillipsmfg.com/#sle.
 - 4. SCAFCO Corporation: www.scafco.com/#sle.
 - 5. Steel Construction Systems: www.steelconsystems.com/#sle.
 - 6. Substitutions: See Section 016000 - Product Requirements.
- B. Non-structural Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/120 at 5 psf.
 - 1. Studs: C-shaped with knurled or embossed faces.
 - 2. Runners: U shaped, sized to match studs.
 - 3. Ceiling Channels: C-shaped.
 - 4. Furring Members: Hat-shaped sections, minimum depth of 7/8 inch.
 - 5. Resilient Furring Channels: Single or double leg configuration; 1/2 inch channel depth.
- C. Shaft Wall Studs and Accessories: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 and specified performance requirements.
- D. Partition Head To Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and fastened as indicated on drawings.
- E. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection and prevent rotation of studs while maintaining structural performance of partition.
 - 1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI S100.
 - 2. Material: ASTM A653/A653M steel sheet, SS Grade 50/340, with G60/Z180 hot-dipped galvanized coating.

3. Provide components UL-listed for use in UL-listed fire-resistance-rated head of partition joint systems indicated on drawings.
 4. Provide top track preassembled with connection devices spaced to fit stud spacing indicated on drawings; minimum track length of 12 feet.
- F. Preformed Top Track Firestop Seal:
1. Provide components UL-listed for use in UL-listed fire-resistance-rated head of partition joint systems indicated on drawings.
 2. Products:
 - a. Hilti, Inc; Top Track Seal CFS TTS: www.us.hilti.com/#sle.
 - b. Specified Technologies Inc; SpeedFlex TTG Track Top Gasket: www.stfirestop.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
- G. Non-structural Framing Accessories:
1. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.
 2. Framing Connectors: ASTM A653/A653M G90 galvanized steel clips; secures cold rolled channel to wall studs for lateral bracing.
- H. Grid Suspension Systems: Steel grid system of main tees and support bars connected to structure using hanging wire.
1. Products:
 - a. USG Corporation; Drywall Suspension System: www.usg.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

2.3 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. National Gypsum Company: www.nationalgypsum.com/#sle.
 5. USG Corporation: www.usg.com/#sle.
- 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, unless otherwise indicated.
 2. At Assemblies Indicated with Fire-Resistance Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
 3. Thickness:
 - a. Vertical Surfaces: 5/8 inch.
- C. Impact Resistant Wallboard:
1. Application: High-traffic areas indicated.
 2. Surface Abrasion: Level 3, minimum, when tested in accordance with ASTM C1629/C1629M.
 3. Indentation: Level 1, minimum, when tested in accordance with ASTM C1629/C1629M.
 4. Soft Body Impact: Level 3, minimum, when tested in accordance with ASTM C1629/C1629M.
 5. Hard Body Impact: Level 2, minimum, when tested in accordance with ASTM C1629/C1629M.
 6. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 7. Paper-Faced Type: Gypsum wallboard, as defined in ASTM C1396/C1396M.
 8. Type: Fire-resistance-rated Type X, UL or WH listed.
 9. Thickness: 5/8 inch.
 10. Edges: Tapered.
 11. Paper-Faced Products:
 - a. American Gypsum Company; M-Bloc IR Type X: www.americangypsum.com/#sle.
 - b. CertainTeed Corporation; Extreme Impact Resistant Drywall with M2Tech: www.certainteed.com/#sle.
 - c. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond XP Hi-Impact Gypsum Board: www.goldbondbuilding.com/#sle.

- d. USG Corporation; USG Sheetrock Brand Mold Tough VHI Firecode X Panels: www.usg.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
- D. Backing Board For Wet Areas:
- 1. Application: Surfaces behind tile in wet areas including tub and shower surrounds.
 - 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 3. Glass Mat Faced Board: Coated glass mat water-resistant gypsum backing panel as defined in ASTM C1178/C1178M.
 - a. Fire-Resistance-Rated Type: Type X core, thickness 5/8 inch.
 - b. Products:
 - 1) CertainTeed Corporation; 5/8" GlasRoc Tile Backer Type X: www.certainteed.com/#sle.
 - 2) Georgia-Pacific Gypsum; DensShield Tile Backer: www.gpgypsum.com/#sle.
 - 3) Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond eXP Fire-Shield Tile Backer: www.goldbondbuilding.com/#sle.
 - 4) Substitutions: See Section 016000 - Product Requirements.
- E. Backing Board For Non-Wet Areas: Water-resistant gypsum backing board as defined in ASTM C1396/C1396M; sizes to minimum joints in place; ends square cut.
- 1. Application: Vertical surfaces behind thinset tile, except in wet areas.
 - 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 3. At Assemblies Indicated with Fire-Resistance Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
 - 4. Type: Type X, in locations indicated.
 - 5. Type X Thickness: 5/8 inch.
 - 6. Edges: Tapered.
 - 7. Products:
 - a. Georgia-Pacific Gypsum; DensArmor Plus: www.gpgypsum.com/#sle.
 - b. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond XP Fire-Shield Gypsum Board: www.goldbondbuilding.com/#sle.
- F. Ceiling Board: Special sag resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
- 1. Application: Ceilings, unless otherwise indicated.
 - 2. Thickness: 1/2 inch.
 - 3. Edges: Tapered.
 - 4. Products:
 - a. CertainTeed Corporation; 1/2" Easi-Lite: www.certainteed.com/#sle.
 - b. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond High Strength LITE Gypsum Board: www.goldbondbuilding.com/#sle.
 - c. USG Corporation; 1/2 Inch Sheetrock Brand UltraLight Panels: www.usg.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- G. Acoustical Sound Dampening Wall and Ceiling Board: Two layers of heavy paper-faced, high-density gypsum board separated by a viscoelastic polymer layer and capable of achieving STC rating of 50 or more in typical stud wall assemblies as calculated in accordance with ASTM E413 and when tested in accordance with ASTM E90.
- 1. Thickness: 5/8 inch.
 - 2. Long Edges: Tapered.
 - 3. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 4. Products:
 - a. CertainTeed Corporation; SilentFX Quick Cut Type X Gypsum Board: www.certainteed.com/#sle.
 - b. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond SoundBreak XP Wall Board: www.goldbondbuilding.com/#sle.
- H. Bullet Resistant Sheathing and Wallboard: Woven roving, multi-ply, ballistic grade fiberglass cloth with thermoset polyester resin; comply with UL 752 Level 1.
- 1. Thickness: [] inch.

2. In 1-Hour Fire-Resistance-Rated Partitions: UL listed for assembly used.
3. Products:
 - a. ArmorCore by Waco Composites; Bullet Resistant Fiberglass Panels: www.armorcore.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- I. Exterior Sheathing Board: Sizes to minimize joints in place; ends square cut.
 1. Application: Exterior sheathing, unless otherwise indicated.
 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 3. Glass Mat Faced Sheathing: Glass mat faced gypsum substrate as defined in ASTM C1177/C1177M.
 4. Core Type: Type X, as indicated.
 5. Type X Thickness: 5/8 inch.
 6. Edges: Square.
 7. Glass Mat Faced Products:
 - a. CertainTeed Corporation; GlasRoc Type X Exterior Sheathing: www.certainteed.com/#sle.
 - b. Georgia-Pacific Gypsum; DensGlass Sheathing: www.gpgypsum.com/#sle.
 - c. Georgia-Pacific Gypsum; DensGlass Fireguard Sheathing: www.gpgypsum.com/#sle.
 - d. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond eXP Fire-Shield Sheathing: www.goldbondbuilding.com/#sle.
 - e. USG Corporation; USG Securock Brand Ultralight Glass-Mat Sheathing Firecode X: www.usg.com/#sle.
 - f. Substitutions: See Section 016000 - Product Requirements.
- J. Shaftwall and Coreboard: Type X; 1 inch thick by 24 inches wide, beveled long edges, ends square cut.
 1. Paper-Faced Type: Gypsum shaftliner board or gypsum coreboard as defined ASTM C1396/C1396M; water-resistant faces.
 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 3. Paper-Faced Products:
 - a. CertainTeed Corporation; M2Tech Type X Shaftliner: www.certainteed.com/#sle.
 - b. Georgia-Pacific Gypsum; ToughRock Shaftliner: www.gpgypsum.com/#sle.
 - c. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond Shaftliner XP: www.goldbondbuilding.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.

2.4 GYPSUM BOARD ACCESSORIES

- A. Acoustic Insulation: ASTM C665; preformed glass fiber, friction fit type, unfaced. Thickness: 2 inch.
- B. Acoustical Shielding: Recycled ethylene vinyl acetate (EVA) sheet membrane; applied between studs and gypsum board.
 1. Fire Resistance: Where fire-resistance rating is specified for the wall in which the acoustical shielding membrane is mounted, provide assemblies that have been tested in accordance with ASTM E119 for the same rating as the wall.
- C. Sound Isolation Tape: Elastomeric foam tape for sound decoupling.
 1. Surface Burning Characteristics: Provide assemblies with flame spread index of 75 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 2. Tape Thickness: 1/4 inch.
- D. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.
- E. Water-Resistive Barrier: See Section 072500.
- F. Finishing Accessories: ASTM C1047, extruded aluminum alloy (6063 T5) or galvanized steel sheet ASTM A924/A924M G90, unless noted otherwise.
 1. Types: As detailed or required for finished appearance.
 2. Special Shapes: In addition to conventional corner bead and control joints, provide U-bead at exposed panel edges.
 3. Products:

- a. Same manufacturer as framing materials.
- G. Decorative Metal Trim:
 - 1. Material: Extruded aluminum alloy 6063-T5 temper.
 - 2. Finish: Anodized, clear.
 - 3. Type: Profile as selected from manufacturer's standard range.
- H. Moisture Guard Trim: ASTM C1047, rigid plastic, 48 inch length, applied to bottom edge of gypsum board.
 - 1. Height: 1-3/4 inch.
 - 2. Depth: 5/8 inch.
 - 3. Products:
 - a. Waterguard USA; Waterguard: www.waterguard-usa.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- I. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
 - 1. Paper Tape: 2 inch wide, creased paper tape for joints and corners, except as otherwise indicated.
 - 2. Joint Compound: Drying type, vinyl-based, ready-mixed.
- J. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill screws, corrosion-resistant.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that project conditions are appropriate for work of this section to commence.

3.2 SHAFT WALL INSTALLATION

- A. Shaft Wall Framing: Install in accordance with manufacturer's installation instructions.
 - 1. Fasten runners to structure with short leg to finished side, using appropriate power-driven fasteners at not more than 24 inches on center.
 - 2. Install studs at spacing required to meet performance requirements.
- B. Shaft Wall Liner: Cut panels to accurate dimensions and install sequentially between special friction studs.
 - 1. On walls over sixteen feet high, screw-attach studs to runners top and bottom.
 - 2. Seal perimeter of shaft wall and penetrations with acoustical sealant.

3.3 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C754 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.
 - 1. Extend partition framing to structure where indicated and to ceiling in other locations.
 - 2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
 - 3. Partitions Terminating at Structure: Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs with continuous bridging.
 - 4. 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.

- E. Standard Wall Furring: Install at concrete walls scheduled to receive gypsum board, not more than 4 inches from floor and ceiling lines and abutting walls. Secure in place on alternate channel flanges at maximum 24 inches on center.
 - 1. Orientation: Horizontal.
 - 2. Spacing: As indicated.
- F. Blocking: Install wood blocking for support of:
 - 1. Framed openings.
 - 2. Wall-mounted cabinets.
 - 3. Plumbing fixtures.
 - 4. Toilet partitions.
 - 5. Toilet accessories.
 - 6. Wall-mounted door hardware.

3.4 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- B. Sound Isolation Tape: Apply to vertical studs and top and bottom tracks/runners in accordance with manufacturer's instructions.
- C. Acoustic Sealant: Install in accordance with manufacturer's instructions.
 - 1. Place one bead continuously on substrate before installation of perimeter framing members.
 - 2. Place continuous bead at perimeter of each layer of gypsum board.
 - 3. Seal around all penetrations by conduit, pipe, ducts, and rough-in boxes, except where firestopping is provided.
- D. Acoustical Shielding: Install in accordance with manufacturer's instructions for application between studs and gypsum board.

3.5 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 in most economical direction, with ends and edges occurring over firm bearing.
- C. Fire-Resistance-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
- D. Exterior Sheathing: Comply with ASTM C1280. Install sheathing vertically vertically, with edges butted tight and ends occurring over firm bearing.
 - 1. Seal joints, cut edges, and holes with water-resistant sealant.
- E. Installation on Metal Framing: Use screws for attachment of gypsum board except face layer of nonrated double-layer assemblies, which may be installed by means of adhesive lamination.
- F. Bullet Resistant Sheathing and Wallboard:
 - 1. Install bullet-resistant sheathing according to manufacturer's written recommendations and with manufacturer-approved fasteners.
 - 2. Cover all joints between boards with a 4 inch strip of the same thickness material as the boards, centered on the joint.

3.6 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
 - 1. Not more than 30 feet apart on walls and ceilings over 50 feet long.
- B. Corner Beads: Install at external corners, using longest practical lengths.
- C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.
- D. Decorative Trim: Install at locations shown on drawings and in accordance with manufacturer's instructions.
- E. Moisture Guard Trim: Install on bottom edge of gypsum board according to manufacturer's instructions and in locations indicated on drawings.

3.7 JOINT TREATMENT

- A. Glass Mat Faced Gypsum Board and Exterior Glass Mat Faced Sheathing: Use fiberglass joint tape, embed and finish with setting type joint compound.
- B. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.
- C. 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, wall coverings, 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: Wall areas above finished ceilings, whether or not accessible in the completed construction.
- D. 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.
 - 2. Taping, filling, and sanding are not required at surfaces behind adhesive applied ceramic tile and fixed cabinetry.
- E. 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.

3.8 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

END OF SECTION

**SECTION 093000
TILING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Ceramic and porcelain wall and floor tile.
- B. Ceramic trim.
- C. Non-ceramic trim.

1.2 REFERENCE STANDARDS

- A. ANSI A108.1a - American National Standard Specifications for Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar 2017.
- B. ANSI A108.1b - American National Standard Specifications for Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex-Portland Cement Mortar 2017.
- C. ANSI A108.1c - Contractor's Option: Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex-Portland Cement Mortar 1999 (Reaffirmed 2021).
- D. ANSI A108.4 - American National Standard Specifications for Installation of Ceramic Tile with Organic Adhesive or Water Cleanable Tile-Setting Epoxy Adhesive 2019.
- E. ANSI A108.5 - American National Standard Specifications for Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar 2021.
- F. ANSI A108.6 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and -Grout Epoxy 1999 (Reaffirmed 2019).
- G. ANSI A108.8 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant Furan Resin Mortar and Grout 1999 (Reaffirmed 2019).
- H. ANSI A108.9 - American National Standard Specifications for Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout 1999 (Reaffirmed 2019).
- I. ANSI A108.10 - American National Standard Specifications for Installation of Grout in Tilework 2017.
- J. ANSI A108.11 - American National Standard Specifications for Interior Installation of Cementitious Backer Units 2018.
- K. ANSI A108.12 - American National Standard for Installation of Ceramic Tile with EGP (Exterior Glue Plywood) Latex-Portland Cement Mortar 1999 (Reaffirmed 2019).
- L. ANSI A108.13 - American National Standard for Installation of Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone 2005 (Reaffirmed 2021).
- M. ANSI A118.3 - American National Standard Specifications for Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy and Water Cleanable Tile-Setting Epoxy Adhesive 2021.
- N. ANSI A118.7 - American National Standard Specifications for High Performance Cement Grouts for Tile Installation 2019.
- O. ANSI A118.10 - American National Standard Specifications for Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone 2014 (Reaffirmed 2019).
- P. ANSI A118.12 - American National Standard Specifications for Crack Isolation Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation 2014 (Reaffirmed 2019).
- Q. ANSI A118.15 - American National Standard Specifications for Improved Modified Dry-Set Cement Mortar 2019.
- R. ANSI A136.1 - American National Standard for Organic Adhesives for Installation of Ceramic Tile 2020.
- S. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation 2021.

1.3 ADMINISTRATIVE REQUIREMENTS

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

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
- C. Shop Drawings: Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, control and expansion joints, thresholds, ceramic accessories, and setting details.
- D. Samples: Mount tile and apply grout on two plywood panels, minimum 18 by 18 inches in size illustrating pattern, color variations, and grout joint size variations.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Tile: 1 percent of each size, color, and surface finish combination, but not less than one box of each type.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum five years of documented experience.
- B. Installer Qualifications:
 - 1. Company specializing in performing tile installation, with minimum of five years of documented experience.

1.6 MOCK-UPS

- A. See Section 014000 - Quality Requirements for general requirements for mock-up.
- B. Construct tile mock-up where indicated on drawings, incorporating all components specified for the location.
 - 1. Minimum size of mock-up is indicated on drawings.
 - 2. Approved mock-up may remain as part of work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.8 FIELD CONDITIONS

- A. Do not install solvent-based products in an unventilated environment.
- B. Maintain ambient and substrate temperature above 50 degrees F and below 100 degrees F during installation and curing of setting materials.

PART 2 PRODUCTS

2.1 TILE

- A. Manufacturers:
 - 1. Refer to Finish Legend.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Tile Products: As scheduled.

2.2 TRIM AND ACCESSORIES

- A. Ceramic Trim: Matching bullnose, double bullnose, cove base, and cove ceramic shapes in sizes coordinated with field tile.
 - 1. Applications:
 - a. Open Edges: Bullnose.
 - b. Inside Corners: Jointed.
 - c. Floor to Wall Joints: Cove base.

2. Manufacturers: Same as for tile.
- B. Non-Ceramic Trim: Satin natural anodized extruded aluminum, style and dimensions to suit application, for setting using tile mortar or adhesive.
 1. Applications:
 - a. Open edges of wall tile.
 - b. Open edges of floor tile.
 - c. Wall corners, outside and inside.
 - d. Transition between floor finishes of different heights.
 - e. Expansion and control joints, floor and wall.
 - f. Floor to wall joints.
 - g. Borders and other trim as indicated on drawings.
 2. Manufacturers:
 - a. Schluter-Systems: www.schluter.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

2.3 SETTING MATERIALS

- A. Manufacturers:
 1. ARDEX Engineered Cements: www.ardexamericas.com/#sle.
 2. Bostik Inc: www.bostik-us.com/#sle.
 3. Custom Building Products: www.custombuildingproducts.com/#sle.
 4. LATICRETE International, Inc: www.laticrete.com/#sle.
 5. Merkrete, by Parex USA, Inc: www.merkrete.com/#sle.
 6. TEC, an H.B. Fuller Construction Products Brand: www.tecspecialty.com/#sle.
 7. Substitutions: See Section 016000 - Product Requirements.
- B. Improved Latex-Portland Cement Mortar Bond Coat: ANSI A118.15.
 1. Products:
 - a. ARDEX Engineered Cements; S 28: www.ardexamericas.com/#sle.
 - b. Custom Building Products; Complete Contact-LFT Premium Rapid Setting Large Format Tile Mortar, with Multi-Surface Bonding Primer: www.custombuildingproducts.com/#sle.
 - c. LATICRETE International, Inc; MULTIMAX LITE: www.laticrete.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- C. Organic Adhesive: ANSI A136.1, thinset mastic type.
 1. Use Type I in areas subject to prolonged moisture exposure.
 2. Products:
 - a. ARDEX Engineered Cements; ARDEX D14: www.ardexamericas.com/#sle.
 - b. Custom Building Products; ReliaBond Ceramic Tile Adhesive - Type 1: www.custombuildingproducts.com/#sle.
 - c. LATICRETE International, Inc; LATICRETE 15 Premium Mastic: www.laticrete.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.

2.4 GROUTS

- A. Provide setting and grout materials from same manufacturer.
- B. Manufacturers:
 1. ARDEX Engineered Cements: www.ardexamericas.com/#sle.
 2. Bostik Inc: www.bostik-us.com/#sle.
 3. Custom Building Products: www.custombuildingproducts.com/#sle.
 4. LATICRETE International, Inc: www.laticrete.com/#sle.
 5. Merkrete, by Parex USA, Inc: www.merkrete.com/#sle.
 6. TEC, an H.B. Fuller Construction Products Brand: www.tecspecialty.com/#sle.
 7. Substitutions: See Section 016000 - Product Requirements.
- C. High Performance Polymer Modified Grout: ANSI A118.7 polymer modified cement grout.
 1. Applications: Use this type of grout where indicated and where no other type of grout is indicated.

2. Use sanded grout for joints 1/8 inch wide and larger; use unsanded grout for joints less than 1/8 inch wide.
3. Color(s): As selected by Architect from manufacturer's full line.
4. Products:
 - a. ARDEX Engineered Cements; ARDEX FL: www.ardexamericas.com/#sle.
 - b. Custom Building Products; Prism Color Consistent Grout: www.custombuildingproducts.com/#sle.
 - c. LATICRETE International, Inc; LATICRETE PERMACOLOR Grout: www.laticrete.com/#sle.
 - d. Merkrete, by Parex USA, Inc; Merkrete Pro Grout: www.merkrete.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.
- D. Epoxy Grout: ANSI A118.3 chemical resistant and water-cleanable epoxy grout.
 1. Applications: Where indicated.
 2. Color(s): As selected by Architect from manufacturer's full line.
 3. Products:
 - a. ARDEX Engineered Cements; ARDEX WA: www.ardexamericas.com/#sle.
 - b. Custom Building Products; CEG-IG 100% Solids Industrial Grade Epoxy Grout: www.custombuildingproducts.com/#sle.
 - c. LATICRETE International, Inc; LATICRETE SPECTRALOCK PRO Premium Grout: www.laticrete.com/#sle.
 - d. Merkrete, by Parex USA, Inc; Merkrete Pro Epoxy: www.merkrete.com/#sle.
 - e. Substitutions: See Section 016000 - Product Requirements.

2.5 MAINTENANCE MATERIALS

- A. Grout Sealer: Liquid-applied, moisture and stain protection for existing or new Portland cement grout.
 1. Composition: Water-based colorless silicone.
 2. Products:
 - a. Merkrete, by Parex USA, Inc; Merkrete Revive: www.merkrete.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

2.6 ACCESSORY MATERIALS

- A. Concrete Floor Slab Crack Isolation Membrane: Material complying with ANSI A118.12; not intended as waterproofing.
 1. Crack Resistance: No failure at 1/8 inch gap, minimum.
- B. Waterproofing Membrane at Floors: Specifically designed for bonding to cementitious substrate under thick mortar bed or thin-set tile; complying with ANSI A118.10.
 1. Crack Resistance: No failure at 1/16 inch gap, minimum; comply with ANSI A118.12.
 2. Fluid or Trowel Applied Type:
 - a. Material: Synthetic rubber or Acrylic.
 - b. Thickness: 25 mils, minimum, dry film thickness.
 - c. Products:
 - 1) ARDEX Engineered Cements; ARDEX 8+9: www.ardexamericas.com/#sle.
 - 2) Custom Building Products; RedGard Crack Prevention and Waterproofing Membrane: www.custombuildingproducts.com/#sle.
 - 3) LATICRETE International, Inc; LATICRETE HYDRO BAN: www.laticrete.com/#sle.
 - 4) Merkrete, by Parex USA, Inc; Merkrete Hydro Guard 1: www.merkrete.com/#sle.
 - 5) Substitutions: See Section 016000 - Product Requirements.
 3. Bonded Sheet Membrane Type:
 - a. Material: Polyethylene sheet membrane with non-woven fabric laminated to both sides, 20 to 30 mils thick, nominal.
 - b. Products:
 - 1) ARDEX Engineered Cements; ARDEX SK 175: www.ardexamericas.com/#sle.
 - 2) LATICRETE International, Inc; LATICRETE HYDRO BAN Sheet Membrane: www.laticrete.com/#sle.
 - 3) Noble Company; NobleSeal TS: www.noblecompany.com/#sle.
 - 4) Substitutions: See Section 016000 - Product Requirements.

- C. Reinforcing Mesh: 2 by 2 inch size weave of 16/16 wire size; welded fabric, galvanized.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that subfloor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive tile.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.
- C. Verify that subfloor surfaces are dust free and free of substances that could impair bonding of setting materials to subfloor surfaces.
- D. Verify that required floor-mounted utilities are in correct location.

3.2 PREPARATION

- A. Protect surrounding work from damage.
- B. Vacuum clean surfaces and damp clean.
- C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.
- D. Install backer board in accordance with ANSI A108.11 and board manufacturer's instructions. Tape joints and corners, cover with skim coat of setting material to a feather edge.
- E. Prepare substrate surfaces for adhesive installation in accordance with adhesive manufacturer's instructions.

3.3 INSTALLATION - GENERAL

- A. Install tile, thresholds, and stair treads and grout in accordance with applicable requirements of ANSI A108.1a through ANSI A108.20, manufacturer's instructions, and TCNA (HB) recommendations.
- B. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.
- C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.
- D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.
- E. Form internal angles square and external angles bullnosed.
- F. Install non-ceramic trim in accordance with manufacturer's instructions.
- G. Sound tile after setting. Replace hollow sounding units.
- H. Keep control and expansion joints free of mortar, grout, and adhesive.
- I. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
- J. Grout tile joints unless otherwise indicated. Use standard grout unless otherwise indicated.
- K. At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.

3.4 INSTALLATION - FLOORS - THIN-SET METHODS

- A. Over interior concrete substrates, install in accordance with TCNA (HB) Method F116, organic adhesive, with standard grout, unless otherwise indicated.
 - 1. Use uncoupling membrane under all tile unless other underlayment is indicated.
 - 2. Where waterproofing membrane is indicated, install in accordance with TCNA (HB) Method F122, with latex-Portland cement grout.
 - 3. Where epoxy bond coat and grout are indicated, install in accordance with TCNA (HB) Method F131.

3.5 INSTALLATION - WALL TILE

- A. Over coated glass mat backer board on studs, install in accordance with TCNA (HB) Method W245.

- B. Over gypsum wallboard on wood or metal studs install in accordance with TCNA (HB) Method W243, thin-set with dry-set or latex-Portland cement bond coat, unless otherwise indicated.

3.6 CLEANING

- A. Clean tile and grout surfaces.

3.7 PROTECTION

- A. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION

SECTION 095100
ACOUSTICAL CEILINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Acoustical units.

1.2 REFERENCE STANDARDS

- A. ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings 2022.
- B. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels 2019.
- C. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions 2022.
- D. ASTM E1264 - Standard Classification for Acoustical Ceiling Products 2022.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
- B. Do not install acoustical units until after interior wet work is dry.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate grid layout and related dimensioning.
- C. Product Data: Provide data on suspension system components and acoustical units.
- D. Samples: Submit two full size samples illustrating material and finish of acoustical units.
- E. Samples: Submit two samples each, 8 inches long, of suspension system main runner.
- F. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Acoustical Units: Quantity equal to 5 percent of total installed.

1.5 QUALITY ASSURANCE

- A. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.6 FIELD CONDITIONS

- A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acoustic Tiles/Panels:
 - 1. Armstrong World Industries, Inc: www.armstrong.com/#sle.
- B. Suspension Systems:
 - 1. Same as for acoustical units.

2.2 ACOUSTICAL UNITS

- A. Acoustical Units - General: ASTM E1264, Class A.
- B. Acoustical Panels: Products as scheduled.

2.3 SUSPENSION SYSTEM(S)

- A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips, and splices as required.
- B. Exposed Steel Suspension System: Formed steel, commercial quality cold rolled; heavy-duty.
 - 1. Profile: Tee; 15/16 inch wide face.
 - 2. Construction: Double web.
 - 3. Finish: White painted.

2.4 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
- B. Hanger Wire: 12 gauge, 0.08 inch galvanized steel wire.
- C. Perimeter Moldings: Same metal and finish as grid.
- D. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that layout of hangers will not interfere with other work.

3.2 INSTALLATION - SUSPENSION SYSTEM

- A. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions and as supplemented in this section.
- B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- C. Lay out system to a balanced grid design with edge units no less than 50 percent of acoustical unit size.
- D. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
 - 1. Use longest practical lengths.
- E. Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- F. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- G. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- H. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.
- I. Do not eccentrically load system or induce rotation of runners.

3.3 INSTALLATION - ACOUSTICAL UNITS

- A. Install acoustical units in accordance with manufacturer's instructions.
- B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Fit border trim neatly against abutting surfaces.
- D. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- E. Cutting Acoustical Units:

1. Cut to fit irregular grid and perimeter edge trim.
 2. Make field cut edges of same profile as factory edges.
- F. Install hold-down clips on panels within 20 ft of an exterior door.

3.4 TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

END OF SECTION

SECTION 095413
CEMENTITIOUS WOOD FIBER CEILING PANELS

RELATED DOCUMENTS

- 1.1 DRAWINGS AND GENERAL CONDITIONS OF CONTRACT, INCLUDING GENERAL AND SUPPLEMENTARY CONDITIONS AND DIVISIONS-01 SPECIFICATION SECTIONS APPLY TO WORK OF THIS SECTION.

SUMMARY

- 2.1 SECTION INCLUDES
 - A. Cementitious wood fiber acoustical ceiling panels and system

REFERENCES

- 3.1 AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM):
 - A. ASTM C 423 Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
 - B. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials
 - C. ASTM E 2768-11(2018) Standard Test Method for Extended Duration Surface Burning Characteristics of Building Materials
 - D. ASTM E 580 Installation of Metal Suspension Systems in Areas Requiring Moderate Seismic Restraint
 - E. ASTM C 636 / C636M – 19 Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels
 - F. ASTM C 754 Installation of Steel Framing Members to Receive Screw-Attached Gypsum Board
 - G. ASTM E 1264 Classification for Acoustical Ceiling Products
 - H. ASTM D 3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
- 3.2 INTERNATIONAL BUILDING CODE
- 3.3 ASHRAE STANDARD 62.1-2004, "VENTILATION FOR ACCEPTABLE INDOOR AIR QUALITY"
- 3.4 NFPA 70 NATIONAL ELECTRICAL CODE
- 3.5 ASCE 7 AMERICAN SOCIETY OF CIVIL ENGINEERS, MINIMUM DESIGN LOADS FOR BUILDINGS AND OTHER STRUCTURES
- 3.6 INTERNATIONAL CODE COUNCIL-EVALUATION SERVICES - AC 156 ACCEPTANCE CRITERIA FOR SEISMIC QUALIFICATION TESTING OF NON-STRUCTURAL COMPONENTS
- 3.7 INTERNATIONAL CODE COUNCIL-EVALUATION SERVICES REPORT - SEISMIC ENGINEER REPORT
 - A. ESR 1308 - Armstrong Suspension Systems
- 3.8 INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS - SEISMIC ENGINEER REPORT
 - A. 0244 - Armstrong Single Span Suspension System

SYSTEM DESCRIPTION

- 4.1 1" TECTUM FINALE PB ACOUSTICAL CEILING AND WALL SYSTEMS ARE MANUFACTURED FROM DOMESTIC CEMENTITIOUS WOOD FIBER. BUILT-IN FURRING PIECES WITH FACTORY-FILLED FIBERGLASS PLANT-BASED BINDER INFILL PANELS PROVIDE MAXIMUM SOUND CONTROL AND INSTALL FASTER.

SUBMITTALS

- 5.1 PRODUCT DATA: SUBMIT MANUFACTURER'S TECHNICAL DATA FOR EACH TYPE OF TECTUM FINALE PB CEILING OR WALLS REQUIRED.
- 5.2 SAMPLES: MINIMUM 12-INCH X 12-INCH SAMPLES OF SPECIFIED TECTUM FINALE PB INTERIOR PANELS.
- 5.3 SHOP DRAWINGS: LAYOUT AND DETAILS OF TECTUM FINALE PB INTERIOR PANELS SHOW LOCATIONS OF ITEMS THAT ARE TO BE COORDINATED WITH THE INSTALLATION AS REQUIRED.
- 5.4 COUNTRY OF ORIGIN: SUBMITTALS MUST BE ACCOMPANIED BY LETTER, LABEL, OR CERTIFICATION INDICATING THE MANUFACTURING COUNTRY OF ORIGIN. COMPLY WITH MADE IN USA REQUIREMENTS AS APPLICABLE FOR THE PROJECT.
- 5.5 CERTIFICATIONS: UL CERTIFICATIONS THAT PRODUCTS FACE MATERIAL ONLY COMPLIES WITH SPECIFIED REQUIREMENTS, INCLUDING LABORATORY REPORTS SHOWING COMPLIANCE WITH SPECIFIED TESTS AND STANDARDS. ACOUSTICAL PERFORMANCE, PRODUCTS MUST BE TESTED TO THE A AND D-20 METHODS.

QUALITY ASSURANCE

- 6.1 SINGLE-SOURCE RESPONSIBILITY: PROVIDE ACOUSTICAL PANEL UNITS AND GRID COMPONENTS BY A SINGLE MANUFACTURER.
- 6.2 FIRE PERFORMANCE CHARACTERISTICS: IDENTIFY ACOUSTICAL CEILING COMPONENTS WITH APPROPRIATE UL MARKINGS.
- A. Surface Burning Characteristics: Tested per ASTM E 84 (face material and furring) and complying with ASTM E 1264 Classification.

- 6.3 COORDINATION OF WORK: COORDINATE ACOUSTICAL CEILING WORK WITH INSTALLERS OF RELATED WORK INCLUDING, BUT NOT LIMITED TO BUILDING INSULATION, GYPSUM BOARD, LIGHT FIXTURES, MECHANICAL SYSTEMS, ELECTRICAL SYSTEMS, AND SPRINKLERS.

DELIVERY, STORAGE AND HANDLING

- 7.1 DELIVER ACOUSTICAL CEILING UNITS TO PROJECT SITE IN ORIGINAL, UNOPENED PACKAGES AND STORE THEM IN A FULLY ENCLOSED SPACE WHERE THEY WILL BE PROTECTED AGAINST DAMAGE FROM MOISTURE, DIRECT SUNLIGHT, SURFACE CONTAMINATION, AND OTHER CAUSES.
- 7.2 BEFORE INSTALLING ACOUSTICAL CEILING UNITS, PERMIT THEM TO REACH ROOM TEMPERATURE AND A STABILIZED MOISTURE CONTENT.
- 7.3 HANDLE ACOUSTICAL CEILING UNITS CAREFULLY TO AVOID CHIPPING EDGES OR DAMAGED UNITS IN ANY WAY.
- 7.4 PROVIDE LABELS INDICATING BRAND NAME, STYLE, SIZE, AND THICKNESS

PROJECT / SITE CONDITIONS

- 8.1 ENVIRONMENTAL REQUIREMENTS:
- A. Do not install ceiling panels until building is closed in and HVAC system is operational.
 - B. Locate materials onsite at least 72 hours before beginning installation to allow materials to reach temperature and moisture content equilibrium.
- 8.2 MAINTAIN THE FOLLOWING CONDITIONS IN AREAS WHERE ACOUSTICAL MATERIALS ARE TO BE INSTALLED 72 HOURS BEFORE, DURING, AND AFTER INSTALLATION:
- A. Relative Humidity: 25 – 85%
 - B. Uniform Temperature: 32 – 120 degrees F (0 – 49 degrees C)

WARRANTY

- 9.1 TECTUM FINALE PB CEILING AND WALL PANELS: SUBMIT A WRITTEN WARRANTY EXECUTED BY THE MANUFACTURER AGREEING TO REPAIR OR REPLACE PANELS THAT FAIL WITHIN THE WARRANTY PERIOD. FAILURES INCLUDE, BUT ARE NOT LIMITED TO THE FOLLOWING:
- A. Defects in materials or factory workmanship
- 9.2 TECTUM FINALE PB CEILING AND WALL PANELS WARRANTY: THIRTY (30) YEARS FROM DATE OF SUBSTANTIAL COMPLETION.
- 9.3 THE WARRANTY SHALL NOT DEPRIVE THE OWNER OF OTHER RIGHTS THE OWNER MAY HAVE UNDER OTHER PROVISIONS OF THE CONTRACT DOCUMENTS AND WILL BE IN ADDITION TO AND RUN CONCURRENT WITH OTHER WARRANTIES MADE BY THE CONTRACTOR UNDER THE REQUIREMENTS OF THE CONTRACT DOCUMENTS.

PART 1 PRODUCTS

- 10.1 MANUFACTURER
- 10.2 TECTUM FINALE PB CEILING AND WALL PANELS:
- A. Tectum by Armstrong World Industries, Inc.
- 10.3 SUSPENSION SYSTEM AND ACCESSORIES:
- A. Armstrong World Industries, Inc.

TECTUM FINALE PB CEILING AND WALL PANELS

11.1 ACOUSTICAL PANELS:

- A. Surface Texture: Coarse
- B. Composition: Aspen wood fibers bonded with inorganic hydraulic cement
- C. Finish: Surface appearance shall be consistent from panel to panel. Factory-applied latex paint with Sodium Silicate surface coating for abuse resistance. Natural (TNA) finish is unpainted.
- D. Color: As selected by Architect.
- E. Size: As indicated.
- F. Edge Profile: As selected by Architect.
- G. UL Classified Noise Reduction Coefficient (NRC) ASTM C 423: A Mounting – 0.80; D-20 Mounting – 0.85, Classified with UL label.
- H. UL Classified Flame Spread: ASTM E 1264; Class A. Product must be able to meet this criteria after being painted six (6) times.
- I. Light Reflectance (LR) ASTM E 1477: up to 0.75.
- J. Dimensional Stability / Mold Resistance: HumiGuard Plus and no significant mold growth when tested by ASTM D 3273
- K. Acceptable Product: Tectum Finale PB; as manufactured by Armstrong World Industries

METAL SUSPENSION SYSTEMS

12.1 TECTUM FINALE PB PANEL ACCESSORIES:

- A. Manufacturer's standard accessories as required for complete installation.

PART 2 EXECUTION

13.1 EXAMINATION

13.2 DO NOT PROCEED WITH INSTALLATION UNTIL ALL WET WORK SUCH AS CONCRETE, TERRAZZO, PLASTERING AND PAINTING HAS BEEN COMPLETED AND THOROUGHLY DRIED OUT, UNLESS EXPRESSLY PERMITTED BY MANUFACTURER'S PRINTED RECOMMENDATIONS.

PREPARATION

14.1 MEASURE EACH CEILING AND/OR WALL AREA AND ESTABLISH LAYOUT OF ACOUSTICAL UNITS. COORDINATE PANEL LAYOUT WITH MECHANICAL AND ELECTRICAL FIXTURES.

14.2 COORDINATION: FURNISH LAYOUTS FOR PRESET INSERTS, CLIPS, AND OTHER CEILING ANCHORS WHOSE INSTALLATION IS SPECIFIED IN OTHER SECTIONS.

- A. Furnish concrete inserts and similar devices to other trades for installation well in advance of time needed for coordination of other work.

INSTALLATION

15.1 INSTALL TECTUM FINALE PB CEILING AND WALL PANELS IN ACCORDANCE WITH MANUFACTURER'S INSTALLATION INSTRUCTIONS. SEE ARMSTRONGCEILINGS.COM/TECTUM FOR MORE INFORMATION.

15.2 FOR HIGH HUMIDITY INSTALLATIONS, USE ¾" PRESSURE TREATED WOOD FURRING STRIPS TO MAINTAIN AN AIR GAP BETWEEN STRUCTURE AND BACK OF THE TECTUM FINALE PB PANELS.

ADJUSTING AND CLEANING

16.1 REPLACE DAMAGED AND BROKEN TECTUM FINALE PB PANELS.

16.2 CLEAN EXPOSED SURFACES OF ACOUSTICAL CEILINGS INCLUDING TRIM, EDGE MOLDINGS, AND SUSPENSION MEMBERS. COMPLY WITH MANUFACTURER'S INSTRUCTIONS FOR CLEANING AND TOUCH UP OF MINOR FINISH DAMAGE. REMOVE ANY TECTUM FINALE PB CEILING/WALL PANELS THAT CANNOT BE SUCCESSFULLY CLEANED AND/OR REPAIRED. REPLACE WITH ATTIC STOCK OR NEW PRODUCT TO ELIMINATE EVIDENCE OF DAMAGE.

16.3 CLEANING AND DISINFECTING GUIDELINES

- A. Tectum Finale PB Panels are part of the Armstrong World Industries CleanAssure Family of Products. The CleanAssure family of products includes panels, suspension systems, and trim that can be disinfected using CDC recommended and EPA-approved disinfectants. Due to the potential impact on the finish, please follow the specific guidance below:
 - 1. It is recommended that only clear cleaners be used, as dyed liquids can permanently discolor the finish of the ceiling tiles.
 - 2. Cleaning is only recommended for the finished face of the board.
 - 3. The panels should never be soaked in water or other liquids, as this can have an adverse effect on board integrity. Use the safety recommendations for gloves and eye protection that are given by the manufacturer of the cleaner and cleaning equipment.
- B. Tectum Finale PB panels have been tested using the "Fog" disinfectant method; using Diversey – Morning Mist Neutral Disinfectant Cleaner - Diluted 2oz per gallon
- C. Disinfectant Method – FOG
 - 1. Use the equipment manufacturer's instructions regarding distance from the surface, protective gear, and ventilation.
 - 2. If another cleaner has been used in the fogging equipment, be sure to thoroughly clean the equipment before use to avoid potential contamination of the board surface with a non-compatible or staining cleaner.
 - 3. Remove any obvious dirt before evenly applying cleaner.
 - 4. Wipe dry with a clean, white microfiber cloth. Alternatively, the board may be air dried.
- D. Disclaimer: Cleaning conditions and aesthetics may be impacted by additional site conditions. These instructions pertain only to the maintenance of the aesthetics and integrity of Armstrong Ceiling Solutions products. Please consult the manufacturer's instructions and guidance regarding any cleaning product or disinfectant product for use and efficacy.

END OF SECTION

SECTION 095421
METAL PAN CEILINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Metal pan ceilings.
- B. Suspended metal support system and perimeter trim.

1.2 REFERENCE STANDARDS

- A. ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings 2022.
- B. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels 2019.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- D. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions 2022.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate work of this section with installation of mechanical and electrical components and with other construction activities affected by work of this section.
- B. Preinstallation Meeting: Convene one week before starting work of this section.
- C. Sequencing: Supply hanger clips during steel deck erection. Supply additional hangers and inserts as required.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Furnish for component profiles.
- C. Shop Drawings: Indicate reflected ceiling plan.
- D. Samples: Submit two samples 6 by 6 inch in size showing color and finish of components exposed to view.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.6 MOCK-UPS

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Construct in-place mock-up, 6 feet long by 6 feet wide minimum; include suspension system, panels, and closures.
- C. Locate mock-up where directed.
- D. Mock-up may remain as part of the work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Accept factory-finished products on site in manufacturer's unopened factory packaging; reject opened packages.
- B. Protect factory-finished products from damage by storing in manufacturer's unopened factory packaging in dry storage area.

1.8 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Metal Pan Ceilings:
 - 1. Armstrong World Industries, Inc; Metalworks Capz: www.armstrongceilings.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Suspension Systems:
 - 1. Armstrong World Industries, Inc: www.armstrongceilings.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.

2.2 PERFORMANCE REQUIREMENTS

- A. Design to support imposed loads of indicated elements without eccentric loading of supports. Where supported elements may induce rotation of ceiling system components, provide stabilizing reinforcement.
- B. Design for maximum deflection of 1/360 of span.
- C. Surface Burning Characteristics: Flame spread index of [____], smoke developed index of [____], when tested in accordance with ASTM E84.

2.3 METAL PAN CEILING ASSEMBLIES

- A. Metal Pan Ceiling System: Panels, suspension members, trim, and accessories as required to provide a complete system.
- B. Suspended Ceiling System: Individual panels suspended with tie wire; with finish edge trim.

2.4 SUSPENSION SYSTEM

- A. Metal Suspension Systems - General: Comply with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips, and splices as required.
 - 1. Materials:
 - a. Steel Suspension Wire: Manufacturer's standard suspension wire and installation accessories.

2.5 ACCESSORIES

- A. Sound-Absorptive Backer: Manufacturer's standard material, factory-laminated to backside of perforated panels in sufficient thickness to achieve specified NRC rating for panels.
 - 1. Thickness, Density, and Acoustical Performance: 1 inch thick with density of 1.5 pcf, for NRC 0.75.
- B. Perimeter Trim: Manufacturer's standard compatible trim.
 - 1. Acceptable Product:
 - a. Armstrong; Axiom.

2.6 FABRICATION

- A. Shop cut metal panels to accommodate mechanical and electrical items.
- B. Factory-form internal and external corners of same material, thickness, finish, and profile to match exposed metal panels.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that layout of hangers will not interfere with other work.
- C. Verify that field measurements are as indicated on shop drawings.
- D. Start of installation constitutes acceptance of project conditions.

3.2 PREPARATION

- A. Coordinate the location of hangers with other work.
- B. Install after major above-ceiling work is complete.

3.3 INSTALLATION - SUSPENSION SYSTEM:

- A. Install suspension system in accordance with ASTM C636/C636M, ASTM E580/E580M, and manufacturer's instructions and as supplemented by this section.
- B. Install hangers and inserts coordinated with overhead work. Provide additional hangers and supports as required.
- C. Suspension System, Nonseismic: Hang suspension system independent of walls, columns, ducts, pipes, and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- D. Where ducts, facility services, or equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- E. Do not eccentrically load system or induce rotation of runners.
- F. Edge Moldings: Install at intersection of ceiling and vertical surfaces and penetrations, using components of maximum length, set level.
 - 1. Use longest practical lengths.

3.4 INSTALLATION - METAL PANS

- A. Install panels and other system components in accordance with manufacturer's instructions.
- B. Install edge moldings at junctions with other finishes and at vertical surfaces; use maximum piece lengths.
- C. Exercise care when site cutting sight-exposed finished components to ensure surface finish is not defaced.
- D. Insulation: Install above panel members; fit tight between grid members ; place insulation with facing side down.

3.5 TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.
- C. Maximum Variation From Dimensioned Position: 1/4 inch.

3.6 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Clean surfaces.
- C. Replace damaged or abraded components.

END OF SECTION

SECTION 095423
LINEAR METAL CEILINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Linear metal ceilings.
- B. Suspended metal support system and perimeter trim.
- C. Supplementary insulation above ceiling.

1.2 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- B. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method 2022.
- C. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels 2019.
- D. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions 2022.

1.3 DESIGN REQUIREMENTS

- A. Design components to ensure light fixtures will not induce eccentric loads. Where components may induce rotation of ceiling system components, provide stabilizing reinforcement.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate work of this section with installation of mechanical and electrical components and with other construction activities affected by work of this section.
- B. Preinstallation Meeting: Convene one week before starting work of this section.
- C. Sequencing: Supply hanger clips during steel deck erection. Supply additional hangers and inserts as required.

1.5 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Furnish for component profiles.
- C. Samples: Submit two samples 6 by 6 inch in size illustrating color and finish of components exposed to view.
- D. Manufacturer's qualification statement.
- E. Installer's qualification statement.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in performing the work of this section.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc.

1.7 MOCK-UPS

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Construct in-place mock-up, 6 feet long by 6 feet wide, minimum; include suspension system, panels, closures in mock-up.
- C. Locate mock-up where directed.
- D. Mock-up may remain as part of the work.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.
- B. Accept factory-finished products on site in manufacturer's unopened factory packaging only; reject opened packages.
- C. Protect factory-finished products from damage to appearance by storing products in manufacturer's unopened factory packaging in dry storage area.

1.9 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 5-year manufacturer warranty; include coverage for corrosion resistance and discoloration of surface finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Linear Metal Ceilings:
 - 1. Armstrong World Industries, Inc; Metal Works: www.armstrongceilings.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.

2.2 LINEAR METAL CEILINGS

- A. Linear Metal Ceiling System: Panels, suspension members, trim, and accessories as required to provide a complete system.
- B. Performance Requirements:
 - 1. Design to support imposed loads of indicated items without eccentric loading of supports.
 - 2. Design for maximum deflection of 1/360 of span.
 - 3. Noise Reduction Coefficient (NRC): 0.70, measured in accordance with ASTM C423 with insulation installed.

2.3 COMPONENTS

- A. Linear Metal Panels:
 - 1. Type: Linear panel with filler strips; snap-in installation.
 - a. Size and Configuration: As indicated on drawings.
 - b. Panel Profile: Channel shaped with square edges.
 - c. Filler Strip: Manufacturer's standard recessed strip to fill space between panels.
- B. Acoustical Backer: Manufacturer's standard non-woven fabric; as required to achieve specified acoustic performance.
- C. Edge Molding, Expansion Joints, and Splices: Same material, thickness, and finish as linear panels.
- D. End Caps: Formed metal; same color and finish as sight-exposed surfaces of linear panels.
- E. Accessories: Stabilizer bars as required for suspended grid system; sight-exposed surfaces same color and finish as sight-exposed surfaces of linear panels.
- F. Suspension Members: Formed steel sections, with integral attachment points; galvanized finish; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
- G. Suspension Wire: Steel, annealed, galvanized finish, 9 gauge, 0.1144 inch diameter.
- H. Subgirt Members: Hot-dip galvanized steel sheet, ASTM A653/A653M, with G90/Z275 coating; formed to resist imposed loads and to provide attachment for linear ceiling and accessories.

2.4 FABRICATION

- A. Shop cut linear panels to accommodate mechanical and electrical items.
- B. Factory-form internal and external corners of same material, thickness, finish, and profile to match exposed linear panels ; back brace internal corners.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that layout of hangers will not interfere with other work.
- C. Verify that required utilities are available, in proper location, and ready for use.
- D. Verify that field measurements are as indicated.

3.2 INSTALLATION

- A. Suspension Components:
 - 1. Install after above-ceiling work is complete in accordance with manufacturer's instructions, ASTM C636/C636M, and ASTM E580/E580M.
 - 2. Hang carrying members independent of walls, columns, ducts, light fixtures, pipe, and conduit; where carrying members are spliced, avoid visible displacement of face panels with adjacent panels.
 - 3. Where ducts or other equipment prevent regular spacing of hangers, reinforce nearest adjacent hangers to span the required distance.
- B. Linear Metal Ceiling:
 - 1. Install linear panels and other system components in accordance with manufacturer's instructions.
 - 2. Butt interior end joints tight.
 - 3. Set exterior end joints with 1/16 inch gap for expansion and contraction.
 - 4. Provide expansion joints to accommodate plus or minus 1 inch movement and maintain visual closure.
 - 5. Field miter corners at changes in panel direction.
 - 6. Install filler strips between linear panels at interior locations.
 - 7. Install edge moldings at junctions with other finishes and at vertical surfaces; use maximum piece lengths.
 - 8. Install end caps at sight-exposed ends of linear panels.
 - 9. Exercise care when site cutting sight-exposed finished components to ensure surface finish is not defaced.
- C. Insulation: Install above panel members; fit tight between grid members ; place insulation with facing side down.

3.3 TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.
- C. Maximum Variation From Dimensioned Position: 1/4 inch.

3.4 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Clean surfaces.
- C. Replace damaged or abraded components.

END OF SECTION

**SECTION 096500
RESILIENT FLOORING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Static control resilient tile flooring.
- B. Resilient base.

1.2 REFERENCE STANDARDS

- A. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source 2019a, with Editorial Revision (2020).
- B. ASTM F1066 - Standard Specification for Vinyl Composition Floor Tile 2004 (Reapproved 2018).
- C. ASTM F1861 - Standard Specification for Resilient Wall Base 2021.
- D. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source 2023.

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- C. Shop Drawings: Indicate floor patterns.
- D. Selection Samples: Submit manufacturer's complete set of color samples for Architect's initial selection.
- E. Verification Samples: Submit two samples, in size illustrating color and pattern for each resilient flooring product specified.
- F. Concrete Testing Standard: Submit a copy of ASTM F710.
- G. Concrete Sub-floor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.
- H. Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of sub-floor is acceptable.
- I. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing specified flooring with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in installing specified flooring with minimum three years documented experience.
- C. Testing Agency Qualifications: Independent firm specializing in performing concrete slab moisture testing and inspections of the type specified in this section.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.
- B. Store all materials off of the floor in an acclimatized, weather-tight space.
- C. Maintain temperature in storage area between 55 degrees F and 90 degrees F.
- D. Protect roll materials from damage by storing on end.
- E. Do not double stack pallets.

1.6 FIELD CONDITIONS

- A. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

PART 2 PRODUCTS

2.1 TILE FLOORING

- A. Vinyl Plank Flooring (LVT): Meeting ASTM F 1700.
 - 1. Class: As indicated by product designations.
 - 2. Type: Type B, embossed surface.
 - 3. Thickness: 0.080 inch minimum, unless noted otherwise.
 - 4. Basis-of-Design Product: As scheduled.
- B. Static Control Tile: Homogeneous; color and pattern throughout thickness.
 - 1. Minimum Requirements: Vinyl composition tile complying with ASTM F1066, Class 2.
 - 2. Electrical Resistance:
 - a. Dissipative Tile: Resistance between 1.0 megohms and 1000 megohms as tested in accordance with ASTM F150.
 - 3. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
 - 4. Tile Size: 12 by 12 inch.
 - 5. Total Thickness: 0.125 inch.
 - 6. Acceptable Products: As scheduled.

2.2 RESILIENT BASE

- A. Resilient Base: ASTM F1861, Type TP, rubber, thermoplastic; top set Style B, Cove.
 - 1. Manufacturers:
 - a. Johnsonite, a Tarkett Company: www.johnsonite.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
 - 2. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E648 or NFPA 253.
 - 3. Height: 4 inch.
 - 4. Thickness: 0.125 inch.
 - 5. Finish: Satin.
 - 6. Length: Roll.
 - 7. Color: To be selected by Architect from manufacturer's full range.
 - 8. Accessories: Premolded external corners and internal corners.
 - 9. Acceptable Products: As scheduled.

2.3 ACCESSORIES

- A. Subfloor Filler: White premix latex; type recommended by adhesive material manufacturer.
- B. Primers and Adhesives: Waterproof; types recommended by flooring manufacturer.
- C. Moldings, Transition and Edge Strips: Same material as flooring.
- D. Copper Grounding Strips: Type and size as recommended by static control flooring manufacturer.
- E. Floor Polish for Static Control Flooring: Fluid-applied polish, intended to protect electrical properties of flooring, as recommended by static control flooring manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.
- C. Cementitious Sub-floor Surfaces: Verify that substrates are dry enough and ready for resilient flooring installation by testing for moisture and pH.
 - 1. Test in accordance with ASTM F710.

2. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.
- D. Verify that required floor-mounted utilities are in correct location.

3.2 PREPARATION

- A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- B. Remove sub-floor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with sub-floor filler to achieve smooth, flat, hard surface.
- C. Prohibit traffic until filler is fully cured.
- D. Clean substrate.
- E. Apply primer as required to prevent "bleed-through" or interference with adhesion by substances that cannot be removed.

3.3 INSTALLATION - GENERAL

- A. Starting installation constitutes acceptance of sub-floor conditions.
- B. Install in accordance with manufacturer's written instructions.
- C. Spread only enough adhesive to permit installation of materials before initial set.
- D. Place copper grounding strip in conductive adhesive and apply additional adhesive to top side of strip before installing static control flooring. Allow strip to extend beyond flooring in accordance with static control flooring manufacturer's instructions.
- E. Fit joints and butt seams tightly.
- F. Set flooring in place, press with heavy roller to attain full adhesion.
- G. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.
- H. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
 1. Resilient Strips: Attach to substrate using adhesive.
- I. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

3.4 INSTALLATION - TILE FLOORING

- A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.
- B. Tile Pattern: As indicated.
- C. Install plank tile with a random offset of at least 6 inches from adjacent rows.

3.5 INSTALLATION - RESILIENT BASE

- A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.
- B. Miter internal corners. At external corners, use premolded units. At exposed ends, use premolded units.
- C. Install base on solid backing. Bond tightly to wall and floor surfaces.
- D. Scribe and fit to door frames and other interruptions.

3.6 CLEANING

- A. Remove excess adhesive from floor, base, and wall surfaces without damage.
- B. Clean in accordance with manufacturer's written instructions.

3.7 PROTECTION

- A. Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION

**SECTION 096813
TILE CARPETING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Carpet tile, fully adhered.

1.2 REFERENCE STANDARDS

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- C. Shop Drawings: Indicate layout of joints and direction of carpet pile.
- D. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.
- E. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- F. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Carpet Tiles: Quantity equal to 5 percent of total installed of each color and pattern installed.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing specified carpet tile with minimum three years documented experience.
- B. Installer Qualifications: Company specializing in installing carpet tile with minimum three years documented experience and approved by carpet tile manufacturer.

1.5 FIELD CONDITIONS

- A. Store materials in area of installation for minimum period of 24 hours prior to installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Tile Carpeting:
 - 1. J+J Flooring: www.jjflooring.com.
 - 2. Substitutions: See Section 016000 - Product Requirements.

2.2 MATERIALS

- A. Products:
 - 1. As scheduled.

2.3 ACCESSORIES

- A. Sub-Floor Filler: White premix latex; type recommended by flooring material manufacturer.
- B. Edge Strips: Embossed aluminum, color as selected by Architect.
- C. Carpet Tile Adhesive: Recommended by carpet tile manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that sub-floor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.

- B. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to sub-floor surfaces.
- C. Cementitious Sub-floor Surfaces: Verify that substrates are dry enough and ready for flooring installation by testing for moisture and pH.
 - 1. Test in accordance with ASTM F710.
 - 2. Obtain instructions if test results are not within limits recommended by flooring material manufacturer and adhesive materials manufacturer.
- D. Verify that required floor-mounted utilities are in correct location.

3.2 PREPARATION

- A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- B. Remove sub-floor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with sub-floor filler.
- C. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.
- D. Vacuum clean substrate.

3.3 INSTALLATION

- A. Starting installation constitutes acceptance of sub-floor conditions.
- B. Install carpet tile in accordance with manufacturer's instructions.
- C. Blend carpet from different cartons to ensure minimal variation in color match.
- D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.
- E. Lay carpet tile in square pattern, with pile direction parallel to next unit, set parallel to building lines.
- F. Fully adhere carpet tile to substrate.
- G. Trim carpet tile neatly at walls and around interruptions.
- H. Complete installation of edge strips, concealing exposed edges.

3.4 CLEANING

- A. Remove excess adhesive without damage, from floor, base, and wall surfaces.
- B. Clean and vacuum carpet surfaces.

END OF SECTION

**SECTION 096900
ACCESS FLOORING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Adjustable height access flooring systems.

1.2 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design 2010.
- B. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures Most Recent Edition Cited by Referring Code or Reference Standard.
- C. CISCA (AF) - Recommended Test Procedures for Access Floors 2016.
- D. ICC (IBC) - International Building Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. ICC A117.1 - Accessible and Usable Buildings and Facilities 2017.
- F. ICC-ES AC300 - Acceptance Criteria for Access Floors 2010, with Editorial Revision (2014).
- G. NFPA 75 - Standard for the Fire Protection of Information Technology Equipment 2020.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week before starting work of this section.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's data sheets including loading capacities, materials, finishes, dimensions of components, profiles, and accessories.
- C. Shop Drawings: Indicate floor layout, appurtenances or interruptions, edge details, ramps.
- D. Samples: Submit two samples of floor grid and panel, 6 by 6 inch in size illustrating finish.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Manufacturer's Instructions: Indicate special procedures, perimeter conditions requiring special attention .
- G. Designer's Qualification Statement.
- H. Manufacturer's Qualification Statement.
- I. Installer's Qualification Statement.
- J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Materials: Supply an additional 5 (five) percent of access flooring system components.
 - 3. Panel Lifting Devices: One, of manufacturer's standard type.

1.5 QUALITY ASSURANCE

- A. Designer Qualifications: Design floor system structure layout for this project under direct supervision of a Professional Structural Engineer experienced in design of floors of the type required and licensed in the State in which the Project is located.
- B. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum three years of documented experience.
- C. Installer Qualifications: Company specializing in performing the type of work required in this section and approved by access flooring manufacturer.

1.6 MOCK-UP

- A. Construct access flooring system mock-up, minimum 5 panels long by 5 panels wide, showing specified components and accessories.
- B. Locate where directed.
- C. Mock-up may remain as part of the Work.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Access Flooring - Adjustable Height:
 - 1. Global IFS: [www.global IFS.com/#sle](http://www.globalIFS.com/#sle).
 - 2. Haworth, Inc.: www.haworth.com.
 - 3. Tate Access Floors, Inc: www.tateaccessfloors.com/#sle.
 - 4. Substitutions: See Section 016000 - Product Requirements.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Comply with the following system requirements and as indicated for specified components.
 - 1. Test in accordance with CISCA (AF).
 - 2. Comply with requirements of NFPA 75.
 - 3. Comply with requirements of ICC-ES AC300.
 - 4. Accessibility: Comply with ICC A117.1 and ADA Standards.
 - 5. Structural Design Live Loads: Comply with requirements of ICC (IBC).
 - a. Uniformly Distributed Loads: In compliance with ICC (IBC) Table 1607.1, for access floor systems.
 - 1) Office Use: 50 pounds per sq ft.
 - 2) Computer Use: 100 pounds per sq ft.
 - b. Concentrated Loads: Over an area of 2 feet by 2 feet, 2000 pounds minimum, in compliance with ICC (IBC) Table 1607.1, for access floor systems.
 - 6. Seismic Performance: Access flooring designed to withstand effects of earthquake motions determined according to ASCE 7.
 - 7. Lateral Stability: Design system for lateral stability in all directions, with or without panels in place.

2.3 ACCESS FLOORING - ADJUSTABLE HEIGHT

- A. Factory-fabricated system consisting of removable floor panels and supporting understructure that allows access to space below floor without requiring removal of panels other than the one directly above the space to which access is needed; provide components and accessories required for complete installation.
- B. Configuration:
 - 1. Bolted panels on stringerless understructure.
- C. Components:
 - 1. Pedestal Assembly:
 - a. Material: Steel.
 - b. Finish: Galvanized.
 - c. Base: Manufacturer's standard shape and size in accordance with system performance requirements.
 - d. Column: Threaded supporting rod to permit 1-1/2 inch adjustment.
 - e. Head: Manufacturer's standard shape and size to accept specified configuration.
 - f. Maximum Pedestal Axial Load: 5000 pounds without permanent deformation, when tested in accordance with CISCA (AF).
 - 2. Floor Panels:
 - a. Construction:
 - 1) Concrete core laminated with sheet steel plates.
 - 3. Floor Covering: Field applied, as indicated.
 - a. Resilient Tile: As specified in Section 096500.

2.4 ACCESSORIES - ADJUSTABLE HEIGHT

- A. Ramps: Same materials, structural strength, and construction as floor panels; flush extruded aluminum cover plates at junction with floor system.
 - 1. Ramp Surface: Sheet rubber; single color as selected.
- B. Railings: Manufacturer's standard.
- C. Air Grilles: Galvanized steel sheet; with straight vanes and shut-off damper; with integral fire damper.

- D. Electrostatic Grounding Connectors: Solid copper.
- E. Cable Cutout Protection: Manufacturer's standard type, self-extinguishing.
- F. Gaskets: Closed cell sponge rubber, preformed to suit.
- G. Wall Base: Extruded plastic angles.
- H. Sealant: Any water-based, moisture-curing, or chemically-curing joint sealant suitable for purpose and compatible with materials being sealed; except acrylic latex emulsion.

2.5 FABRICATION

- A. Fabrication Tolerances:
 - 1. Floor Panel Flatness: Plus or minus 0.02 inch in any direction.
 - 2. Floor Panel Width or Length From Specified Size: Plus or minus 0.02 inch.
 - 3. Floor Panel Squareness: Plus or minus 0.03 inch difference between opposite diagonal dimensions.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify field measurements are as indicated on shop drawings.
- B. Verify that substrates comply with tolerances, dimensioned clearances, and other requirements specified in other sections, and that substrates are clean, dry, and free of conditions and deleterious substances that might interfere with system installation.
- C. Verify that required utilities are available, in proper location, and are ready for use.
- D. Start of installation constitutes acceptance of project conditions.

3.2 PREPARATION

- A. Vacuum clean substrate surfaces.

3.3 INSTALLATION - ADJUSTABLE HEIGHT ACCESS FLOORING

- A. Install components in accordance with manufacturer's instructions.
- B. Secure pedestal base plate to subfloor with adhesive.
- C. Install additional base units where grid pattern is interrupted by room appurtenances or at cut-outs.
- D. Install grilles as indicated on drawings.
- E. Close field cut floor panels with edge trim.
- F. Cut holes in floor panels to accommodate Owner equipment as indicated on drawings. Provide cable cut-out protection.
- G. Provide floor with edge trim and end closures. Provide lateral braces at stair edges and other locations where pedestals are not braced.
- H. Provide gaskets and sealant to ensure airtight seal where holes are cut in elevated floor for penetration of cable.
- I. Provide positive electrical earth grounding of entire floor assembly in accordance with NFPA 75.
- J. Railings:
 - 1. Extend railing posts through floor panels to structural floor; secure to flange fittings anchored to structural floor.
 - 2. Brace posts in position at floor panels with floor collar retainers.
 - 3. Electrically ground railings to floor system.

3.4 TOLERANCES

- A. Maximum Out of Level Floor Panel Tolerance: 1/16 inch in 10 ft, non-cumulative.

3.5 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.

- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

3.6 ADJUSTING

- A. Adjust pedestals to achieve a level floor and to assure adjacent floor panel surfaces are flush.

3.7 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals, for closeout submittals.
- B. Demonstration and Training:
 - 1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain access flooring system.
 - 2. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 3. Provide minimum of two hours of training.

3.8 PROTECTION

- A. Do not permit traffic over unprotected floor surface.

END OF SECTION

**SECTION 097200
WALL COVERINGS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Surface preparation.
- B. Wall covering for wall applications.

1.2 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- B. ASTM F793/F793M - Standard Classification of Wall Coverings by Use Characteristics 2020.

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on wall covering and adhesive.
- C. Shop Drawings: Indicate wall elevations with seaming layout.
- D. Samples: Submit two samples of wall covering in size illustrating color, finish, and texture.
- E. Test Reports: Indicate verification of flame and smoke ratings, when tested by UL.
- F. Manufacturer's Installation Instructions: Indicate special procedures.
- G. Maintenance Data: Submit data on cleaning, touch-up, and repair of covered surfaces.
- H. Manufacturer's Qualification Statement.
- I. Installer's Qualification Statement.
- J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Wall Covering Materials: 25 linear feet of each color and pattern of wall covering; store where directed.
 - 3. Package and label each roll by manufacturer, color and pattern, and destination room number.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.5 MOCK-UPS

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Provide panel, 2 panel drops wide, full height, illustrating installed wall covering and joint seaming technique.
- C. Locate where directed.
- D. Mock-up may remain as part of the Work.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Inspect roll materials at arrival on site, to verify acceptability.
- B. Protect packaged adhesive from temperature cycling and cold temperatures.
- C. Do not store roll goods on end.

1.7 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the adhesive or wall covering product manufacturer.
- B. Maintain these conditions 24 hours before, during, and after installation of adhesive and wall covering.
- C. Provide lighting level of 80 ft candles measured mid-height at substrate surfaces.

PART 2 PRODUCTS

2.1 WALL COVERINGS

- A. General Requirements:
 - 1. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84.
- B. Wall Covering: Fabric-backed vinyl roll stock.
 - 1. Comply with ASTM F793/F793M, Category V, Type II.
 - 2. Provide digitally printed custom graphic wall covering on feature wall as indicated. Coordinate with Architect.
 - 3. Acceptable Products: As scheduled.
- C. Adhesive: Type recommended by wall covering manufacturer to suit application to substrate.
- D. Substrate Filler: As recommended by adhesive and wall covering manufacturers; compatible with substrate.
- E. Substrate Primer and Sealer: Alkyd enamel type.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that substrate surfaces are prime painted and ready to receive work, and comply with requirements of wall covering manufacturer.
- B. Measure moisture content of surfaces using an electronic moisture meter. Do not apply wall coverings if moisture content of substrate exceeds level recommended by wall covering manufacturer.
- C. Verify flatness tolerance of surfaces does not vary more than 1/8 inch in 10 feet nor vary at a rate greater than 1/16 inch/ft.

3.2 PREPARATION

- A. Fill cracks in substrate and smooth irregularities with filler; sand smooth.
- B. Wash impervious surfaces with tetra-sodium phosphate, rinse and neutralize; wipe dry.
- C. Surface Appurtenances: Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.
- D. Surfaces: Correct defects and clean surfaces that affect work of this section. Remove existing coatings that exhibit loose surface defects.
- E. Marks: Seal with shellac those that may bleed through surface finishes.
- F. Apply one coat of primer sealer to substrate surfaces. Allow to dry. Lightly sand smooth.
- G. Vacuum clean surfaces free of loose particles.

3.3 INSTALLATION

- A. Apply adhesive and wall covering in accordance with manufacturer's instructions.
- B. Apply adhesive to wall surface immediately prior to application of wall covering.
- C. Razor trim edges on flat work table. Do not razor cut on gypsum board surfaces.
- D. Apply wall covering smooth, without wrinkles, gaps or overlaps. Eliminate air pockets and ensure full bond to substrate surface.
- E. Butt edges tightly.
- F. Horizontal seams are not acceptable.
- G. Do not seam within 2 inches of internal corners or within 6 inches of external corners.
- H. Install wall covering before installation of bases and items attached to or spaced slightly from wall surface.
- I. Do not install wall covering more than 1/4 inch below top of resilient base.
- J. Cover spaces above and below windows, above doors, in pattern sequence from roll.
- K. Apply wall covering to electrical wall plates prior to replacing.
- L. Where wall covering tucks into reveals, or metal wallboard or plaster stops, apply with contact adhesive within 6 inches of wall covering termination. Ensure full contact bond.

- M. Install termination trim.
- N. Remove excess adhesive while wet from seam before proceeding to next wall covering sheet. Wipe clean with dry cloth.

3.4 CLEANING

- A. Clean wall coverings of excess adhesive, dust, dirt, and other contaminants.
- B. Reinstall wall plates and accessories removed prior to work of this section.

3.5 PROTECTION

- A. Do not permit construction activities at or near finished wall covering areas.

END OF SECTION

**SECTION 099100
PAINTING**

PART 1 - GENERAL

1.1 SUMMARY

- A. Related Documents: General and Supplementary Conditions of the Contract, Division 01 General Requirements, and Drawings are applicable to this Section.
- B. Section Includes:
 - 1. Complete surface preparation and finishing for field application of coatings and requirements for field finishing mechanical and electrical equipment.
 - 2. Examine specifications for various other trades and their provisions regarding their painting. Surfaces that are left unfinished by other sections of the specifications shall be painted or finished as a part of this Section.
 - 3. Colors, including deep tones, will be selected by the Architect. Number of colors to be used on job will be determined by Architect.

1.2 SURFACES NOT TO RECEIVE FIELD FINISHING

- A. Do not paint copper, bronze, chrome plated items, nickel, stainless steel, Monel metal, lead, face brick, prefinished wall, ceiling, and floor coverings, items with factory applied final finish (except where exposed on roofs and in finished spaces), elevator shafts, crawl spaces, chases, and plenums above suspended ceilings unless otherwise specified or scheduled.

1.3 DEFINITIONS

- A. Conform to ASTM D16 for interpretation of terms used in this Section.

1.4 QUALITY ASSURANCE

- A. Product Manufacturer: Company specializing in manufacturing quality paint and finish products with 3 years' experience.
- B. Applicator: Company specializing in commercial painting and finishing with 2 years' experience.
- C. Product Labels: Include manufacturer's name, type of paint, stock number, color and label analysis on label of containers.

1.5 REGULATORY REQUIREMENTS

- A. Conform to applicable building code for flame spread/fuel contribution/smoke development rating requirements for finishes.
- B. Comply with applicable city, county, state, and federal requirements and ordinances regarding maximum VOC (Volatile Organic Compound) content of all coatings.

1.6 TESTS

- A. Provide periodic testing with Wet Film Thickness gage to verify that proper thickness of finish coatings are being applied.

1.7 SUBMITTALS

- A. Provide product data describing physical performance criteria and composition on all finishing products.
- B. Submit 2 samples, 12 by 12 inches in size illustrating range of colors and textures selected for each surface finishing product scheduled.
- C. Submit certification from manufacturer of coatings listing all products proposed for each. Certify that each product meets current applicable regulations and ordinances regarding maximum VOC content.

1.8 FIELD SAMPLES

- A. Provide field sample panel, 96 inches long by 96 inches wide, illustrating each coating color, texture, and finish intended for use.

- B. Locate where directed.
- C. Accepted sample may remain as part of the Work.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and protect products under provisions of Division 01 section "Product Requirements"
- B. Deliver products to site in sealed and labeled containers; inspect to verify acceptance.
- C. Container labeling to include manufacturer's name, type of paint, brand name, brand code, coverage, surface preparation, drying time, cleanup, color designation, and instructions for mixing and reducing.
- D. Store paint materials at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in well-ventilated area, unless required otherwise by manufacturer's instructions.
- E. Take precautionary measures to prevent fire hazards and spontaneous combustion.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply materials when surface and ambient temperatures are outside the ranges required by paint manufacturer.
- B. Provide continuous ventilation and heating facilities to maintain surface and ambient temperatures above 45 degrees F for 24 hours before, during, and 48 hours after application of finishes, unless required otherwise by manufacturer's instructions.
- C. Do not apply exterior coatings during rain or snow, or when relative humidity is above 75 percent, unless required otherwise by manufacturer's instructions.
- D. Minimum Application Temperatures for Latex Paints: 45 degrees F for interiors; 50 degrees F for exterior; unless required otherwise by manufacturer's instructions.
- E. Minimum Application Temperature for Varnish and Finishes: 65 degrees F for interior or exterior, unless required otherwise by manufacturer's instructions.
- F. Provide lighting level of 80 ft candles measured mid- height at substrate surface.

1.11 EXTRA STOCK

- A. Provide a 5 gallon container of each color to Owner.
- B. Label each container with color, color number, texture, and room locations, in addition to the manufacturer's label.
- C. Furnish under provisions of Section 017000.

1.12 SCAFFOLDS AND PROTECTION

- A. Provide adequate safe ladders, scaffolds, and stages necessary to complete work.
- B. Protect completed finish and paint work, and protect adjacent finish surfaces from paint splatter, spills and stains. Use adequate drop cloths and masking procedures during progress of work.

1.13 PRECAUTIONS

- A. Do not store paints, oils, thinners and other flammable items inside the building and shall be stored in approved containers when not in actual use during the painting job. The fire hazard shall be kept at a minimum.
- B. Precaution shall be taken to protect the public and construction workers during the progress of the work.
- C. Furnish a temporary fire extinguisher of suitable chemicals and capacity, located near flammable materials.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements indicated, provide products of one of the following:
 - 1. Sherwin-Williams.
 - 2. P.P.G. Industries.
 - 3. Behr Process Corporation (Behr).

4. Benjamin Moore.

- B. Materials selected for coating systems for each type surface shall be product of a single manufacturer unless otherwise specified. Secondary products such as linseed oil, turpentine and shellacs shall be first quality products of a reputable manufacturer.

2.2 MATERIALS

- A. Coatings: Ready mixed. Process pigments to a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating with good flow and brushing properties; capable of drying or curing free of streaks or sags.
- B. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified, of commercial quality.
- C. Patching Materials: Latex filler.

2.3 FINISHES

- A. Color and Sheen: As scheduled.

2.4 INTERIOR PAINT SCHEDULE

- A. Drywall (Gypsum):
1. Acrylic Latex:
 - a. PPG Paints: 1 coat PPG Paints Speedhide Zero VOC Primer 6-4900XI, 2 coats PPG Paints Speedhide Zero VOC. Sheen as indicated.
 - b. Sherwin-Williams: 1 coat High Build Latex Primer B28W8601, 2 coats Sherwin-Williams ProMar 200 Zero VOC. Sheen as indicated.
 - c. Behr: 1 coat Behr Premium Plus Interior Drywall Primer 73, 2 coats Behr Pro i300 Interior Paint. Sheen as indicated.
 - B. Galvanized Metal:
 1. High Performance Coating, Water Based Acrylic
 - a. PPG Paints: 1 coat DEVFLEX Direct-to-Metal 4020 primer
 - 1) Flat: 2 Coats DEVLFEY 4020 Primer/Finish.
 - 2) Eggshell: 2 coats DEVFLEX High Performance WB Acrylic 4212 topcoat.
 - 3) Semi-Gloss: 2 coats DEVFLEX High Performance WB Acrylic 4216 topcoat.
 - b. Sherwin-Williams:
 - 1) Flat: 2 coats Sherwin-Williams Pro-Cryl Universal Primer B66-310 Series,
 - 2) Eg-Shel 2 coats Sherwin-Williams Pro Industrial Acrylic Eg-Shel B66-660 Series.
 - 3) Semi-Gloss 2 coats Sherwin-Williams Pro Industrial Acrylic Semi-Gloss B66-650 Series.
 - c. Behr: 1 coat Behr Premium Plus Multi-Surface Primer & Sealer 436.
 - 1) Flat: 2 coats Premium Plus Ultra Interior Matte 1750 topcoat.
 - 2) Eggshell: 2 coats Premium Plus Ultra Eggshell 2750 topcoat.
 - 3) Semi-Gloss: 2 coats Direct To Metal Semi-Gloss 3200 topcoat.
 - C. Shop Primed Ferrous Metal:
 1. High Performance Coating, Water-Based Acrylic:
 - a. PPG Paints: Eggshell: 2 topcoats DEVFLEX High Performance WB Acrylic Eggshell 4212 over prepared substrate. Test for adhesion.
 - b. 2 topcoats Sherwin-Williams Pro Industrial Eg-Shel B66-660 Series.
 - c. Behr: Eggshell: 1 coat Premium Plus Multi-Surface Primer & Sealer, 2 coats Premium Plus Ultra Eggshell 2750 topcoat.
 - D. Decking (Ferrous Unprimed), Bar Joists (Unprimed):
 1. Water-Based Acrylic Dry Fall:
 - a. PPG Paints: 1 coat Pitt-Tech Int/Ext Primer/Finish DTM Industrial Enamel 90-712, 2 coats Speedhide Super Tech WB Dry Fall Flat 6-725XI topcoat.
 - b. Sherwin-Williams: 1 coat Pro-Cryl Universal Primer B66-310 Series, 2 coats Sherwin-Williams Pro Industrial Waterborne Acrylic Dryfall B42W181.
 - c. Behr: 1 coat Behr Premium Plus Multi-Surface Primer & Sealer 436, 2 coats Behr Pro Dryfall 890.

- E. Decking (Pre-primed/Prefinished), Bar Joists (Shop Primed):
 - 1. Water-Based Acrylic Dry Fall:
 - a. PPG Paints: 2 topcoats Speedhide Super Tech WB Dry Fall Flat 6-725XI over prepared substrate.
 - b. Sherwin-Williams: 2 coats Pro Industrial Waterborne Acrylic Dryfall B42W181 over Prepared substrate.
 - c. Behr: 2 coats Behr Pro Dryfall 890 over prepared substrate.
- F. Decking (Galvanized):
 - 1. Water-Based Acrylic Dry Fall:
 - a. PPG Paints: 2 topcoats Speedhide Super Tech WB Dry Fall Flat 6-725XI over prepared substrate.
 - b. Sherwin-Williams: 2 coats Pro Industrial Waterborne Acrylic Dryfall B42W181 over prepared substrate.
 - c. Behr: 2 coats Behr Pro Dryfall 890 over prepared surface.

2.5 EXTERIOR PAINT SCHEDULE

- A. Structural Iron and Ferrous Steel:
 - 1. High Performance Coating, Water-Based Acrylic:
 - a. PPG Paints: Flat: 1 coat DEVFLEX Direct-to-Metal 4020 primer, 2 coats DEVFLEX Direct-to-Metal 4020 Primer/Finish topcoat.
 - b. Sherwin-Williams: 2 coats Sherwin-Williams DTM Primer/Finish B66W1.
 - c. PPG Paints: Eggshell: 1 coat DEVFLEX Direct-to-Metal 4020 primer, 2 coats DEVFLEX High Performance WB Acrylic Satin 4212 topcoat.
 - d. Sherwin-Williams: 1 coat Pro-Cryl Universal Primer B66-310 Series, 2 coats Sherwin-Williams Pro Industrial Acrylic Eg-Shel B66-660 Series.
 - e. PPG Paints: Semi-Gloss: 1 coat DEVFLEX Direct-to-Metal 4020 primer, 2 coats DEVFLEX High Performance WB Semi-Gloss Acrylic 4216 topcoat.
 - f. Sherwin-Williams: 1 coat Pro-Cryl Universal Primer B66-310 Series, 2 coats Sherwin-Williams Pro Industrial Acrylic Semi-Gloss B66-650 Series.
 - g. Behr: Semi-Gloss: 1 coat Behr Premium Plus Multi-Surface Primer & Sealer 436, 2 coats Behr Direct To Metal Semi-Gloss 3200 topcoat.
- B. Shop Primed Metal Doors, Trim, Panels and Miscellaneous Surfaces:
 - 1. High Performance Coating, Urethane: (rust inhibitive, UV stable)
 - a. PPG Paints: Gloss: 1 coat Pitt-Guard Direct-To-Rust Epoxy Mastic Coatings 97-145, 2 coats Pitthane Ultra Gloss Urethane 95 Series.
 - b. Sherwin-Williams: 1 coat Macropoxy 646 Fast Cure Epoxy B58-600 Series, 2 coats Acrolon 218 HS Acrylic Polyurethane B65-650 topcoat.
 - c. Behr: 1 coat US Coatings EpoxyGrip 2000 Epoxy Mastic, 2 coats US Coatings UreGrip 3000 Aliphatic Acrylic Urethane Gloss topcoat.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces and substrate conditions are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report to Architect any condition that may potentially affect proper application.
- C. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums
 - 1. Plaster and Gypsum Wallboard: 12 percent.
 - 2. Interior Located Wood: 15 percent, measured in accordance with ASTM D2016.
- D. Test shop applied primers for compatibility with subsequent cover materials.
- E. Beginning of installation means acceptance of existing surfaces and substrate.

3.2 PREPARATION

- A. Remove electrical plates, hardware, light fixture trim, and fittings prior to preparing surfaces or finishing.
- B. Correct minor defects and clean surfaces which affect work of this Section. Remove existing coatings which exhibit loose surface defects.
- C. Impervious Surfaces: Remove mildew by scrubbing with solution of tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- D. Galvanized Surfaces: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.
- E. Uncoated Steel and Iron Surfaces: Remove grease, scale, dirt, and rust. Where heavy coatings of scale are evident, remove by wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Spot prime paint after repairs.
- F. Shop Primed Steel Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.
- G. Wood and Metal Doors Scheduled for Painting: Seal top and bottom edges with primer.

3.3 PROTECTION

- A. Protect elements surrounding the work of this Section from damage or disfiguration.
- B. Repair damage to other surfaces caused by work of this Section.
- C. Furnish drop cloths, shields, and protective methods to prevent spray or droppings from disfiguring other surfaces.
- D. Remove empty paint containers from site.

3.4 APPLICATION

- A. The intent of these Specifications is to produce the highest quality appearance of paint and finish surfaces. Employ skilled mechanics only. The proper preparation of all surfaces will be strictly enforced and wherever finished surfaces show any defects due to improper preparation, workmanship, etc., the defects shall be removed and the work refinished at the expense of the Contractor.
- B. Apply products in accordance with manufacturer's instructions. Final finish coats shall have visual evidence of solid hiding and uniform appearance, and shall be free and smooth of brush marks, streaks, sags, runs, laps, or skipped areas.
- C. Do not apply finishes to surfaces that are not dry.
- D. Apply each coat to uniform finish and thickness.
- E. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.
- F. Sand lightly between coats on wood and metal items to achieve required finish.
- G. Allow applied coat to dry before next coat is applied.
- H. Where clear finishes are required, tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.
- I. Prime back surfaces of interior and exterior woodwork scheduled to be painted with primer paint.
- J. Prime back surfaces of interior woodwork scheduled to receive stain or varnish finish with gloss varnish reduced 25 percent with mineral spirits.
- K. Edges of paint adjoining other materials or colors shall be sharp and clean with no overlapping.

3.5 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

- A. Paint all shop primed equipment. Paint shop prefinished items where exposed to view in finished spaces. In mechanical rooms, repair shop pre-finished coatings which have been scratched or otherwise damaged with identical touch-up paint. Sand prior to touching up as required.
- B. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- C. Paint all grilles, registers, diffusers, and speaker grilles to match adjacent wall and ceiling surfaces, except that factory pre-finished items need not be painted if installed in a suspended acoustical ceiling system where the acoustical panels match the mechanical or electrical item color.

- D. In all finished spaces, prime and paint exposed pipes, conduit, boxes, ducts, hangers, brackets, collars and supports. Paint to match adjacent surfaces.
- E. Repair or replace identification markings on mechanical or electrical equipment when painted accidentally.
- F. Paint interior surfaces of air ducts and convectors that are visible through grilles and louvers with one coat of flat black paint, to limit of sight line. Paint dampers exposed behind louvers, grilles, and convector to match face panels.
- G. Paint all surfaces of plywood backboards for electrical and telephone equipment before installing equipment.
- H. Replace electrical plates, hardware, light fixture trim, and fittings removed prior to finishing.
- I. Paint exposed air handlers, roof ventilators, goose necks, exhaust fans and other items on the roof with 2 coats exterior enamel. Prepare surfaces in accordance with the base metal or primer as specified herein.
- J. Paint concrete support bases with gray floor deck enamel.
- K. Pipe hangers and other supports need not be painted except where installed in crawl spaces, where they shall be painted with a thick coat of asphaltic paint.

3.6 CLEANING/TOUCH-UP

- A. As Work proceeds, promptly remove paint where spilled, splashed, or spattered.
- B. During progress of Work maintain premises free of unnecessary accumulation of tools, equipment, surplus materials, and debris.
- C. Collect cotton waste, cloths, and material which may constitute a fire hazard, place in closed metal containers and remove daily from site.
- D. Spot painting will be allowed to correct soiled or damaged paint surfaces only when touch-up spot will blend into surrounding finish and is invisible to normal viewing (as determined by the Architect). Otherwise, re-coat entire section to corners or to a visible stopping point.

3.7 V.O.C. (VOLATILE ORGANIC COMPOUND) COMPLIANCE

- A. Products listed in following schedule and/or substitutes proposed for use by Contractor must be formulated to meet all applicable ordinances and regulations regarding maximum V.O.C. content. Utilize products which have been specially formulated to meet such requirements.

END OF SECTION 099100

1.1 SECTION 101400
SIGNAGE

PART 1 GENERAL

2.1 SECTION INCLUDES

- A. Code required signage.

2.2 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines current edition.
- B. ADA Standards - 2010 ADA Standards for Accessible Design 2010.
- C. ICC A117.1 - Accessible and Usable Buildings and Facilities 2017.

2.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's printed product literature for each type of sign, indicating sign styles, font, foreground and background colors, locations, overall dimensions of each sign.
- C. Signage Schedule: Provide information sufficient to completely define each sign for fabrication, including room number, room name, other text to be applied, sign and letter sizes, fonts, and colors.
 - 1. When room numbers to appear on signs differ from those on drawings, include the drawing room number on schedule.
 - 2. When content of signs is indicated to be determined later, request such information from Owner through Architect at least 2 months prior to start of fabrication; upon request, submit preliminary schedule.
 - 3. Submit for approval by Owner through Architect prior to fabrication.
- D. Samples: Submit two samples of each type of sign, of size similar to that required for project, illustrating sign style, font, and method of attachment.
- E. Selection Samples: Where colors are not specified, submit two sets of color selection charts or chips.
- F. Verification Samples: Submit samples showing colors specified.
- G. Manufacturer's Installation Instructions: Include installation templates and attachment devices.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.

2.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

2.5 DELIVERY, STORAGE, AND HANDLING

- A. Package signs as required to prevent damage before installation.
- B. Store tape adhesive at normal room temperature.

2.6 FIELD CONDITIONS

- A. Do not install tape adhesive when ambient temperature is lower than recommended by manufacturer.
- B. Maintain this minimum temperature during and after installation of signs.

PART 2 PRODUCTS

3.1 MANUFACTURERS

- A. Flat Signs:
 - 1. Best Sign Systems, Inc: www.bestsigns.com/#sle.
 - 2. Inpro: www.inprocorp.com/#sle.

3. Mohawk Sign Systems, Inc: www.mohawksign.com/#sle.
4. Seton Identification Products: www.seton.com/aec/#sle.
5. Substitutions: See Section 016000 - Product Requirements.

3.2 SIGNAGE APPLICATIONS

- A. Accessibility Compliance: Signs are required to comply with ADA Standards and ICC A117.1 and applicable building codes, unless otherwise indicated; in the event of conflicting requirements, comply with the most comprehensive and specific requirements.
- B. Provide interior signage only as required to comply with building code.

3.3 SIGN TYPES

- A. Flat Signs: Signage media without frame.
 1. Edges: Square.
 2. Corners: Radiused.
 3. Wall Mounting of One-Sided Signs: Tape adhesive.
- B. Color and Font: Unless otherwise indicated:
 1. Character Font: As approved by Architect.
 2. Character Case: Upper case only.
 3. Background Color: As approved by Architect.
 4. Character Color: Contrasting color.

3.4 TACTILE SIGNAGE MEDIA

- A. Applied Character Panels: Acrylic plastic base, with applied acrylic plastic letters and braille.
 1. Total Thickness: 1/8 inch.
 2. Letter Thickness: 1/8 inch.
 3. Letter Edges: Square.

3.5 ACCESSORIES

- A. Tape Adhesive: Double sided tape, permanent adhesive.

PART 3 EXECUTION

4.1 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.

4.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install neatly, with horizontal edges level.
- C. Locate signs and mount at heights indicated on drawings and in accordance with ADA Standards and ICC A117.1.

END OF SECTION

SECTION 102113.17
PHENOLIC TOILET COMPARTMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Phenolic toilet compartments.
- B. Urinal and vestibule screens.

1.2 REFERENCE STANDARDS

- A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the work with placement of support framing and anchors in walls and ceilings.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on panel construction, hardware, and accessories.
- C. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall supports, door swings.
- D. Manufacturer's Installation Instructions: Indicate special procedures.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Phenolic Toilet Compartments:
 - 1. ASI Global Partitions; Alpaco Elegance: www.asi-globalpartitions.com/#sle.
 - 2. Substitutions: Section 016000 - Product Requirements.

2.2 PHENOLIC TOILET COMPARTMENTS

- A. Toilet Compartments: Factory fabricated doors, pilasters, and divider panels made of solid phenolic core panels with integral melamine finish, floor-mounted headrail-braced.
 - 1. Color: Single color as selected.
- B. Doors:
 - 1. Thickness: 3/4 inch.
 - 2. Width: 24 inch.
 - 3. Width for Handicapped Use: 36 inch, out-swinging.
 - 4. Height: 58 inch.
- C. Panels:
 - 1. Thickness: 1/2 inch.
 - 2. Height: 58 inch.
 - 3. Depth: As indicated on drawings.
- D. Pilasters:
 - 1. Thickness: 3/4 inch.
 - 2. Width: As required to fit space; minimum 3 inch.

2.3 ACCESSORIES

- A. Pilaster Shoes: Formed ASTM A666 Type 304 stainless steel with No. 4 finish, 3 inch high, concealing floor fastenings.
 - 1. Provide adjustment for floor variations with screw jack through steel saddles integral with pilaster.
 - 2. Provide ceiling attachment using two adjustable hanging studs, attached to above-ceiling framing.
- B. Head Rails: Hollow stainless steel pipe in manufacturer's standard size, with cast socket wall brackets.

- C. Wall and Pilaster Brackets: Polished stainless steel; manufacturer's standard type for conditions indicated on drawings.
- D. Attachments, Screws, and Bolts: Stainless steel , tamper proof type.
 - 1. For attaching panels and pilasters to brackets: Through-bolts and nuts ; tamper proof.
- E. Hardware: Polished stainless steel:
 - 1. Pivot hinges, gravity type, adjustable for door close positioning; three per door.
 - 2. Door Latch: Type 304 stainless steel with indicator of occupancy. Latch to be mounted to the pilaster with integrated function as keeper for in-swinging doors. Latch will provide emergency access through an accessible slotted center pin in the external indicator.
 - 3. Door strike and keeper with rubber bumper; mounted on pilaster in alignment with door latch.
 - 4. Coat hook with rubber bumper; one per compartment, mounted on door.
 - 5. Provide door pull for outswinging doors.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify correct spacing of and between plumbing fixtures.
- C. Verify correct location of built-in framing, anchorage, and bracing.

3.2 INSTALLATION

- A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.
- B. Maintain 3/8 inch to 1/2 inch space between wall and panels and between wall and end pilasters.
- C. Attach panel brackets securely to walls using anchor devices.
- D. Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.
- E. Field touch-up of scratches or damaged finish will not be permitted. Replace damaged or scratched materials with new materials.

3.3 TOLERANCES

- A. Maximum Variation From True Position: 1/4 inch.
- B. Maximum Variation From Plumb: 1/8 inch.

3.4 ADJUSTING

- A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch.
- B. Adjust hinges to position doors in partial opening position when unlatched. Return out-swinging doors to closed position.
- C. Adjust adjacent components for consistency of line or plane.

END OF SECTION

SECTION 102600 WALL AND DOOR PROTECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Bumper rails.
- B. Crash rails.
- C. Corner guards.

1.2 REFERENCE STANDARDS

- A. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics 2010 (Reapproved 2018).
- B. ASTM D543 - Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents 2021.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- D. ASTM F476 - Standard Test Methods for Security of Swinging Door Assemblies 2014.
- E. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi 2015, with Editorial Revision (2021).

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Indicate physical dimensions, features, anchorage details, and rough-in measurements.
- C. Shop Drawings: Include plans, elevation, sections, and attachment details.
- D. Samples: Submit samples illustrating component design, configurations, joinery, color and finish.
- E. Manufacturer's Instructions: Indicate special procedures, perimeter conditions requiring special attention.
- F. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- G. Maintenance Data: Manufacturer's instructions for care and cleaning of each type of product. Include information about both recommended and potentially detrimental cleaning materials and methods.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver wall and door protection items in original, undamaged protective packaging. Label items to designate installation locations.
- B. Protect work from moisture damage.
- C. Protect work from UV light damage.
- D. Do not deliver products to project site until areas for storage and installation are fully enclosed, and interior temperature and humidity are in compliance with manufacturer's recommendations for each type of item.
- E. Store products in either horizontal or vertical position, in compliance with manufacturer's instructions.

1.5 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 5-year manufacturer warranty for metal crash rails. Complete forms in Owner's name and register with manufacturer.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of materials beyond that expected of normal use, as intended by manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Crash Rails and Corner Guards:
 - 1. Construction Specialties, Inc: www.c-sgroup.com/#sle.
 - 2. Inpro: www.inprocorp.com/#sle.

3. Substitutions: See Section 016000 - Product Requirements.

2.2 PERFORMANCE CRITERIA

- A. Impact Strength: Unless otherwise noted, provide protection products and assemblies that have been successfully tested for compliance with applicable provisions of ASTM D256 and/or ASTM F476.
- B. Chemical and Stain Resistance: Unless otherwise noted, provide protection products and assemblies with chemical and stain resistance complying with applicable provisions of ASTM D543.
- C. Fungal Resistance: Unless otherwise noted, provide protection products and assemblies which pass ASTM G21 testing.

2.3 PRODUCT TYPES

- A. Bumper Rails: Factory- or shop-fabricated, with preformed end caps and internal and external corners:
 1. Performance of Installed Assembly:
 - a. Support vertical live load of 100 lb/lineal ft with deflection not to exceed 1/50 of span between supports.
 - b. Resist lateral force of 250 lbs at any point without damage or permanent set.
 2. Material: High impact vinyl, color as selected from manufacturer's standard colors.
 3. Surface Burning Characteristics: Provide assemblies with flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 4. Mounting: Surface mounted on aluminum retainer.
- B. Corner Guards - Surface Mounted:
 1. Material: Type 304 stainless steel, No. 4 finish, thickness as required for impact resistance.
 2. Width of Wings: 2 inches.
 3. Corner: Square.
 4. Length: One piece.
 5. Height: Full height of wall.
- C. Adhesives and Primers: As recommended by manufacturer.
- D. Mounting Brackets and Attachment Hardware: Appropriate to component and substrate.

2.4 FABRICATION

- A. Fabricate components with tight joints, corners and seams.
- B. Pre-drill holes for attachment.
- C. Form end trim closure by capping and finishing smooth.

2.5 SOURCE QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Provide wall and door protection systems of each type from a single source and manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.
- B. Verify that field measurements are as indicated on drawings.
- C. Verify that substrate surfaces for adhered items are clean and smooth.
 1. Test painted or wall covering surfaces for adhesion in inconspicuous area, as recommended by manufacturer. Follow adhesive manufacturer's recommendations for remedial measures at locations and/or application conditions where adhesion test's results are unsatisfactory.
- D. Start of installation constitutes acceptance of project conditions.

3.2 INSTALLATION

- A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to supporting construction.
- B. Position top of bumper rail 36 inches from finished floor.

- C. Position corner guard 4 inches above finished floor to [] inches high.
- D. Terminate rails 1 inch short of door openings and intersecting walls.

3.3 TOLERANCES

- A. Maximum Variation From Required Height: 1/4 inch.
- B. Maximum Variation From Level or Plane For Visible Length: 1/4 inch.

3.4 CLEANING

- A. Clean wall and door protection items of excess adhesive, dust, dirt, and other contaminants.

END OF SECTION

**SECTION 102800
TOILET, BATH, AND LAUNDRY ACCESSORIES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Commercial toilet accessories.
- B. Under-lavatory pipe supply covers.
- C. Utility room accessories.

1.2 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 2015a (Reapproved 2019).
- C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.
- D. ASTM B456 - Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium 2017.
- E. ASTM C1822 - Standard Specification for Insulating Covers on Accessible Lavatory Piping 2021.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- G. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi 2015, with Editorial Revision (2021).

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

1.4 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

2.1 MANUFACTURERS

- A. Commercial Toilet, Shower, and Bath Accessories:
 - 1. American Specialties, Inc: www.americanspecialties.com/#sle.
 - 2. Bradley Corporation: www.bradleycorp.com/#sle.
 - 3. Bobrick Washroom; www.bobrick.com.
 - 4. Substitutions: Section 016000 - Product Requirements.
- B. Under-Lavatory Pipe Supply Covers:
 - 1. Plumberex Specialty Products, Inc: www.plumberex.com/#sle.
 - 2. Substitutions: Section 016000 - Product Requirements.

2.2 MATERIALS

- A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
 - 1. Grind welded joints smooth.
 - 2. Fabricate units made of metal sheet of seamless sheets, with flat surfaces.
- B. Keys: Provide two keys for each accessory to Owner; master key lockable accessories.
- C. Stainless Steel Sheet: ASTM A666, Type 304.

- D. Stainless Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.
- E. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.

2.3 FINISHES

- A. Stainless Steel: Satin finish, unless otherwise noted.
- B. Chrome/Nickel Plating: ASTM B456, SC 2, polished finish, unless otherwise noted.
- C. Baked Enamel: Pretreat to clean condition, apply one coat primer and minimum two coats epoxy baked enamel.

2.4 COMMERCIAL TOILET ACCESSORIES

- A. As scheduled.

2.5 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 flexible PVC.
 - a. Surface Burning Characteristics: Flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
 - b. Comply with ASTM C1822, type indicated.
 - c. Microbial and Fungal Resistance: Comply with ASTM G21.
 - 4. Color: White.
 - 5. Fasteners: Reusable, snap-locking fasteners with no sharp or abrasive external surfaces.

2.6 UTILITY ROOM ACCESSORIES

- A. Combination Utility Shelf/Mop and Broom Holder: 0.05 inch thick stainless steel, Type 304, with 1/2 inch returned edges, 0.06 inch steel wall brackets.
 - 1. Hooks: Three, 0.06 inch stainless steel rag hooks at shelf front.
 - 2. Mop/broom holders: Four spring-loaded rubber cam holders at shelf front.
 - 3. Length: Manufacturer's standard length for number of holders/hooks.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify exact location of accessories for installation.
- C. Verify that field measurements are as indicated on drawings.
- D. See Section 061000 for installation of blocking, reinforcing plates, and concealed anchors in walls and ceilings.

3.2 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.

3.3 PROTECTION

- A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION

SECTION 104400 FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fire extinguishers.
- B. Fire extinguisher cabinets.
- C. Accessories.

1.2 REFERENCE STANDARDS

- A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2013a (Reapproved 2017).
- B. FM (AG) - FM Approval Guide current edition.
- C. NFPA 10 - Standard for Portable Fire Extinguishers 2022.
- D. UL (DIR) - Online Certifications Directory Current Edition.

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide extinguisher operational features.
- C. Shop Drawings: Indicate locations of cabinets and cabinet physical dimensions.
- D. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.4 FIELD CONDITIONS

- A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Fire Extinguishers:
 - 1. Ansul, a Tyco Business: www.ansul.com/#sle.
 - 2. Kidde, a unit of United Technologies Corp: www.kidde.com/#sle.
 - 3. Nystrom, Inc: www.nystrom.com/#sle.
 - 4. Pyro-Chem, a Tyco Business: www.pyrochem.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.
- B. Fire Extinguisher Cabinets and Accessories:
 - 1. Kidde, a unit of United Technologies Corp: www.kidde.com/#sle.
 - 2. Larsen's Manufacturing Co: www.larsensmfg.com/#sle.
 - 3. Nystrom, Inc: www.nystrom.com/#sle.
 - 4. Potter-Roemer: www.potterroemer.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.

2.2 FIRE EXTINGUISHERS

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
 - 1. Provide extinguishers labeled by UL (DIR) or FM (AG) for purpose specified and as indicated.
- B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
 - 1. Class: A:B:C type.
 - 2. Size: 5 pound.
 - 3. Finish: Baked polyester powder coat, red color.

4. Temperature range: Minus 40 degrees F to 120 degrees F.
- C. Dry Chemical Type Fire Extinguishers: Stainless steel tank, with pressure gauge.
 1. Class: K type.
 2. Size: 1.6 gallons.
 3. Size and classification as scheduled.
 4. Finish: Polished stainless steel.
 5. Temperature range: Minus 20 degrees F to 120 degrees F.

2.3 FIRE EXTINGUISHER CABINETS

- A. Fire Rating: Listed and labeled in accordance with ASTM E814 requirements for fire resistance rating of walls where being installed.
- B. Cabinet Construction: Match adjacent construction.
 1. Formed primed steel sheet; 0.036 inch thick base metal.
- C. Cabinet Configuration: Semi-recessed type.
 1. Size to accommodate accessories.
 2. Projected Trim: Returned to wall surface, with 2-1/2 inch projection, and 2 inch wide face.
 3. Provide cabinet enclosure with right angle inside corners and seams, and with formed perimeter trim.
- D. Door: 0.036 inch metal thickness, reinforced for flatness and rigidity with nylon catch. Hinge doors for 180 degree opening with two butt hinge.
- E. Door Glazing: Float glass, clear, 1/8 inch thick, and set in resilient channel glazing gasket.
- F. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.
- G. Weld, fill, and grind components smooth.
- H. Finish of Cabinet Interior: Primed for field painting to match adjacent wall surface.

2.4 ACCESSORIES

- A. Extinguisher Brackets: Formed steel, galvanized and enamel finished.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify rough openings for cabinet are correctly sized and located.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install cabinets plumb and level in wall openings, not more than 48 inches from finished floor to inside bottom of cabinet.
- C. Secure rigidly in place.
- D. Place extinguishers in cabinets.

END OF SECTION

**SECTION 107500
FLAGPOLES**

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 ground-mounted flagpoles made from aluminum and steel.
- B. Owner-Furnished Material: Flag(s).
- C. Related Sections:
 - 1. Section 07 6200 "Sheet Metal Flashing and Trim" for counterflashing flashing at roof-mounted flagpoles.
 - 2. Section 26 5600 "Exterior Lighting" for site lighting fixtures.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Flagpole assemblies, including anchorages and supports, shall withstand the effects of gravity loads, and the following loads and stresses within limits and under conditions indicated according to the following design criteria:
 - 1. Seismic Loads: $S_s=0.121$, $S=0.064$ according to ASCE 7.
 - 2. Wind Loads: $W=90$ mph according to NAAMM FP 1001, "Guide Specifications for Design of Metal Flagpoles".
 - 3. Base flagpole design on nylon or cotton flags of maximum standard size suitable for use with flagpole or flag size indicated, whichever is more stringent.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, operating characteristics, fittings, accessories, and finishes for flagpoles.
- B. Shop Drawings: For flagpoles. Include plans, elevations, details, and attachments to other work. Show general arrangement, jointing, fittings, accessories, grounding, anchoring, and support.
 - 1. Include section, and details of foundation system for ground-mounted flagpoles.
- C. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

- D. Delegated-Design Submittal: For flagpole assemblies 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. Include loads, point reactions, and locations for attachment of flagpoles to building's structure.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified professional engineer.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flagpoles to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Source Limitations: Obtain flagpole as complete unit, including fittings, accessories, bases, and anchorage devices, from single source from single manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. General: Spiral wrap flagpoles with heavy paper and enclose in a hard fiber tube or other protective container.

PART 2 - PRODUCTS

2.1 FLAGPOLES

- A. Flagpole Construction, General: Construct flagpoles in one piece if possible. If more than one piece is necessary, comply with the following:
 - 1. Fabricate shop and field joints without using fasteners, screw collars, or lead caulking.
 - 2. Provide flush hairline joints using self-aligning, snug-fitting, internal sleeves.
 - 3. Provide self-aligning, snug-fitting joints.
- B. Exposed Height: 25 feet
- C. Aluminum Flagpoles: Provide cone-tapered flagpoles fabricated from seamless extruded tubing complying with ASTM B 241, Alloy 6063, with a minimum wall thickness of 3/16 inch.
- D. Steel Flagpoles: Provide cone-tapered flagpoles fabricated from standard-weight, seamless steel pipe complying with ASTM A 53, Type S, Grade B or steel tube complying with ASTM A 513.
- E. Metal Foundation Tube: Manufacturer's standard corrugated-steel foundation tube, not less than 0.064-inch- nominal wall thickness. Provide with 3/16-inch steel bottom plate and support plate; 3/4-inch- diameter, steel ground spike; and steel centering wedges welded together.

Galvanize steel after assembly. Provide loose hardwood wedges at top of foundation tube for plumbing pole.

1. Provide flashing collar of same material and finish as flagpole.
2. Provide steel ground protectors extending 12 inches aboveground and 6 inches below ground for steel flagpoles where flashing collars are not provided.

F. Sleeve for Aluminum Flagpole: PVC pipe foundation sleeve, made to fit flagpole, for casting into concrete foundation.

1. Provide flashing collar of same material and finish as flagpole.

G. Cast-Metal Shoe Base: For anchor-bolt mounting; provide with anchor bolts.

1. Provide units made from aluminum with same finish and color as flagpoles.
2. Provide ground spike at grade-mounted flagpoles.

2.2 FITTINGS

A. Finial Ball: Manufacturer's standard flush-seam ball, sized as indicated or, if not indicated, to match flagpole-butt diameter.

1. 0.063-inch spun aluminum, finished to match flagpole.
2. Spun stainless steel, finished to match flagpole.
3. Spun copper alloy, finished to match flagpole.

B. External Halyard: Ball-bearing, nonfouling, revolving truck assembly of cast metal with continuous 5/16-inch-diameter, braided polypropylene halyard and 9-inch cast-metal cleats with fasteners. Finish exposed metal surfaces to match flagpole.

1. Provide one halyard and one cleat at each flagpole.
2. Provide cast-metal cleat covers, finished to match flagpole, secured with cylinder locks.
3. Provide halyard covers consisting of a 2-inch channel, 60 inches long, finished to match flagpole.
4. Halyard Flag Snaps: Provide two bronze swivel snap hooks per halyard.

a. Provide with neoprene or vinyl covers.

5. Plastic Halyard Flag Clips: Made from injection-molded, UV-stabilized, acetal resin (Delrin). Clips attach to flag and have two eyes for inserting both runs of halyards. Provide two flag clips per halyard.

a. Product: Subject to compliance with requirements, provide "Quiet Halyard" flag clasp by Lingo.

2.3 MISCELLANEOUS MATERIALS

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.

B. Drainage Material: Crushed stone, or crushed or uncrushed gravel; coarse aggregate.

C. Sand: ASTM C 33, fine aggregate.

- D. Elastomeric Joint Sealant: Single-component nonsag urethane joint sealant complying with requirements in Section 079200 "Joint Sealants" for Use NT (nontraffic) and for Use M, G, A, and, as applicable to joint substrates indicated, for Use O.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.4 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.5 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

2.6 STEEL FINISHES

- A. Flagpole Interior Finish: Apply one coat of bituminous paint on interior of flagpole or otherwise treat to prevent corrosion.
- B. Galvanized Finish: Hot-dip galvanize after fabrication to comply with ASTM A 123.
- C. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with Manufacturer's recommendation for finish selected. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.
- D. Polyurethane Enamel Finish: Immediately after cleaning, apply manufacturer's standard primer and two-coat, high-gloss, high-build polyurethane-enamel finish.
 - 1. Color: As selected by Architect from manufacturer's full range.
- E. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.
 - 1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, including foundation; accurate placement, pattern, orientation of anchor bolts, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

- A. Prepare uncoated metal flagpoles that are set in foundation tubes by painting below-grade portions with a heavy coat of bituminous paint.
- B. Foundation Excavation: Excavate to neat clean lines in undisturbed soil. Remove loose soil and foreign matter from excavation and moisten earth before placing concrete. Place and compact drainage material at excavation bottom.
- C. Provide forms where required due to unstable soil conditions and for perimeter of flagpole base at grade. Secure and brace forms to prevent displacement during concreting.
- D. Place concrete, as specified in Section 03 3000 "Cast-in-Place Concrete." Compact concrete in place by using vibrators. Moist-cure exposed concrete for not less than seven days or use nonstaining curing compound.
- E. Trowel exposed concrete surfaces to a smooth, dense finish, free of trowel marks, and uniform in texture and appearance. Provide positive slope for water runoff to perimeter of concrete base.

3.3 FLAGPOLE INSTALLATION

- A. General: Install flagpoles where shown and according to Shop Drawings and manufacturer's written instructions.
- B. Ground Set: Place foundation tube or sleeve in center, and brace to prevent displacement during concreting. Place concrete. Plumb and level foundation tube or sleeve and allow concrete to cure. Install flagpole, plumb, in foundation tube or sleeve.
 - 1. Foundation Tube: Place tube seated on bottom plate between steel centering wedges and install hardwood wedges to secure flagpole in place. Place and compact sand in foundation tube and remove hardwood wedges. Seal top of foundation tube with a 2-inch layer of elastomeric joint sealant and cover with flashing collar.
- C. Baseplate: Cast anchor bolts in concrete foundation. Install baseplate on washers placed over leveling nuts on anchor bolts and adjust until flagpole is plumb. After flagpole is plumb, tighten retaining nuts and fill space under baseplate solidly with nonshrink, nonmetallic grout. Finish exposed grout surfaces smooth and slope 45 degrees away from edges of baseplate.

END OF SECTION

**SECTION 109900
MISCELLANEOUS SPECIALTIES**

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. Miscellaneous specialty items as listed herein.

1.3 ACTION SUBMITTALS

- A. Product Data: Including all pertinent performance characteristics and criteria.
- B. Shop Drawings: Indicate materials, construction, sizes, quantities, finishes, and installation details.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Instructions: For installation, maintenance, and repair.

PART 2 PRODUCTS

2.1 PRODUCTS

- A. Fire Control Key Box: Provide fire department key control box complete with alarm tamper switch at location near main entrance to be determined.
 - 1. Acceptable Product: Model 3200 by Knox Box.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces and conditions are ready to receive work of this Section.
- B. Notify Architect of any existing conditions which will adversely affect execution.
- C. Beginning of execution will constitute acceptance of existing conditions.

3.2 PREPARATION

- A. Prepare substrate surfaces as recommended by manufacturer.

3.3 INSTALLATION

- A. Install using skilled workers in accordance with manufacturer's published instructions and recommendations.

3.4 ADJUSTING

- A. Adjust and fit items to be flush with adjacent construction.
- B. Fasten or adhere for tight connections and joints.

END OF SECTION

**SECTION 122400
WINDOW SHADES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Window shades and accessories.

1.2 REFERENCE STANDARDS

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week prior to commencing work related to products of this section; require attendance of all affected installers.
- B. Sequencing:
 - 1. Do not fabricate shades until field dimensions for each opening have been taken.
 - 2. Do not install shades until final surface finishes and painting are complete.

1.4 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets including materials, finishes, fabrication details, dimensions, profiles, mounting requirements, and accessories.
- C. Shop Drawings: Include shade schedule indicating size, location and keys to details.
- D. Shop Drawings - Motorized Shades: Provide schematic system riser diagram indicating component interconnections. Include requirements for interface with other systems.
- E. Certificates: Manufacturer's documentation that line voltage components are UL listed or UL recognized.
- F. Source Quality Control Submittals: Provide test reports indicating compliance with specified fabric properties.
- G. Selection Samples: Include fabric samples in full range of available colors and patterns.
 - 1. Motorized Shades: Include finish selections for controls.
- H. Verification Samples: Minimum size 6 inches square, representing actual materials, color and pattern.
- I. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- J. Project Record Documents: Record actual locations of control systems and show interconnecting wiring.
- K. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of shop drawings.
- L. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of this type with minimum three years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver shades in manufacturer's unopened packaging, labeled to identify each shade for each opening.
- B. Handle and store shades in accordance with manufacturer's recommendations.

1.7 FIELD CONDITIONS

- A. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.8 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

- B. Provide manufacturer's warranty from Date of Substantial Completion, covering the following:
 - 1. Shade Hardware: One year.
 - 2. Electric Motors: One year.
 - 3. Fabric: One year.
 - 4. Aluminum and Steel Coatings: One year.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manually Operated Roller Shades:
 - 1. Draper, Inc: www.draperinc.com/#sle.
 - 2. Hunter Douglas Architectural: www.hunterdouglasarchitectural.com/#sle.
 - 3. MechoSystems; MechoShade System: www.mechoshade.com.
 - 4. TimberBlindMetroShade: www.timberblinds.com/commercial-division/#sle.
 - 5. SWFcontract, a division of Springs Window Fashions, LLC.: www.swfcontract.com/#sle.
 - 6. Substitutions: See Section 016000 - Product Requirements.
- B. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

2.2 WINDOW SHADE APPLICATIONS

- A. Interior Roller Shades: Sheer shades.
 - 1. Type: Roll down, closed position is at window sill.
 - 2. Fabric: As scheduled.
 - 3. Color: As selected by Architect from manufacturer's full range of colors.
 - 4. Mounting: Inside (between jambs).
 - 5. Operation: Manual.

2.3 ROLLER SHADES

- A. Roller Shades: Fabric roller shades complete with mounting brackets, roller tubes, hembars, hardware and accessories.
 - 1. Drop: Regular roll.
 - 2. Size: As indicated on drawings.
- B. Fabric: Non-flammable, color-fast, impervious to heat and moisture, and able to retain its shape under normal operation.
 - 1. Sheer Shades: Reduce glare yet still reveal considerable details to the outside; no privacy; Openness Factor greater than 1 percent.
 - 2. Translucent Shades: Soften the light and reveal only shadow-like outlines to the outside; substantial privacy; Openness Factor less than 1 percent.
- C. Roller Tubes: As required for type of operation.
 - 1. Material: Extruded aluminum or galvanized steel; as required for shade location.
 - 2. Size: Manufacturer's standard, selected for suitability for installation conditions, span, and weight of shades.
 - 3. Fabric Attachment: Utilize extruded channel in tube to accept vinyl spline welded to fabric edge.
- D. Hembars: Designed for weight requirements and adaptation to uneven surfaces, to maintain bottom of shade straight and flat.
 - 1. Style: Exposed aluminum bottom bar, rectangular profile with closed ends, containing a spline groove top to receive and secure fabric end.
 - 2. Finish: Painted.
 - 3. Color: As selected from manufacturer's standard colors.
- E. Manual Operation for Interior Shades: Clutch operated continuous loop; beaded ball chain.

2.4 ACCESSORIES

- A. Fascias: Size as required to conceal shade mounting.
 - 1. Style: As selected by Architect from shade manufacturer's full selection.

- 2. Material and Color: To match shade.
- B. Brackets and Mounting Hardware: As recommended by manufacturer for mounting configuration and span indicated.
- C. Fasteners: Non-corrosive, and as recommended by shade manufacturer.

2.5 FABRICATION

- A. Field measure finished openings prior to ordering or fabrication.
- B. Fabricate shades to fit openings within specified tolerances.
 - 1. Vertical Dimensions: Fill openings from head to sill with 1/2 inch space between bottom bar and window stool.
 - 2. Horizontal Dimensions - Inside Mounting: Provide symmetrical light gaps on both sides of shade not to exceed 3/4 inch total.
- C. Dimensional Tolerances: As recommended in writing by manufacturer.
- D. At openings requiring continuous multiple shade units with separate rollers, locate roller joints at window mullion centers; butt rollers end-to-end.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine finished openings for deficiencies that may preclude satisfactory installation.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Start of installation shall be considered acceptance of substrates.

3.2 PREPARATION

- A. Prepare surfaces using methods recommended by manufacturer for achieving best result for substrate under the project conditions.
- B. Coordinate with window installation and placement of concealed blocking to support shades.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved shop drawings, using mounting devices as indicated.
- B. Installation Tolerances:
 - 1. Inside Mounting: Maximum space between shade and jamb when closed of 1/16 inch.
 - 2. Maximum Offset From Level: 1/16 inch.
- C. Replace shades that exceed specified dimensional tolerances at no extra cost to Owner.
- D. Adjust level, projection and shade centering from mounting bracket. Verify there is no telescoping of shade fabric. Ensure smooth shade operation.

3.4 CLEANING

- A. Clean soiled shades and exposed components as recommended by manufacturer.
- B. Replace shades that cannot be cleaned to "like new" condition.

3.5 CLOSEOUT ACTIVITIES

- A. See Section 017800 - Closeout Submittals, for closeout submittals.
- B. See Section 017900 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate operation and maintenance of window shade system to Owner's personnel.

3.6 PROTECTION

- A. Protect installed products from subsequent construction operations.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

3.7 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

SECTION 123600 COUNTERTOPS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Countertops for architectural cabinet work.
- B. Sinks molded into countertops.

1.2 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2022.
- B. IAPMO Z124 - Plastic Plumbing Fixtures 2017, with Errata.
- C. ISFA 2-01 - Classification and Standards for Solid Surfacing Material 2013.
- D. NEMA LD 3 - High-Pressure Decorative Laminates 2005.
- E. PS 1 - Structural Plywood 2009 (Revised 2019).

1.3 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Specimen warranty.
- B. Shop Drawings: Complete details of materials and installation ; combine with shop drawings of cabinets and casework specified in other sections.
- C. Verification Samples: For each finish product specified, minimum size 6 inches square, representing actual product, color, and patterns.
- D. Test Reports: Chemical resistance testing, showing compliance with specified requirements.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.6 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 COUNTERTOPS

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS), unless noted otherwise.
- B. Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.
 - 1. Flat Sheet Thickness: 1/2 inch, minimum.
 - 2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
 - a. Manufacturers:
 - 1) Dupont: www.corian.com/#sle.

- 2) Substitutions: See Section 016000 - Product Requirements.
 - b. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - c. Sinks and Bowls: Integral castings; minimum 3/4 inch wall thickness; comply with IAPMO Z124.
 - d. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.
 - e. Color and Pattern: As scheduled.
 - f. Other Components Thickness: 1/2 inch, minimum.
 - g. Exposed Edge Treatment: Built up to minimum 1-1/4 inch thick; radiused edge; use marine edge at sinks.
 - h. Back and End Splashes: Same sheet material, square top; minimum 4 inches high.
 - i. Fabricate in accordance with manufacturer's standard requirements.
- C. Natural Quartz and Resin Composite Countertops: Sheet or slab of natural quartz and plastic resin over continuous substrate.
1. Flat Sheet Thickness: 1-1/4 inch, minimum.
 2. Natural Quartz and Resin Composite Sheets, Slabs and Castings: Complying with ISFA 3-01 and NEMA LD 3; orthophthalic polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
 - a. Manufacturers:
 - 1) Dupont: www.corianquartz.com/#sle.
 - 2) Substitutions: See Section 016000 - Product Requirements.
 - b. Factory fabricate components to the greatest extent practical in sizes and shapes indicated; comply with the MIA Dimension Stone Design Manual.
 - c. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - d. NSF approved for food contact.
 - e. Sinks: Integral castings; minimum 3/4 inch wall thickness; comply with IAPMO Z124.
 - f. Finish on Exposed Surfaces: Polished.
 - g. Color and Pattern: As scheduled.
 3. Other Components Thickness: 3/4 inch, minimum.
 4. Exposed Edge Treatment: Built up to minimum 1-1/4 inch thick; radiused edge.
 5. Back and End Splashes: Same sheet material, square top; minimum 4 inches high.
 6. Fabricate in accordance with manufacturer's standard requirements.

2.2 MATERIALS

- A. Plywood for Supporting Substrate: PS 1 Exterior Grade, A-C veneer grade, minimum 5-ply; minimum 3/4 inch thick; join lengths using metal splines.
- B. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.
- C. Cove Molding for Top of Splashes: Rubber with semi-gloss finish and T-spline to fit between splash and wall; 1/2 inch by 1/2 inch.
- D. Joint Sealant: Mildew-resistant silicone sealant, color as selected by Architect..

2.3 FABRICATION

- A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
 1. Join lengths of tops using best method recommended by manufacturer.
 2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
 - a. Rout a 1/8 inch drip groove at underside of exposed overlapping edges, set back 1/2 inch from face of edge.
 3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.
- B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.

1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
 2. Height: 4 inches, unless otherwise indicated.
- C. Solid Surfacing: Fabricate tops and wall panels up to 144 inches long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.
1. Integral sinks: Shop-mount securely to countertop with adhesives, using flush configuration, as per manufacturer's instructions, and as detailed on drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
- B. Seal joint between back/end splashes and vertical surfaces.
 1. Where indicated use rubber cove molding.
 2. Where applied cove molding is not indicated use specified sealant.

3.4 TOLERANCES

- A. Variation From Horizontal: 1/8 inch in 10 feet, maximum.
- B. Offset From Wall, Countertops: 1/8 inch maximum; 1/16 inch minimum.
- C. Field Joints: 1/8 inch wide, maximum.

3.5 CLEANING

- A. Clean countertops surfaces thoroughly.

3.6 PROTECTION

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

END OF SECTION

SECTION 21 0517 - SLEEVES & SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

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.
 - 2. Sleeve-seal systems.
 - 3. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide "Link-Seal" as manufactured by Pipeline Seal and Insulator, Inc. or comparable product by one of the following:
 - 1. Metraflex Company (The).
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Composite

3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- 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 adequate annular clear space between piping and concrete slabs and walls.
 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves for pipes passing through interior partitions.
 1. Cut sleeves to length for mounting flush with both surfaces.
 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07.
- D. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space

between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

END OF SECTION

SECTION 21 0518 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

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. Escutcheons.
 - 2. Floor plates.

1.3 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- 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 piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - f. Bare Piping in Equipment Rooms: One-piece, cast-brass type 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: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.

END OF SECTION

SECTION 21 0553 - IDENTIFICATION FOR FIRE-SUPPRESSION 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. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.

1.3 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 and the proposed content for each label.
- D. Valve Schedules: Valve numbering scheme.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, 0.032 inchthick, with predrilled holes for attachment hardware.
 - 2. Letter Color: White.

3. Background Color: Black.
 4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 6. Fasteners: Stainless-steel rivets or self-tapping screws.
 7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. 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.
- C. Equipment-Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.
- 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 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. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; pipe size; and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.
- D. Pipe-Label Colors:
 - 1. Background Color: Red.
 - 2. Letter Color: White.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping-system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032 inch thick, with predrilled holes for attachment hardware.
 - 2. Fasteners: Brass wire-link chain or S-hook.
 - 3. Valve-Tag Color: Red.
 - 4. Letter Color: White.
- B. 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. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS

- A. Warning Tags: 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.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 LABEL INSTALLATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install or permanently fasten labels on each major item of mechanical equipment.
- D. Locate equipment labels where accessible and visible.
- E. Piping Color-Coding: Painting of piping is specified in Section 09 9123 "Interior Painting."
- F. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection excluding short takeoffs. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.3 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems. List tagged valves in a valve-tag schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:
 - 1. Valve-Tag Size and Shape:
 - a. Fire-Suppression Standpipe: 1-1/2 inches, round.
 - b. Wet-Pipe Sprinkler System: 1-1/2 inches, round.
 - c. Dry-Pipe Sprinkler System: 1-1/2 inches, round.

- d. Foam-Water System: 1-1/2 inches, round.
- e. Clean-Agent Fire-Extinguishing System: 1-1/2 inches, round.

3.4 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 21 1313 - WET-PIPE SPRINKLER 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. Pipes, fittings, and specialties.
 - 2. Fire-protection valves.
 - 3. Fire-department connections.
 - 4. Sprinklers.
 - 5. Alarm devices.
 - 6. Pressure gages.

1.3 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum.

1.4 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.5 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- B. High-Pressure Piping System Component: Listed for 250-psig minimum working pressure.
- C. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- D. Sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications: According to NFPA 13 unless otherwise indicated.
 - a. Building Service Areas: Ordinary Hazard, Group 1.
 - b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
 - c. General Storage Areas: Ordinary Hazard, Group 1.
 - d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
 - e. Office and Public Areas: Light Hazard.
 - f. Detention Areas: Light Hazard.
 - g. Laundries: Ordinary Hazard, Group 1.
 - h. Restaurant Service Areas: Ordinary Hazard, Group 1.
3. Minimum Density for Automatic-Sprinkler Piping Design: According to NFPA 13 unless otherwise indicated.
4. Maximum Protection Area per Sprinkler: According to NFPA 13 unless otherwise indicated.
5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated.

1.6 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Plumbing Systems.
 2. Mechanical Systems.
 3. Items penetrating finished ceiling include the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets
 - c. Fire Alarm and Security devices.
- E. Qualification Data: For qualified Installer and professional engineer.

- F. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- G. Fire-hydrant flow test report.
- H. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- I. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."
- D. Sprinkler equipment and installation to be approved by authorities having jurisdiction.
- E. State certified sprinkler contractor shall have a minimum of five years specialized experience in sprinkler system design and installation. The project foreman shall have a minimum of three years experience in the installation of sprinkler systems.

1.8 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

- A. Standard Weight Schedule 40, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- B. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- C. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- D. Malleable- or Ductile-Iron Unions: UL 860.
- E. Cast-Iron Flanges: ASME 16.1, Class 125.
- F. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- G. Grooved-Joint, Steel-Pipe Appurtenances:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 2. Pressure Rating: 175 psig minimum.
 3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
 4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
 - 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
 - 2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
 - 1. Valves shall be UL listed or FM approved.
 - 2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.
 - 3. Minimum Pressure Rating for High-Pressure Piping: 250 psig.
- B. Ball Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Victaulic Company.
 - 2. Standard: UL 1091 except with ball instead of disc.
 - 3. Valves NPS 1-1/2 and Smaller: Bronze body with threaded ends.
 - 4. Valves NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
 - 5. Valves NPS 3: Ductile-iron body with grooved ends.
- C. Iron Butterfly Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Global Safety Products, Inc.
 - b. Kennedy Valve; a division of McWane, Inc.
 - c. NIBCO INC.
 - d. Tyco Fire & Building Products LP.
 - e. Victaulic Company.

2. Standard: UL 1091.
3. Pressure Rating: 175 psig.
4. Body Material: Cast or ductile iron.
5. Style: Lug or wafer.
6. End Connections: Grooved.

D. Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. Fire-End & Croker Corporation.
 - e. Kennedy Valve; a division of McWane, Inc.
 - f. Metraflex, Inc.
 - g. NIBCO INC.
 - h. Potter Roemer.
 - i. Reliable Automatic Sprinkler Co., Inc.
 - j. Tyco Fire & Building Products LP.
 - k. Victaulic Company.
 - l. Viking Corporation.
 - m. Watts Water Technologies, Inc.
2. Standard: UL 312.
3. Pressure Rating: 250 psig minimum.
4. Type: Swing check.
5. Body Material: Cast iron.
6. End Connections: Flanged or grooved.

E. Bronze OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. NIBCO INC.
2. Standard: UL 262.
3. Pressure Rating: 175 psig.
4. Body Material: Bronze.
5. End Connections: Threaded.

F. Iron OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.

- d. Hammond Valve.
 - e. Mueller Co.; Water Products Division.
 - f. NIBCO INC.
 - g. Tyco Fire & Building Products LP.
 - h. Watts Water Technologies, Inc.
2. Standard: UL 262.
 3. Pressure Rating: 250 psig minimum.
 4. Body Material: Cast or ductile iron.
 5. End Connections: Flanged or grooved.
- G. Indicating-Type Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Global Safety Products, Inc.
 - b. Kennedy Valve; a division of McWane, Inc.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Tyco Fire & Building Products LP.
 - f. Victaulic Company.
 2. Standard: UL 1091.
 3. Pressure Rating: 175 psig minimum.
 4. Valves NPS 2 and Smaller:
 - a. Valve Type: Ball or butterfly.
 - b. Body Material: Bronze.
 - c. End Connections: Threaded.
 5. Valves NPS 2-1/2 and Larger:
 - a. Valve Type: Butterfly.
 - b. Body Material: Cast or ductile iron.
 - c. End Connections: Flanged, grooved, or wafer.
 6. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch visual indicating device.

2.5 TRIM AND DRAIN VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum.

2.6 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating:
 - a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.
 - b. High-Pressure Piping Specialty Valves: 250 psig minimum.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AFAC Inc.
 - b. Globe Fire Sprinkler Corporation.
 - c. Reliable Automatic Sprinkler Co., Inc.
 - d. Tyco Fire & Building Products LP.
 - e. Venus Fire Protection Ltd.
 - f. Victaulic Company.
 - g. Viking Corporation
2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.

C. Automatic (Ball Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
2. Standard: UL 1726.
3. Pressure Rating: 175 psig minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4.
6. End Connections: Threaded.

2.7 FIRE-DEPARTMENT CONNECTIONS

A. Flush-Type, Fire-Department Connection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Elkhart Brass Mfg. Company, Inc.
 - b. Guardian Fire Equipment, Inc.
 - c. Potter Roemer.
2. Standard: UL 405.
 3. Type: Flush, for wall mounting.
 4. Pressure Rating: 175 psig minimum.
 5. Body Material: Corrosion-resistant metal.
 6. Inlets: Storz Connection matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
 7. Caps: Brass, lugged type, with gasket and chain.
 8. Escutcheon Plate: Rectangular, brass, wall type.
 9. Outlet: With pipe threads.
 10. Body Style: Horizontal.
 11. Number of Inlets: As required unless otherwise indicated.
 12. Outlet Location: As required unless otherwise indicated.
 13. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE or AUTO SPKR."
 14. Finish: Polished chrome plated.

2.8 SPRINKLER SPECIALTY PIPE FITTINGS

A. Flow Detection and Test Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

B. Sprinkler Inspector's Test Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Triple R Specialty.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.
2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig minimum.

4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

2.9 SPRINKLERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Reliable Automatic Sprinkler Co., Inc.
 2. Tyco Fire & Building Products LP.
 3. Viking Corporation.
- B. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 2. Pressure Rating for Residential Sprinklers: 175 psig maximum.
 3. Pressure Rating for Automatic Sprinklers: 175 psig minimum.
 4. Pressure Rating for High-Pressure Automatic Sprinklers: 250 psig minimum.
- C. Automatic Sprinklers with Heat-Responsive Element:
1. Early-Suppression, Fast-Response Applications: UL 1767.
 2. Nonresidential Applications: UL 199.
 3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- D. Sprinkler Finishes:
1. Chrome plated.
 2. Bronze.
 3. Painted.
- E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
 2. Sidewall Mounting: Chrome-plated steel, one piece, flat.
- F. Sprinkler Guards:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reliable Automatic Sprinkler Co., Inc. (The).
 - b. Tyco Fire Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.

2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

2.10 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Electrically Operated Alarm Bell:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fire-Lite Alarms, Inc.; a Honeywell company.
 - b. Notifier; a Honeywell company.
 - c. Potter Electric Signal Company.
 2. Standard: UL 464.
 3. Type: Vibrating, metal alarm bell.
 4. Size: 10-inch diameter.
 5. Finish: Red-enamel factory finish, suitable for outdoor use.
- C. Water-Flow Indicators:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. McDonnell & Miller; ITT Industries.
 - b. Potter Electric Signal Company.
 - c. Viking Corporation.
 - d. Watts Industries (Canada) Inc.
 2. Standard: UL 346.
 3. Water-Flow Detector: Electrically supervised.
 4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
 5. Type: Paddle operated.
 6. Pressure Rating: 250 psig.
 7. Design Installation: Horizontal or vertical.
- D. Pressure Switches:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Potter Electric Signal Company.
 - b. Tyco Fire & Building Products LP.
 - c. United Electric Controls Co.
 - d. Viking Corporation.
 2. Standard: UL 346.

3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

E. Valve Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fire-Lite Alarms, Inc.; a Honeywell company.
 - b. Kennedy Valve; a division of McWane, Inc.
 - c. Potter Electric Signal Company.
 - d. System Sensor; a Honeywell company.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.

F. Indicator-Post Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, Subject to compliance with requirements, provide products by one of the following:
 - a. Potter Electric Signal Company.
 - b. System Sensor; a Honeywell company.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.11 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. AMETEK; U.S. Gauge Division.
 2. Ashcroft, Inc.
 3. Brecco Corporation.
 4. WIKA Instrument Corporation.
- B. Standard: UL 393.
- C. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- D. Pressure Gage Range: 0 to 250 psig minimum.
- E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

- F. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building.
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping.

3.3 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- G. Install sprinkler piping with drains for complete system drainage.
- H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

- I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- J. Install alarm devices in piping systems.
- K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- M. Pressurize and check preaction sprinkler system piping and air compressors.
- N. Fill sprinkler system piping with water.
- O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 0517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 21 0517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 21 0518 "Escutcheons for Fire-Suppression Piping."

3.4 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- I. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- J. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- K. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- L. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.5 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 - 2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

3.6 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

3.7 FIRE-DEPARTMENT CONNECTION INSTALLATION

- A. Install wall-type, fire-department connections.
- B. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.8 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section.

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Start and run excess-pressure pumps.
 - 6. Coordinate with fire-alarm tests. Operate as required.
 - 7. Coordinate with fire-pump tests. Operate as required.
 - 8. Verify that equipment hose threads are same as local fire-department equipment.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.10 CLEANING

- A. Clean dirt and debris from sprinklers.

- B. Remove and replace sprinklers with paint other than factory finish.

3.11 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves and pressure-maintenance pumps.

3.12 PIPING SCHEDULE

- A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
- B. Standard-pressure, wet-pipe sprinkler system, shall be one of the following:
 - 1. Standard-weight Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Standard-weight Schedule 40, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.13 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: Recessed sprinklers.
 - 3. Rooms with Gypsum board Ceilings: Concealed sprinklers.
 - 4. Wall Mounting: Sidewall sprinklers.
 - 5. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.
 - 6. Special Applications: Extended-coverage, flow-control, Institutional(security) sprinklers, and quick-response sprinklers where indicated.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
 - 1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 - 2. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
 - 3. Upright and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION

SECTION 21 1316 - DRY-PIPE SPRINKLER 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. Pipes, fittings, and specialties.
 - 2. Fire-protection valves.
 - 3. Sprinkler specialty pipe fittings.
 - 4. Sprinklers.
 - 5. Alarm devices.
 - 6. Manual control stations.
 - 7. Pressure gages.
- B. Related Sections:
 - 1. Section 21 1313 "Wet-Pipe Sprinkler Systems" for wet-pipe sprinkler piping.
 - 2. Section 28 3111 "Digital, Addressable Fire-Alarm System" for alarm devices not specified in this Section.

1.3 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Dry-pipe sprinkler system piping designed to operate at working pressure 175 psig maximum.

1.4 SYSTEM DESCRIPTIONS

- A. Combined Clean Agent/Double-Interlock Preaction Sprinkler System: Automatic sprinklers are attached to piping containing low-pressure air. Actuation of a fire-detection system in the same area as sprinklers opens the deluge valve permitting water to flow into the sprinkler piping:
 - 1. System Operating Sequence
 - a. Refer to Section 212200 "Clean-Agent Fire-Extinguishing Systems" for operating sequence.

1.5 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

- B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Pipe routing shall be in accordance with the penetration control drawings. Shop drawings shall use the penetration control drawings as background and include a penetration control legend. Penetrations through acoustically significant construction shall be sealed airtight in accordance with the penetration control drawings, resiliently sealed penetration details and Section 07 9200 – Joint Sealants.
- D. Wood blocking sleeves shall be provided in lieu of metal sleeves at penetrations through acoustically-significant gypsum board construction, as indicated on the penetration control drawings and details.
- E. Sprinkler system design shall be approved by authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - 2. Sprinkler Occupancy Hazard Classifications: According to NFPA 13 unless otherwise indicated:
 - a. Office and Public Area: Light Hazard.
 - b. Storage, Electrical, and Mechanical Rooms: Ordinary Hazard, Group 1.
 - 3. Minimum Density for Automatic-Sprinkler Piping Design: According to NFPA 13 unless otherwise indicated.
 - 4. Maximum Protection Area per Sprinkler: According to NFPA 13 unless otherwise indicated.
 - 5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For dry-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Plumbing Systems including piping.
 - 2. Mechanical Systems including ductwork and piping.
 - 3. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.

b. Air outlets and inlets.

- B. Qualification Data: For qualified Installer and professional engineer.
- C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- D. Fire-hydrant flow test report.
- E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- F. Field quality-control reports.

1.8 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.9 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. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.10 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."
- D. Sprinkler equipment and installation to be approved by authorities having jurisdiction.

- E. State certified sprinkler contractor shall have a minimum of five years specialized experience in sprinkler system design and installation. The project foreman shall have a minimum of three years experience in the installation of sprinkler systems.

1.11 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

- A. Standard Weight Schedule 40, Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- B. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- C. Galvanized, Steel Couplings: ASTM A 865, threaded.
- D. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- E. Malleable- or Ductile-Iron Unions: UL 860.
- F. Cast-Iron Flanges: ASME B16.1, Class 125.
- G. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - 2. Pressure Rating: 175 psig minimum.
 - 3. Galvanized, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
 - 4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
 - 1. Class 125, Cast-Iron and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
 - 2. Class 250, Cast-Iron and Class 300, Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.4 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
 - 1. Valves shall be UL listed or FM approved.
 - 2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.
 - 3. Minimum Pressure Rating for High-Pressure Piping: 250 psig.
- B. Ball Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International, Inc.
 - b. Victaulic Company.
 - 2. Standard: UL 1091 except with ball instead of disc.
 - 3. Valves NPS 1-1/2 and Smaller: Bronze body with threaded ends.
 - 4. Valves NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
 - 5. Valves NPS 3: Ductile-iron body with grooved ends.
- C. Iron Butterfly Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Global Safety Products, Inc.
 - b. Kennedy Valve; a division of McWane, Inc.
 - c. NIBCO INC.
 - d. Tyco Fire & Building Products LP.
 - e. Victaulic Company.
 - 2. Standard: UL 1091.
 - 3. Pressure Rating: 175 psig.
 - 4. Body Material: Cast or ductile iron.
 - 5. Style: Lug or wafer.
 - 6. End Connections: Grooved.
- D. Check Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
 - d. Fire-End & Croker Corporation.
 - e. Kennedy Valve; a division of McWane, Inc.
 - f. Metraflex, Inc.
 - g. NIBCO INC.

- h. Potter Roemer.
 - i. Reliable Automatic Sprinkler Co., Inc.
 - j. Tyco Fire & Building Products LP.
 - k. Victaulic Company.
 - l. Viking Corporation.
 - m. Watts Water Technologies, Inc.
 - 2. Standard: UL 312.
 - 3. Pressure Rating: 250 psig minimum.
 - 4. Type: Swing check.
 - 5. Body Material: Cast iron.
 - 6. End Connections: Flanged or grooved.
- E. Bronze OS&Y Gate Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. NIBCO INC.
 - 2. Standard: UL 262.
 - 3. Pressure Rating: 175 psig.
 - 4. Body Material: Bronze.
 - 5. End Connections: Threaded.
- F. Indicating-Type Butterfly Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Global Safety Products, Inc.
 - b. Kennedy Valve; a division of McWane, Inc.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Tyco Fire & Building Products LP.
 - f. Victaulic Company.
 - 2. Standard: UL 1091.
 - 3. Pressure Rating: 175 psig minimum.
 - 4. Valves NPS 2 and Smaller:
 - a. Valve Type: Ball or butterfly.
 - b. Body Material: Bronze.
 - c. End Connections: Threaded.
 - 5. Valves NPS 2-1/2 and Larger:
 - a. Valve Type: Butterfly.
 - b. Body Material: Cast or ductile iron.
 - c. End Connections: Flanged, grooved, or wafer.
 - 6. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch visual indicating device.

2.5 TRIM AND DRAIN VALVES

- A. General Requirements:
 - 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 - 2. Pressure Rating: 175 psig minimum.

2.6 SPECIALTY VALVES

- A. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 2. Pressure Rating:
 - a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.
 - b. High-Pressure Piping Specialty Valves: 250 psig minimum.
 3. Body Material: Cast or ductile iron.
 4. Size: Same as connected piping.
 5. End Connections: Flanged or grooved.
- B. Deluge Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.
 2. Standard: UL 260.
 3. Design: Hydraulically operated, differential-pressure type.
 4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, drip cup assembly piped without valves and separate from main drain line, fill-line attachment with strainer, and push-rod chamber supply connection.
 5. Dry, Pilot-Line Trim Set: Include dry, pilot-line actuator; air- and water-pressure gages; low-air-pressure warning switch; air relief valve; and actuation device. Dry, pilot-line actuator includes cast-iron, operated, diaphragm-type valve with resilient facing plate, resilient diaphragm, and replaceable bronze seat. Valve includes threaded water and air inlets and water outlet. Loss of air pressure on dry, pilot-line side allows pilot-line actuator to open and causes deluge valve to open immediately.
 6. Air Compressor:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Gast Manufacturing Inc.
 - 2) General Air Products, Inc,
 - 3) Viking Corporation.
 - b. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 - c. Motor Horsepower: Fractional.
 - d. Power: 120-V ac, 60 Hz, single phase.
- C. Automatic (Ball Drip) Drain Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 2. Standard: UL 1726.
 3. Pressure Rating: 175 psig minimum.
 4. Type: Automatic draining, ball check.

5. Size: NPS 3/4.
6. End Connections: Threaded.

2.7 SPRINKLER SPECIALTY PIPE FITTINGS

- A. General Requirements for Dry-Pipe-System Fittings: UL listed for dry-pipe service.
- B. Flow Detection and Test Assemblies:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 3. Pressure Rating: 175 psig minimum.
 4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
 5. Size: Same as connected piping.
 6. Inlet and Outlet: Threaded.
- C. Sprinkler Inspector's Test Fittings:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Triple R Specialty.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.
 2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 3. Pressure Rating: 175 psig minimum.
 4. Body Material: Cast- or ductile-iron housing with sight glass.
 5. Size: Same as connected piping.
 6. Inlet and Outlet: Threaded.

2.8 SPRINKLERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Reliable Automatic Sprinkler Co., Inc.
 2. Tyco Fire & Building Products LP.
 3. Viking Corporation.
- B. General Requirements:
 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 2. Pressure Rating for Residential Sprinklers: 175 psig maximum.
 3. Pressure Rating for Automatic Sprinklers: 175 psig minimum.
 4. Pressure Rating for High-Pressure Automatic Sprinklers: 250 psig minimum.
- C. Automatic Sprinklers with Heat-Responsive Element:

1. Nonresidential Applications: UL 199.
 2. Residential Applications: UL 1626.
 3. Characteristics: Nominal 1/2-inch orifice with discharge coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- D. Sprinkler Finishes:
1. Chrome plated.
 2. Bronze.
 3. Painted.
- E. Special Coatings:
1. Wax.
 2. Lead.
 3. Corrosion-resistant paint.
- F. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
 2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

2.9 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Pressure Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Potter Electric Signal Company.
 - b. Tyco Fire & Building Products LP.
 - c. United Electric Controls Co.
 - d. Viking Corporation.
 2. Standard: UL 346.
 3. Type: Electrically supervised water-flow switch with retard feature.
 4. Components: Single-pole, double-throw switch with normally closed contacts.
 5. Design Operation: Rising pressure signals water flow.
- C. Valve Supervisory Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fire-Lite Alarms, Inc.; a Honeywell company.
 - b. Kennedy Valve; a division of McWane, Inc.
 - c. Potter Electric Signal Company.
 - d. System Sensor; a Honeywell company.
 2. Standard: UL 346.
 3. Type: Electrically supervised.
 4. Components: Single-pole, double-throw switch with normally closed contacts.
 5. Design: Signals that controlled valve is in other than fully open position.
- D. Indicator-Post Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, Subject to compliance with requirements, provide products by one of the following:
 - a. Potter Electric Signal Company.
 - b. System Sensor; a Honeywell company.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.10 CONTROL PANELS

- A. Refer to Section 212200 "Clean-Agent Fire-Extinguishing Systems" for detection devices.

2.11 DETECTION DEVICES

- A. Refer to Section 212200 "Clean-Agent Fire-Extinguishing Systems" for detection devices.

2.12 ALARM DEVICES

- A. Description: Listed and labeled by an NRTL or FM Approved, low voltage, and surface mounting. Comply with requirements in Division 28 Section "Digital, Addressable Fire-Alarm System" or Division 28 Section "Zoned (DC Loop) Fire-Alarm System" for alarm and monitoring devices.
- B. Bells: Minimum 6-inch diameter.
- C. Horns: 90 to 94 dBA.
- D. Strobe Lights: Translucent lens, with "FIRE" or similar caption.

2.13 ELECTRICAL POWER AND WIRING

- A. Electrical power, wiring, and devices are specified in Division 26.

2.14 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. AMETEK; U.S. Gauge Division.
 2. Ashcroft, Inc.
 3. Brecco Corporation.
 4. WIKA Instrument Corporation.
- B. Standard: UL 393.
- C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

- D. Pressure Gage Range: 0 to 250 psig minimum.
- E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.
- F. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements in NFPA 13 for installation of sprinkler piping.
- C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- G. Install sprinkler piping with drains for complete system drainage.
- H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- I. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or to outside building.
- J. Connect air compressor to the following piping and wiring:
 - 1. Pressure gages and controls.
 - 2. Electrical power system.
 - 3. Fire-alarm devices, including low-pressure alarm.

- K. Mount air compressor in accordance with 210548.13 Vibration Control for Fire-Suppression Piping and Equipment.
- L. Install alarm devices in piping systems.
- M. Install hangers and supports for sprinkler system piping according to NFPA 13 and 210548.13 Vibration Control for Fire-Suppression Piping and Equipment. Comply with requirements in NFPA 13 for hanger materials.
 - 1. Provide listed felt lined pipe hangers.
- N. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal and install where they will not be subject to freezing.
- O. Drain dry-pipe sprinkler piping.
- P. Pressurize and check dry-pipe sprinkler system piping and air compressor.
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 0517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 21 0517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 21 0518 "Escutcheons for Fire-Suppression Piping."

3.3 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- I. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 - 2. Dry-Pipe and Deluge Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
 - a. Install air compressor and compressed-air supply piping.

3.5 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

3.6 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 0553 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Start and run air compressors.
 - 6. Coordinate with fire-alarm tests. Operate as required.
 - 7. Verify that equipment hose threads are same as local fire-department equipment.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.8 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.9 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.10 PIPING SCHEDULE

- A. Standard-pressure, dry-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
 - 1. Standard-weight Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 - 2. Standard-weight Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- B. Standard-pressure, dry-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be one of the following:
 - 1. Standard-weight Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 - 2. Standard-weight Schedule 40, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.11 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
1. Rooms without ceilings: Upright sprinklers.
 2. Rooms with suspended ceilings: Recessed sprinklers.
 3. Rooms with gypsum board ceilings or architectural cloud ceilings: Concealed sprinklers.
 4. Wall mounting: Sidewall sprinklers.
 5. Special applications: Extended-coverage, flow-control, and quick-response sprinklers where indicated.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 2. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
 3. Upright and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION

SECTION 21 2200 - CLEAN-AGENT FIRE-EXTINGUISHING 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. Clean-agent fire-extinguishing systems.
 - 2. Pipe and fittings.
 - 3. Valves.
 - 4. Extinguishing-agent containers.
 - 5. Fire-extinguishing clean agent.
 - 6. Discharge nozzles.
 - 7. Manifold and orifice unions.
 - 8. Fire control panels.
 - 9. Detection devices.
 - 10. Manual stations.
 - 11. Switches.
 - 12. Alarm devices.

1.3 DEFINITIONS

- A. EPO: Emergency Power Off.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Prepare in accordance with requirements of NFPA 2001, to include, but not be limited to, the following:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include design calculations.
 - 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, manufacturer-required clearances, method of field assembly, components, and location and size of each field connection.
 - 4. Include diagrams for power, signal, and control wiring.
 - 5. Permit-Approved Documents: Working plans and hydraulic calculations approved by authorities having jurisdiction.

- C. Delegated-Design Submittal: For clean-agent fire-extinguishing systems indicated to comply with performance and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, showing the items described in this Section, and coordinated with all building trades. Coordinate for enclosure integrity in accordance with NFPA 2001 requirements.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For clean-agent fire-extinguishing system to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code.

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. FM Global Compliance: Provide components that are FM Approved and that are listed in FM Approvals' "Approval Guide."
- C. UL Compliance: Provide equipment listed in UL's "Fire Protection Equipment Directory."

2.2 CLEAN-AGENT SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ansul by Johnson Controls Company.
 2. Fike Corporation.
 3. Siemens Industry, Inc., Building Technologies Division.
 4. United Technologies Corporation (UTC Climate, Controls, & Security – Kidde).
- B. Source Limitations: Obtain clean-agent systems from single source from single manufacturer.

- C. Description: Clean-agent fire-extinguishing system shall be an engineered system for total flooding of the hazard area including the room.
- D. Delegated Design: Design clean-agent fire-extinguishing system and obtain approval from authorities having jurisdiction. Design system for Class A, Class B, or Class C fires as appropriate for areas being protected, and include safety factor. Use clean agent indicated and in concentration suitable for normally occupied areas.
- E. Performance Requirements: Discharge HFC 227ea within 10 seconds and maintain 7.1 percent concentration by volume at 70 deg F for 10-minute holding time in hazard areas.
 - 1. HFC 227ea concentration in hazard areas greater than 9.0 percent immediately after discharge or less than 5.8 percent throughout holding time will not be accepted without written authorization from Owner and authorities having jurisdiction.
 - 2. System Capabilities: Minimum 620-psig calculated working pressure and 360-psig initial charging pressure.
- F. Cross-Zoned Detection: Devices located in two separate zones. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating single-detection device in another zone.
- G. System Operating Sequence:
 - 1. Actuating First Detector: Visual indication on annunciator panel. Energize audible and visual alarms (slow pulse), shut down air-conditioning and ventilating systems serving protected area, close doors in protected area, and send signal to fire-alarm system.
 - 2. Actuating Second Detector: Visual indication on annunciator panel. Energize audible and visual alarms (fast pulse), shut down power to protected equipment, start time delay for extinguishing-agent discharge for 30 seconds, and discharge extinguishing agent. On agent discharge, release preaction valve to allow water to fill sprinkler system.
 - 3. Extinguishing-agent discharge will operate audible alarms and strobe lights inside and outside the protected area.
- H. Manual stations shall immediately discharge extinguishing agent when activated.
- I. Operating abort switches will delay extinguishing-agent discharge while being activated, and switches must be reset to prevent agent discharge. Release hand pressure on the switch to cause agent discharge after the time delay has expired.
- J. EPO: Will terminate power to protected equipment immediately on actuation.
- K. Low-Agent Pressure Switch: Initiate trouble alarm if sensing less than set pressure.
- L. Power Transfer Switch: Transfer from normal to standby power source.

2.3 PIPE AND FITTINGS

- A. See "HFC 227ea Agent Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 2001, Section "Distribution," for charging pressure of system.
- C. Steel Pipe: ASTM A53/A53M, Type S, Grade B or ASTM A106/A106M, Grade A and Grade B; Schedule 40, Schedule 80, and Schedule 160, seamless steel pipe.
 - 1. Threaded Fittings:
 - a. Malleable-Iron Fittings: ASME B16.3, Class 300.
 - b. Flanges and Flanged Fittings: ASME B16.5, Class 300 unless Class 600 is indicated.
 - c. Fittings Working Pressure: 620 psig minimum.
 - d. Flanged Joints: Class 300 minimum.
 - 2. Forged-Steel Welding Fittings: ASME B16.11, Class 3000, socket pattern.
 - 3. Steel, Grooved-End Fittings: FM Approved and NRTL listed, ASTM A47/A47M malleable iron or ASTM A536 ductile iron, with dimensions matching steel pipe and ends factory grooved in accordance with AWWA C606.
- D. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch-maximum thickness unless thickness or specific material is indicated.
- E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.
- F. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Steel, Keyed Couplings: UL 213, AWWA C606, approved or listed for clean-agent service, and matching steel-pipe dimensions. Include ASTM A536, ductile-iron housing, rubber gasket, and steel bolts and nuts.

2.4 VALVES

- A. General Valve Requirements:
 - 1. UL listed or FM Approved for use in fire-protection systems.
 - 2. Compatible with type of clean agent used.
- B. Container Valves: With rupture disc or solenoid and manual-release lever, capable of immediate and total agent discharge and suitable for intended flow capacity.
- C. Valves in Sections of Closed Piping and Manifolds: Fabricate to prevent entrapment of liquid, or install valve and separate pressure relief device.

- D. Valves in Manifolds: Check valve; installed to prevent loss of extinguishing agent when container is removed from manifold.

2.5 EXTINGUISHING-AGENT CONTAINERS

- A. Description: Steel tanks complying with ASME Boiler and Pressure Vessel Code: Section VIII, for unfired pressure vessels. Include minimum working-pressure rating that matches system charging pressure, valve, pressure switch, and pressure gage.
 - 1. Finish: Red, enamel or epoxy paint.
 - 2. Manifold: Fabricate with valves, pressure switches, and connections for multiple storage containers, as indicated.
 - 3. Storage-Tank Brackets: Factory- or field-fabricated retaining brackets consisting of steel straps and channels; suitable for container support, maintenance, and tank refilling or replacement.

2.6 FIRE-EXTINGUISHING CLEAN AGENT

- A. HFC 227ea Clean Agent: Heptafluoropropane.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Dupont.
 - 2. Source Limitations: Obtain clean agents from single source from single manufacturer.

2.7 DISCHARGE NOZZLES

- A. Description: Equipment manufacturer's standard one-piece brass or aluminum alloy of type, size, discharge pattern, and capacity required for application.
- B. Material: Corrosion-resistant metal.
- C. Stamped with orifice size and type.

2.8 FIRE CONTROL PANELS

- A. Description: FM Approved or NRTL listed, including equipment and features required for testing, supervising, and operating fire-extinguishing system.
- B. Power Requirements: 120/240 V ac; with electrical contacts for connection to system components and fire-alarm system, and transformer or rectifier as needed to produce power at voltage required for accessories and alarm devices.
- C. Enclosure: NEMA ICS 6, Type 1, enameled-steel cabinet.
 - 1. Mounting: Semi-Recessed.
- D. Supervised Circuits: Separate circuits for each independent hazard area.

1. Detection circuits equal to required number of zones, or addressable devices assigned to required number of zones.
2. Manual pull-station circuit.
3. Alarm circuit.
4. Release circuit.
5. Abort circuit.
6. EPO circuit.

E. Control-Panel Features:

1. Electrical contacts for shutting down fans, activating dampers, and operating system electrical devices.
2. Automatic switchover to standby power at loss of primary power.
3. Storage container, low-pressure indicator.
4. Service disconnect to interrupt system operation for maintenance with visual status indication on the annunciator panel.

- F. Standby Power: Sealed lead calcium batteries with capacity to operate system for 24 hours and alarm for minimum of 15 minutes. Include automatic battery charger that has a varying charging rate between trickle and high depending on battery voltage, and that is capable of maintaining batteries fully charged. Include manual voltage control, dc voltmeter, dc ammeter, electrical contacts for connection to control panel, automatic transfer switch, and suitable enclosure.

2.9 DETECTION DEVICES

- A. Description: Comply with NFPA 2001, NFPA 72, and UL 268; 24 V dc, nominal.
- B. Ionization Detectors: Dual-chamber type, having sampling and referencing chambers, with smoke-sensing element.
- C. Photoelectric Detectors: LED light source and silicon photodiode receiving element.
- D. Signals to the Central Fire-Alarm Control Panel: Any type of local system trouble is reported to central fire-alarm control panel as a composite "trouble" signal. Alarms on each system zone are individually reported to central fire-alarm control panel as separately identified zones.

2.10 MANUAL STATIONS

- A. Description: Surface FM Approved or NRTL listed, with clear plastic hinged cover, 120-V ac or low-voltage compatible with controls. Include contacts for connection to control panel.
- B. Manual Release: "MANUAL RELEASE" caption, and red finish. Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.
- C. Abort Switch: "ABORT" caption, momentary contact, with green finish.
- D. EPO Switch: "EPO" caption, with yellow finish.

2.11 SWITCHES

- A. Description: FM Approved or NRTL listed, where available, 120-V ac or low-voltage compatible with controls. Include contacts for connection to control panel.

2.12 ALARM DEVICES

- A. Description: FM Approved or NRTL listed, low voltage, and surface mounting. Comply with requirements in Section 28 4621 "Addressable Fire-Alarm Systems" or Section 28 4621.13 "Conventional Fire-Alarm Systems" for alarm and monitoring devices.
- B. Bells: Minimum 6-inch diameter.
- C. Horns: 90 to 94 dBA.
- D. Strobe Lights: Translucent lens, with "FIRE" or similar caption.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with enclosure integrity requirements, installation tolerances, and other conditions affecting performance of the Work in accordance with NFPA 2001.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 HFC 227ea AGENT PIPING APPLICATIONS

- A. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.
- B. NPS 2 and Smaller: Schedule 40, steel pipe; malleable-iron threaded fittings; and threaded joints.
- C. NPS 2-1/2 and Larger: Schedule 40, steel pipe; forged-steel welding fittings; and welded or steel, grooved-end fittings; steel, keyed couplings; and grooved joints.

3.3 CLEAN-AGENT SYSTEM INSTALLATION

- A. Install clean-agent containers, piping, and other components level and plumb, in accordance with manufacturers' written instructions.
- B. Clean-Agent Container Mounting:
 - 1. Install clean-agent containers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 03 3000 "Cast-in-Place Concrete."

- C. Grooved Piping Joints: Groove pipe ends in accordance with AWWA C606 dimensions. Assemble grooved-end steel pipe and steel, grooved-end fittings with steel, keyed couplings and lubricant in accordance with manufacturer's written instructions.
- D. Install pipe and fittings, valves, and discharge nozzles in accordance with requirements listed in NFPA 2001, Section "Distribution."
 - 1. Install valves designed to prevent entrapment of liquid, or install pressure relief devices in valved sections of piping systems.
 - 2. Support piping using supports and methods in accordance with NFPA 13.
 - 3. Install control panels, detection system components, alarms, and accessories, in accordance with requirements listed in NFPA 2001, Section "Detection, Actuation, and Control Systems," as required for supervised system application.

3.4 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.5 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 26 0519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 26 0526 "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.
- E. Connect electrical devices to control panel and to building's fire-alarm system. Electrical power, wiring, and devices are specified in Section 28 4621 "Addressable Fire-Alarm Systems" or Section 28 4621 "Conventional Fire-Alarm Systems."

3.6 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Section 26 0523 "Control-Voltage Electrical Power Cables."

3.7 IDENTIFICATION

- A. Identify system components and equipment. Comply with requirements for identification specified in Section 21 0553 "Identification for Fire-Suppression Piping and Equipment."
- B. Identify piping, extinguishing-agent containers, other equipment, and panels in accordance with NFPA 2001.
- C. Install signs at entry doors for protected areas to warn occupants that they are entering a room protected with a clean-agent fire-extinguishing system.
- D. Install signs at entry doors to advise persons outside the room the meaning of horn(s), bell(s), and strobe light(s) outside the protected space.

3.8 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:
 - 1. After installing clean-agent fire-extinguishing system and after electrical circuitry has been energized, test for compliance in accordance with requirements listed in NFPA 2001, Section "Approval of Installation."
 - 2. Clean-agent fire-extinguishing system and associated protected enclosure will be considered defective if either does not pass required tests and inspections.
 - 3. Prepare test and inspection reports in accordance with requirements listed in NFPA 2001, Section "Installation Acceptance."

3.9 CLEANING

- A. Each pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, using a suitable nonflammable cleaner. Pipe network shall be free of particulate matter and oil residue before installing nozzles or discharge devices.

3.10 OPERATIONAL CONDITION SYSTEM FILLING

- A. Preparation:
 - 1. Verify that clean-agent fire-extinguishing system and protected enclosure have passed all required tests and inspections in accordance with NFPA 2001.
 - 2. Verify that clean-agent fire-extinguishing piping system installation is completed and cleaned.
 - 3. Verify complete enclosure integrity.
 - 4. Verify operation of ventilation and exhaust systems.
- B. Filling Procedures:

1. Fill clean-agent fire-extinguishing containers with extinguishing agent, and pressurize to indicated charging pressure.
2. Install filled containers.
3. Energize circuits.
4. Adjust operating controls.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain clean-agent fire-extinguishing systems.

END OF SECTION

SECTION 22 0513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING 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 general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 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 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. 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.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. 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.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.

4. Capacitor start, capacitor run.
 - B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
 - C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
 - D. Motors 1/20 HP and Smaller: Shaded-pole type.
 - E. 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 shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 22 0517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

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.
 - 2. Sleeve-seal systems.
 - 3. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide "Link-Seal" as manufactured by Pipeline Seal and Insulator, Inc. or comparable product by one of the following:
 - 1. Metraflex Company (The).
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Composite

3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- 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 adequate 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 above finished floor level.
 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 1. Cut sleeves to length for mounting flush with both surfaces.
 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

END OF SECTION

SECTION 22 0518 - ESCUTCHEONS FOR PLUMBING PIPING

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. Escutcheons.
 - 2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- 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 piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - f. Bare Piping in Equipment Rooms: One-piece, cast-brass type 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: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.

END OF SECTION

SECTION 22 0523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

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. Bronze ball valves.
2. Iron, single-flange butterfly valves.
3. Iron, grooved-end butterfly valves.
4. Bronze swing check valves.
5. Iron swing check valves.
6. Iron, center-guided check valves.
7. Bronze gate valves.
8. Iron gate valves.
9. Chainwheels.

- B. Related Sections:

1. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.

- G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

- B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.

- C. NSF Compliance: Certification that products comply with NSF 61 and NSF 372.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, gate, and globe valves closed to prevent rattling.
 - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. 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 handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Handlever: For quarter-turn valves NPS 6 and smaller.
 - 4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug-valve head.
 - 5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 - 1. Gate Valves: With rising stem.
 - 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - 3. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
 - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
 - 2. Grooved: With grooves according to AWWA C606.
 - 3. Solder Joint: With sockets according to ASME B16.18.
 - 4. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide NIBCO T-585-80-LF or a comparable product by one of the following:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Milwaukee Valve Company.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE, MPTFE or TFE.
 - h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.

2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES

- A. 150 CWP, Ductile Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
 1. Manufacturers: Subject to compliance with requirements, provide NIBCO LD-1000 or a comparable product by one of the following:
 - a. Crane Co.; Crane Valve Group; Jenkins Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. Tyco Valves & Controls; a unit of Tyco Flow Control.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 150 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.

- B. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
 1. Manufacturers: Subject to compliance with requirements, provide NIBCO LD-2000 or a comparable product by one of the following:

- a. Crane Co.; Crane Valve Group; Jenkins Valves.
- b. Crane Co.; Crane Valve Group; Stockham Division.
- c. Tyco Valves & Controls; a unit of Tyco Flow Control.
- d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 200 psig.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 536, ductile iron.
- e. Seat: EPDM.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Aluminum bronze.

2.4 IRON, GROOVED-END BUTTERFLY VALVES

A. 175 CWP, Iron, Grooved-End Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide NIBCO GD-4765-N or a comparable product by one of the following:

- a. Tyco Fire Products LP; Grinnell Mechanical Products.
- b. Victaulic Company.

2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 175 psig.
- c. Body Material: Coated, ductile iron.
- d. Stem: Two-piece stainless steel.
- e. Disc: Coated, ductile iron.
- f. Seal: EPDM.

2.5 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide NIBCO T-413-Y-LF or a comparable product by one of the following:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Stockham Division.
- c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-80, Type 4.

- b. CWP Rating: 200 psig.
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: PTFE.

2.6 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide NIBCO F-938-33 or a comparable product by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. Milwaukee Valve Company.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Design: Clear or full waterway.
 - e. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - f. Ends: Flanged.
 - g. Trim: Bronze.
 - h. Gasket: Asbestos free.

2.7 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Iron, Globe, Center-Guided Check Valves with Metal Seat:

1. Manufacturers: Subject to compliance with requirements, provide NIBCO F-910-B-LF or a comparable product by one of the following:
 - a. Metraflex, Inc.
 - b. Milwaukee Valve Company.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Style: Globe, spring loaded.
 - f. Ends: Flanged.
 - g. Seat: Bronze.

- B. Class 250, Iron, Globe, Center-Guided Check Valves with Metal Seat:
1. Manufacturers: Subject to compliance with requirements, provide NIBCO F-960-B-LF or a comparable product by one of the following:
 - a. Metraflex, Inc.
 - b. Milwaukee Valve Company.
 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Style: Globe, spring loaded.
 - f. Ends: Flanged.
 - g. Seat: Bronze.
- C. Class 125, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
1. Manufacturers: Subject to compliance with requirements, provide NIBCO F-910-W-LF or a comparable product by one of the following:
 - a. Milwaukee Valve Company.
 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Style: Globe, spring loaded.
 - f. Ends: Flanged.
 - g. Seat: EPDM or NBR.
- D. Class 250, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
1. Manufacturers: Subject to compliance with requirements, provide NIBCO F-960-W-LF or a comparable product by one of the following:
 - a. Milwaukee Valve Company.
 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Style: Globe, spring loaded.

- f. Ends: Flanged.
- g. Seat: EPDM or NBR.

2.8 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide NIBCO T-113-LF or a comparable product by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. Milwaukee Valve Company.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron.

2.9 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide NIBCO F-637-33 or a comparable product by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. Milwaukee Valve Company.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 150 psig.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Disc: Solid wedge.
 - h. Packing and Gasket: Asbestos free.

2.10 CHAINWHEELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Babbitt Steam Specialty Co.
 - 2. Roto Hammer Industries.
 - 3. Trumbull Industries.
- B. Description: Direct-mounted valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 2. Attachment: For connection to ball and butterfly valve stems.
 - 3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
 - 4. Chain: Hot-dip, galvanized 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. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.

- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for ball, butterfly, gate, globe, and plug valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- F. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.

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 valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, or butterfly valves.
 - 2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
 - 3. Throttling Service: Globe valves.
 - 4. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with nonmetallic disc.
 - b. NPS 2-1/2 and Larger for Domestic Water: Center-guided, metal-seat check valves.
 - c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, bronze with bronze trim.
3. Bronze Swing Check Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Ductile Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, aluminum-bronze disc.
2. Ductile Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, aluminum-bronze disc.
3. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 175 CWP.
4. Iron, Center-Guided Check Valves: Class 125, globe, metal seat.
5. Iron Gate Valves: Class 125, NRS.

END OF SECTION

SECTION 22 0529 - HANGERS AND SUPPORTS 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. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Equipment supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Pipe stands.
 - 4. Equipment supports.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.

4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, 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.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-Line, Inc.
 - b. Flex-Strut Inc.
 - c. Thomas & Betts Corporation.
 - d. Unistrut Corporation; Tyco International, Ltd.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Electroplated zinc.

2.4 THERMAL-HANGER SHIELD INSERTS

- 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. ERICO International Corporation.
 2. National Pipe Hanger Corporation.
 3. PHS Industries, Inc.
 4. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 5. Piping Technology & Products, Inc.

- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, 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 C 533, Type I calcium silicate with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.7 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, 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 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

- K. 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.
- L. 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. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
 - 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

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 because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 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.

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 a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

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-69 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 metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. 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 not necessary.
 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 not necessary.
 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.
- J. 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.
- K. 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.
- L. 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.
- M. 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.
- N. 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.
- O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-103 for metal framing system 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, and in accordance with Structural Engineer's requirements.
- R. Provide Type 2 Hangers (Combination Spring and Fiberglass Hangers) on suspended piping connected to isolated equipment as follows: 1" up to 4" diameter, first 3 points of support; 5" to 8" diameter, first 4 points of support; 10" diameter and over, first 6 points of support. Static deflection of first point shall be twice deflection of isolated equipment. Floor-mounted piping shall be isolated with Type 2 Spring Isolators

END OF SECTION

SECTION 22 0553 - IDENTIFICATION 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. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Valve tags.
 - 5. Warning tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- C. Valve numbering scheme.
- D. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- 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.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
 2. Letter Color: White.
 3. Background Color: Black.
 4. Maximum Temperature: Able to withstand temperatures 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 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.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: Yellow.
- 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 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. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; pipe size; and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. 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. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS

- A. Warning Tags: 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.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09 Section.
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.4 VALVE-TAG INSTALLATION

- 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.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches, round.
 - b. Hot Water: 1-1/2 inches, round.

2. Valve-Tag Color:
 - a. Cold Water: Natural.
 - b. Hot Water: Natural.

3. Letter Color:
 - a. Cold Water: Black.
 - b. Hot Water: Black.

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 22 0719 - PLUMBING PIPING INSULATION

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 insulating the following plumbing piping services:
 1. Domestic cold-water piping.
 2. Domestic hot-water piping.
 3. Domestic recirculating hot-water piping.
 4. Domestic chilled-water piping for drinking fountains.
 5. Sanitary waste piping exposed to freezing conditions.
 6. Storm-water piping exposed to freezing conditions.
 7. Roof drains and rainwater leaders.
 8. Supplies and drains for handicap-accessible lavatories and sinks.

1.3 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. 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.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 0529 "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.

1.6 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.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 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 shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Armacell LLC; AP Armaflex.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Owens Corning; SOFTR All-Service Duct Wrap.

H. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Micro-Lok.
 - b. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

- A. Materials shall be 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armacell LLC; Armaflex 520 Adhesive.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 - d. Mon-Eco Industries, Inc.; 22-25.
- 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.

- b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.
 - d. Mon-Eco Industries, Inc.; 22-25.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
- 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; 739, Dow Silicone.
 - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Polyco VP Adhesive.

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
- 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. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
 - b. Vimasco Corporation; 749.
 - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mildry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
- 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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
 - b. Eagle Bridges - Marathon Industries; 550.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
 - d. Mon-Eco Industries, Inc.; 55-50.
 - e. Vimasco Corporation; WC-1/WC-5.
 - 2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: 60 percent by volume and 66 percent by weight.

5. Color: White.

2.4 SEALANTS

A. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
2. Materials shall be 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.

2.5 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 C 1136, Type I.

2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, 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. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: 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.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
 - b. RPR Products, Inc.; Insul-Mate.
2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - 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.
 - d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-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 are acceptable

2.7 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABL, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 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. ABI, Ideal Tape Division; 370 White PVC tape.
 - b. Compac Corporation; 130.
 - c. Venture Tape; 1506 CW NS.
2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inchin width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inchin width.

2.8 SECUREMENTS

A. Bands:

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. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping and Seals.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inchwide with wing seal or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inchwide with wing seal or closed seal.

2.9 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Piping Enclosures:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Truebro; a brand of IPS Corporation.
 - b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
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. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. 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 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, 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. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- 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 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.

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.
 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, 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 pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- 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 beyond damaged areas. Adhere, staple, and seal patches similar 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.
 5. Unions.

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 Division 07 Section "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 Division 07 Section "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.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement or armaflex sheet insulation.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover at removable basket. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 8. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- 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 armaflex insulation sealed vapor tight or insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 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 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 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 preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed 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.

3.7 INSTALLATION OF MINERAL-FIBER 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 factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
 4. For insulation with factory-applied 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 preformed 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 mineral-fiber 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 preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed 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 preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered 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.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. 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.

B. 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.

3.9 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

1. Flat Acrylic Finish: Two 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 PIPING INSULATION SCHEDULE (REFER TO PLANS)
- 3.11 FIELD QUALITY CONTROL
- A. Tests and Inspections: Schedule tests and inspections with Owner with at least seven days' advance notice.
 - B. Remove and replace insulation deficiencies and retest.

END OF SECTION

SECTION 22 1116 - DOMESTIC WATER PIPING

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. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
 - 2. Encasement for piping.

1.3 ACTION SUBMITTALS

- A. Product Data.
- B. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Fire-suppression-water piping.
 - 2. Domestic water piping.
 - 3. Compressed air piping.
 - 4. HVAC hydronic piping.
 - 5. HVAC ductwork.
 - 6. Lighting Fixtures

1.4 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. 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.
- B. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Solder-joint or threaded ends.

2.3 DUCTILE-IRON PIPE AND FITTINGS

- 1. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
- 2. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.

2.4 PIPING JOINING MATERIALS

- 1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2.5 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105.
- B. Form: Sheet or Tube.
- C. Color: Black or Natural.

2.6 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.

2.7 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
- B. Dielectric Unions:
 - 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. Capitol Manufacturing Company.
 - b. EPCO Sales, Inc.
 - c. Hart Industries International, Inc.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - e. Zurn Plumbing Products Group; Wilkins Water Control Products.
 - 2. Description:
 - 3. Pressure Rating: 150 psig at 180 deg F.
 - 4. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Capitol Manufacturing Company.
 - b. EPCO Sales, Inc.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - 3. Factory-fabricated, bolted, companion-flange assembly.
 - 4. Pressure Rating: 150 psig.

5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:

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. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Pipeline Seal and Insulator, Inc.
2. Description:
3. Nonconducting materials for field assembly of companion flanges.
4. Pressure Rating: 150 psig.
5. Gasket: Neoprene or phenolic.
6. Bolt Sleeves: Phenolic or polyethylene.
7. Washers: Phenolic with steel backing washers.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Division 32 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.
- D. Install shutoff valve immediately upstream of each dielectric fitting.
- E. Install domestic water piping level and plumb.
- F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

- G. 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.
- H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- I. Install piping adjacent to equipment and specialties to allow service and maintenance.
- J. Install piping to permit valve servicing.
- K. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- L. Install piping free of sags and bends.
- M. Install fittings for changes in direction and branch connections.
- N. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- O. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- F. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. NPS 1-1/2 and Smaller: Fitting-type coupling.
 - 2. NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet If Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- D. Install hangers for copper piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.

3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 6. NPS 6: 10 feet with 5/8-inch rod.
 7. NPS 8: 10 feet with 3/4-inch rod.
- E. Install supports for vertical steel piping every 15 feet.
- F. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
 4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 22 0553 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
1. Piping Inspections:

- a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 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 final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
2. Piping Tests:
- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.10 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Open throttling valves to proper setting.
 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

- a. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

A. Clean and disinfect potable and non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Under-building-slab, domestic water piping, NPS 3 and smaller, shall be the following:
 - 1. Soft copper tube, ASTM B 88, Type K ASTM B 88, Type L; no joints below slab.
- D. Under-building-slab, domestic water, building-service piping, NPS 4 and larger, shall be the following:
 - 1. Mechanical-joint, ductile-iron pipe; standard-pattern mechanical-joint fittings; and mechanical joints and restraints.
- E. Aboveground domestic water piping, NPS 4 and smaller, shall be the following:
 - 1. Hard copper tube, ASTM B 88, Type L; wrought-copper solder-joint fittings; and soldered joints.

3.13 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use ball or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Throttling Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
 - 3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
 - 4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION

SECTION 22 1119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following domestic water and industrial water piping specialties:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Water pressure-reducing valves.
 - 4. Balancing valves.
 - 5. Temperature-actuated water mixing valves.
 - 6. Strainers.
 - 7. Outlet boxes.
 - 8. Hose stations.
 - 9. Hose bibbs.
 - 10. Wall hydrants.
 - 11. Drain valves.
 - 12. Water hammer arresters.
 - 13. Air vents.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For domestic water piping specialties.
 - 1. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 and NSF 14. Mark "NSF-pw" on plastic piping components.

2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Ames Co.
 - b. Cash Acme.
 - c. Conbraco Industries, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Zurn Plumbing Products Group; Wilkins Div.
- 2. Standard: ASSE 1001.
- 3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
- 4. Body: Bronze.
- 5. Inlet and Outlet Connections: Threaded.
- 6. Finish: Rough bronze.

- B. Hose-Connection Vacuum Breakers:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Cash Acme.
 - b. Conbraco Industries, Inc.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Woodford Manufacturing Company.
 - e. Zurn Plumbing Products Group; Light Commercial Operation.
 - f. Zurn Plumbing Products Group; Wilkins Div.
- 2. Standard: ASSE 1011.
- 3. Body: Bronze, nonremovable, with manual drain.
- 4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
- 5. Finish: Chrome or nickel plated.

C. Pressure Vacuum Breakers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Ames Co.
 - b. Conbraco Industries, Inc.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psigmaximum, through middle 1/3 of flow range.

D. Laboratory-Faucet Vacuum Breakers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - c. Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - d. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
2. Standard: ASSE 1035.
3. Size: NPS 1/4 or NPS 3/8 matching faucet size.
4. Body: Bronze.
5. End Connections: Threaded.
6. Finish: Chrome plated.

2.4 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Ames Co.
 - b. Conbraco Industries, Inc.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psigmaximum, through middle 1/3 of flow range.

2.5 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cash Acme.
 - b. Conbraco Industries, Inc.
 - c. Honeywell Water Controls.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Body: Bronze with chrome-plated finish for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
5. Valves for Booster Heater Water Supply: Include integral bypass.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.6 BALANCING VALVES

A. Memory-Stop Balancing Valves:

1. Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Div.
 - e. Hammond Valve.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig minimum CWP.
4. Size: NPS 2 or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

2.7 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Individual-Fixture, Water Tempering Valves:

1. Subject to compliance with requirements, provide products by one of the following:
 - a. Cash Acme.
 - b. Leonard Valve Company.
 - c. Powers; a Watts Industries Co.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1016, thermostatically controlled water tempering valve.
3. Pressure Rating: 125 psig minimum, unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.

2.8 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.

2.9 OUTLET BOXES

A. Icemaker Outlet Boxes:

1. Basis of Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Acorn Engineering Company.
 - b. Guy Gray Manufacturing.
 - c. IPS Corporation.
 - d. LSP Products Group, Inc.
 - e. Oatey.
 - f. Plastic Oddities; a division of Diverse Corporate Technologies.
2. Mounting: Recessed.
3. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
4. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.10 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.11 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Josam Company.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Tyler Pipe; Wade Div.
 - d. Watts Drainage Products Inc.
 - e. Woodford Manufacturing Company.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.
9. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.

2.12 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.

4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4.
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.13 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AMTROL, Inc.
 - b. Josam Company.
 - c. PPP Inc.
 - d. Sioux Chief Manufacturing Company, Inc.
 - e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - f. Tyler Pipe; Wade Div.
 - g. Watts Drainage Products Inc.
 - h. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.14 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 1/2 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - 1. Locate backflow preventers in same room as connected equipment or system.
 - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 - 3. Do not install bypass piping around backflow preventers.
- B. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.
- C. Install water control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.
- D. Install balancing valves in locations where they can easily be adjusted.
- E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 - 1. Install thermometers and water regulators if specified.
 - 2. Install cabinet-type units recessed in or surface mounted on wall as specified.
- F. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.
- G. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Carpentry, General."
- H. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.
 - 1. Install shutoff valve on outlet if specified.
 - 2. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Carpentry, General."
- I. Install water hammer arresters in water piping according to PDI-WH 201.
- J. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

3.2 CONNECTIONS

- A. Comply with requirements for ground equipment in Section 26 0526 "Grounding and Bonding for Electrical Systems."
- B. Fire-retardant-treated-wood blocking is specified in Section 26 0519 "Conductors and Cables" for electrical connections.

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Pressure vacuum breakers.
 - 2. Intermediate atmospheric-vent backflow preventers.
 - 3. Reduced-pressure-principle backflow preventers.
 - 4. Double-check backflow-prevention assemblies.
 - 5. Carbonated-beverage-machine backflow preventers.
 - 6. Dual-check-valve backflow preventers.
 - 7. Reduced-pressure-detector, fire-protection backflow-preventer assemblies.
 - 8. Double-check, detector-assembly backflow preventers.
 - 9. Water pressure-reducing valves.
 - 10. Outlet boxes.
 - 11. Hose stations.
 - 12. Supply-type, trap-seal primer valves.
 - 13. Trap-seal primer systems.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 - 1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer, double-check backflow-prevention assembly, and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.

- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION

SECTION 22 1316 - SANITARY WASTE AND VENT PIPING

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. Pipe, tube, and fittings.

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. 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.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service and Extra Heavy class(es).
- B. Gaskets: ASTM C 564, rubber.

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Clamp-All Corp.
 - c. Dallas Specialty & Mfg. Co.
 - d. MIFAB, Inc.
 - e. Mission Rubber Company; a division of MCP Industries, Inc.
 - f. Stant.
 - g. Tyler Pipe.
 - 2. Standards: ASTM C 1277 and ASTM C 1540.
 - 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 PVC PIPE AND FITTINGS

- A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.
- B. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- D. Adhesive Primer: ASTM F 656.
- E. Solvent Cement: ASTM D 2564.

2.5 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
- B. 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.
- C. 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.
- D. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 30 Section "Trenching" and "Backfilling" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
 2. PVC not allowed aboveground.
- B. Aboveground, soil and waste piping NPS 5 and larger shall be the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless cast-iron soil pipe and fittings; heavy duty, shielded, stainless-steel couplings; and hubless-coupling joints.
 3. PVC not allowed aboveground.
- C. Underground, soil, waste, and vent piping shall be one of the following:
1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
 2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- D. Underground grease waste and vent piping shall be the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
- E. Aboveground grease waste and vent piping shall be the following:
1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
- F. Aboveground sanitary-sewage force mains shall be the following:
1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.

3.3 PIPING INSTALLATION

- A. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- B. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.
- C. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- D. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- E. Install underground PVC piping according to ASTM D 2321.
- F. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. 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. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- G. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- H. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
- C. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

3.5 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in ODs.

2. In Aboveground Force Main Piping: Fitting-type 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 and Smaller: Use dielectric nipples.

3.6 VALVE INSTALLATION

- A. Comply with requirements in Section 22 0523 for general-duty valve installation requirements.

B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
2. Install gate or full-port ball valve for piping NPS 2 and smaller.
3. Install gate valve for piping NPS 2-1/2 and larger.

- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each pump discharge.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

- B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

- C. Support vertical piping and tubing at base and at each floor.

- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.

4. NPS 6: 60 inches with 3/4-inch rod.
 5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
 4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
 5. NPS 6: 10 feet with 5/8-inch rod.
 6. NPS 8: 10 feet with 3/4-inch rod.
- H. Install supports for vertical copper tubing every 10 feet.
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.8 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 drainage and vent piping to the following:
1. Plumbing Fixtures: Connect drainage 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 drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

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 drainage and vent piping according to 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. 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 drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. 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. 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. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. 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.

3.10 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION

SECTION 22 1319 - SANITARY WASTE PIPING SPECIALTIES

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. Cleanouts.
 - 2. Floor drains.
 - 3. Trench drains.
 - 4. Air-admittance valves.
 - 5. Roof flashing assemblies.
 - 6. Through-penetration firestop assemblies.
 - 7. Miscellaneous sanitary drainage piping specialties.
 - 8. Flashing materials.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FOG: Fats, oils, and greases.
- C. FRP: Fiberglass-reinforced plastic.
- D. HDPE: High-density polyethylene plastic.
- E. PE: Polyethylene plastic.
- F. PP: Polypropylene plastic.
- G. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.
 - 1. Wiring Diagrams: Power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 section.
- B. Coordinate size and location of roof penetrations.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Metal Floor Cleanouts (FCO and FGCO):

- 1. ASME A112.36.2M, Cast-Iron Cleanouts:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

- 1) Josam Company; Josam Div.
- 2) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
- 3) Tyler Pipe; Wade Div.
- 4) Watts Drainage Products Inc.
- 5) Zurn Plumbing Products Group; Specification Drainage Operation.

- 2. Standard: ASME A112.36.2M for adjustable housing cleanout.

- 3. Size: Same as connected branch.

- 4. Type: Adjustable housing.

- 5. Body or Ferrule: Cast iron.

- 6. Clamping Device: Required.

- 7. Outlet Connection: Inside call.

- 8. Closure: Brass plug with straight threads and gasket.

- 9. Adjustable Housing Material: Cast iron with threads.

10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Extra Heavy Duty (FGCO).
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Cast-Iron Wall Cleanouts (WCO):

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Tyler Pipe; Wade Div.
 - d. Watts Drainage Products Inc.
 - e. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
5. Closure: Countersunk, plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, cover plate with screw.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1) Josam Company; Josam Div.
 - 2) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - 3) Tyler Pipe; Wade Div.
 - 4) Watts Drainage Products Inc.
 - 5) Zurn Plumbing Products Group; Specification Drainage Operation.

2.3 TRENCH DRAIN SYSTEMS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MultiDrain Systems, Inc.
 - b. Josam Company; Josam Div.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group Specification Drainage Operation

2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
3. Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps.
 - a. Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated.
 - b. Include extension sections necessary for required depth.
 - c. Include number of units required to form total lengths indicated.
 - d. Frame: Gray-iron or galvanized steel for grates.
4. Grates: Manufacturer's designation "extra heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
 - a. Material: Ductile iron.
 - 1) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
5. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
6. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch-minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch-minimum water seal.

B. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

C. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

D. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

2.5 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Oatey.
 - b. Studor, Inc.
2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
3. Housing: Plastic.
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected fixture or branch vent piping.

B. Stack Air-Admittance Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Oatey.
 - b. Studor, Inc.
2. Standard: ASSE 1050 for vent stacks.
3. Housing: Plastic.
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected stack vent or vent stack.

C. Wall Box for Air-Admittance Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Oatey.
 - b. Studor, Inc.
2. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
3. Size: About 9 inches wide by 8 inches high by 4 inches deep.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
 - 5. Ensure ample clearance at clean out for rodding of drainage system.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall. Provide bolted coverplate cleanouts on vertical rainwater leaders only.
- D. 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. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- E. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
- F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- G. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- H. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.
- I. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- J. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- K. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

- L. Install wood-blocking reinforcement for wall-mounting-type specialties.
- M. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- N. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

- A. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- B. Set flashing on floors and roofs in solid coating of bituminous cement.
- C. Secure flashing into sleeve and specialty clamping ring or device.
- D. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."
- E. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- F. Fabricate and install flashing and pans, sumps, and other drainage shapes.

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

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. Grease interceptors.
 - 2. Solids interceptors.

1.3 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.
- B. PP: Polypropylene plastic.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of interceptor. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.
- B. Shop Drawings: For each type and size of precast concrete interceptor indicated.
 - 1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Piping connections. Include size, location, and elevation of each.
 - 2. Interface with underground structures and utility services.

PART 2 - PRODUCTS

2.1 GREASE INTERCEPTORS

- A. Precast Concrete Grease Interceptors: Comply with ASTM C 913.
1. Include rubber-gasketed joints, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.
 2. Structural Design Loads:
 - a. Light-Traffic Load: Comply with ASTM C 890, A-8.
 3. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of interceptor to finished grade is less than 60 inches.
 4. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
 5. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover.
 - a. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
 - b. Gray Iron: ASTM A 48/A 48M, Class 35, unless otherwise indicated.
 - c. Include indented top design with lettering cast into cover, using wording equivalent to "GREASE INTERCEPTOR."

2.2 SOLIDS INTERCEPTORS

- A. Precast Concrete Solids Interceptors: Comply with ASTM C 913.
1. Include rubber-gasketed joints, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.
 2. Structural Design Loads:
 - a. Light-Traffic Load: Comply with ASTM C 890, A-8.
 3. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of interceptor to finished grade is less than 60 inches.
 4. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
 5. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover.
 - a. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
 - b. Gray Iron: ASTM A 48/A 48M, Class 35, unless otherwise indicated.
 - c. Include indented top design with lettering cast into cover, using wording equivalent to "SOLIDS INTERCEPTOR."

2.3 PRECAST CONCRETE MANHOLE RISERS

- A. Precast Concrete Manhole Risers: ASTM C 913, with rubber-gasket joints.
 - 1. Structural Design Loads:
 - a. Heavy-Traffic Load: Comply with ASTM C 890, A-16.
 - 2. Length: From top of underground concrete structure to grade.
 - 3. Riser Sections: 3-inch minimum thickness and 36-inch diameter.
 - 4. Top Section: Eccentric cone, unless otherwise indicated. Include top of cone to match grade ring size.
 - 5. Gaskets: ASTM C 443, rubber.
 - 6. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals.
- B. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, diameter matching manhole frame and cover, and height as required to adjust the manhole frame and cover to indicated elevation and slope.
- C. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover.
 - 1. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
 - 2. Gray Iron: ASTM A 48/A 48M, Class 35, unless otherwise indicated.
 - 3. Include indented top design with lettering cast into cover, using wording equivalent to the following:
 - a. Grease Interceptors in Sanitary Sewerage System: "GREASE INTERCEPTOR."
 - b. Oil Interceptors in Sanitary Sewerage System: "OIL INTERCEPTOR."
 - c. Solids Interceptors in Sanitary Sewerage System: "SOLIDS INTERCEPTOR."

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 31 2000 "Earth Moving."

3.2 INSTALLATION

- A. Install precast concrete interceptors according to ASTM C 891.
- B. Set interceptors level and plumb.
- C. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.
- D. Set tops of manhole frames and covers flush with finished surface in pavements.

- E. Set tops of grating frames and grates flush with finished surface.
- F. Set metal interceptors level and plumb.
- G. Set tops of metal interceptor covers flush with finished surface in pavements.
- H. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
 - 1. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.
- I. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in Section 22 1316 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Make piping connections between interceptors and piping systems.

3.4 IDENTIFICATION

- A. Identification materials and installation are specified in Section 31 2000 "Earth Moving."
 - 1. Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
 - 2. Use warning tapes or detectable warning tape over ferrous piping.
 - 3. Use detectable warning tape over nonferrous piping and over edges of underground structures.
- B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Grease interceptors.
 - 2. Solids interceptors.

3.5 PROTECTION

- A. Protect sanitary waste interceptors from damage during construction period.
- B. Repair damage to adjacent materials caused by sanitary waste interceptor installation.

END OF SECTION

SECTION 22 1413 - FACILITY STORM DRAINAGE PIPING

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. Pipe, tube, and fittings.

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Storm Drainage Piping: 10-foot head of water.

1.4 ACTION SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. 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.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service and Extra Heavy classes.
- B. Gaskets: ASTM C 564, rubber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Clamp-All Corp.
 - c. Dallas Specialty & Mfg. Co.
 - d. MIFAB, Inc.
 - e. Mission Rubber Company; a division of MCP Industries, Inc.
 - f. Stant.
 - g. Tyler Pipe.
 - 2. Standards: ASTM C 1277 and ASTM C 1540.
 - 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 2000 "Earth Moving."

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from 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. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- K. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- L. Install storm drainage piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.
- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- N. Plumbing Specialties:
 - 1. Install backwater valves in storm drainage gravity-flow piping. Comply with requirements for backwater valves specified in Section 22 1423 "Storm Drainage Piping Specialties."
 - 2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Section 22 1423 "Storm Drainage Piping Specialties."
 - 3. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Section 22 1423 "Storm Drainage Piping Specialties."
- O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 0517 "Sleeves and Sleeve Seals for Plumbing Piping."
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 0517 "Sleeves and Sleeve Seals for Plumbing Piping."

- R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 0518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. 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.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 0529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 - 3. Install carbon-steel 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. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 - 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 - 5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
 - 6. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.
 - 1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. Make connections according to 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.

3.6 IDENTIFICATION

- A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 22 0553 "Identification for Plumbing Piping and Equipment."

3.7 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.
 - 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 storm drainage piping according to 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. 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 storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 5. Prepare reports for tests and required corrective action.

3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground storm drainage piping shall be the following:

1. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.
- C. Underground storm drainage piping shall be the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

END OF SECTION

SECTION 22 1423 - STORM DRAINAGE PIPING SPECIALTIES

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. Roof drains.
 - 2. Miscellaneous storm drainage piping specialties.
 - 3. Cleanouts.
 - 4. Backwater valves.
 - 5. Through-penetration firestop assemblies.
 - 6. Flashing materials.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 METAL ROOF DRAINS

- A. Cast-Iron, Large-Sump, General-Purpose Roof Drains:
 - 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. Josam Company.
 - b. Smith, Jay R. Mfg. Co.
 - c. Tyler Pipe.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.6.4, for general-purpose roof drains.

- B. Cast-Iron, Small-Sump, General-Purpose Roof Drains:
 - 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. Josam Company.
 - b. Smith, Jay R. Mfg. Co.
 - c. Tyler Pipe.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.6.4, for general-purpose roof drains.
 - 3. Body Material: Cast iron.

2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

- A. Conductor Nozzles:
 - 1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
 - 2. Size: Same as connected conductor.

2.3 CLEANOUTS

- A. Floor Cleanouts:
 - 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. Josam Company.
 - b. Smith, Jay R. Mfg. Co.
 - c. Tyler Pipe.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.36.2M, for adjustable housing cleanouts.
- B. Test Tees:
 - 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. Josam Company.
 - b. Smith, Jay R. Mfg. Co.
 - c. Tyler Pipe.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
 - 3. Size: Same as connected drainage piping.

4. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure Plug: Countersunk, brass.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

C. Wall Cleanouts:

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. Josam Company.
 - b. Smith, Jay R. Mfg. Co.
 - c. Tyler Pipe.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
3. Size: Same as connected drainage piping.

2.4 BACKWATER VALVES

A. Cast-Iron, Horizontal Backwater Valves:

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. Josam Company.
 - b. Smith, Jay R. Mfg. Co.
 - c. Tyler Pipe.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.14.1, for backwater valves.
3. Size: Same as connected piping.
4. Body Material: Cast iron.

2.5 FLASHING MATERIALS

- A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft. .
- B. Fasteners: Metal compatible with material and substrate being fastened.
- C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- D. Solder: ASTM B 32, lead-free alloy.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07 Sections.
 - 1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 - 2. Install expansion joints, if indicated, in roof drain outlets.
 - 3. Position roof drains for easy access and maintenance.
- B. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
- C. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
 - 1. Use cleanouts the same size as drainage piping up to NPS 4 . Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
 - 3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate cleanouts at base of each vertical soil and waste stack.
- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. Install horizontal backwater valves in floor with cover flush with floor.
- G. Install test tees in vertical conductors and near floor.
- H. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
- I. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.
- J. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb/sq. ft. lead sheets, 0.0625-inch thickness or thinner.
 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

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

SECTION 22 3300 - ELECTRIC, DOMESTIC-WATER HEATERS

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. Commercial, electric, storage, domestic-water heaters.
 - 2. Domestic-water heater accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of electric, domestic-water heater, from manufacturer.
- B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- C. 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.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which 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. Commercial, Electric, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: Three years.
 - 2) Controls and Other Components: Three years.
 - b. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, ELECTRIC, domestic-WATER HEATERS

- A. Commercial, Electric, Storage, Domestic-Water Heaters:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Bradford White Corporation.
 - b. Lochinvar Corporation.

- c. PVI Industries, LLC.
 - d. Rheem Manufacturing Company.
 - e. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
 - f. State Industries.
 - g. HTP
- 2. Standard: UL 1453.
 - 3. Storage-Tank Construction: Non-ASME-code, steel vertical arrangement.
 - a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
 - 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Pressure Rating: 150 psig.
 - c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
 - 4. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - c. Insulation: Comply with ASHRAE/IESNA 90.1.
 - d. Jacket: Steel with enameled finish.
 - e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
 - f. Temperature Control: Adjustable thermostat.
 - g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
 - h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
 - 5. Special Requirements: NSF 5 construction.

2.2 domestic-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. AMTROL Inc.
 - b. Pentair Pump Group (The); Myers.
 - c. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
 - d. State Industries.
 - e. Taco, Inc.
 - f. Watts.

2. 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.
3. 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 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
- B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. 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 or with ASME B1.20.7 garden-hose threads.
- C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.
- D. Heat-Trap Fittings: 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 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 22 0523 "General-Duty Valves for Plumbing Piping."
 2. Comply with requirements for balancing valves specified in Section 22 1119 "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 domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
- H. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.
- 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 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.

2.3 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to 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. Comply with requirements in Section 01 4000 "Quality Requirements" for retesting and reinspecting requirements and Section 01 7300 "Execution" for requirements for correcting the Work.
- 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 03 3000 "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. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
 - 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 22 0523 "General-Duty Valves for Plumbing Piping."

- C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 1119 "Domestic Water Piping Specialties."
- E. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- F. Fill electric, domestic-water heaters with water.
- G. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 1116 "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 22 0553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 4000 "Quality Requirements"

for retesting and reinspecting requirements and Section 01 7300 "Execution" for requirements for correcting the Work.

- C. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial, electric, domestic-water heaters.

END OF SECTION

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. Commercial, gas-fired, high-efficiency, storage, domestic-water heaters.
 - 2. Domestic-water heater accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of commercial, gas-fired, domestic-water heater, from manufacturer.
- B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.
- C. ASME Compliance:
 - 1. 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.
 - 2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, 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. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: Three years.
 - 2) Controls and Other Components: One year(s).
 - b. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

A. Commercial, Gas-Fired, High-Efficiency, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Bradford White Corporation.
 - b. Lochinvar Corporation.
 - c. PVI Industries, LLC.
 - d. Rheem Manufacturing Company.
 - e. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
 - f. State Industries.
 - g. HTP
 - h. Bock
2. Standard: ANSI Z21.10.3/CSA 4.3.
3. Description: Manufacturer's proprietary design to provide at least 95 percent combustion efficiency at optimum operating conditions.
4. Storage-Tank Construction: ASME-code steel with 150-psig minimum working-pressure rating.
 - a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
 - 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Lining: Glass complying with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
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 complying with ASSE 1005.
 - d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
 - e. Jacket: Steel with enameled finish.
 - f. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for gas-fired, high-efficiency, domestic-water heaters and natural-gas fuel.
 - g. Temperature Control: Adjustable thermostat.
 - h. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.

- i. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. AMTROL, Inc.
- b. Pentair Pump Group.
- c. TACO Comfort Solutions, Inc.
- d. Elbi.
- e. Wessels
- f. Watts.

2. 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.

3. 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 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
- c. Air-Charging Valve: Factory installed.

- B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. 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 or with ASME B1.20.7 garden-hose threads.

- C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

- D. Heat-Trap Fittings: 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 memory-stop balancing valves to provide balanced flow through each domestic-water heater.

- F. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 22 0523.12 "Ball Valves for Plumbing Piping," Section 22 0523.13 "Butterfly Valves for Plumbing Piping," and Section 22 0523.15 "Gate Valves for Plumbing Piping."

1. Comply with requirements for balancing valves specified in Section 22 1119 "Domestic Water Piping Specialties."
 - G. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.
 - H. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
 - I. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.
 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
 - J. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.
 - K. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches 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.
- 2.3 SOURCE QUALITY CONTROL
- A. Factory Tests: Test and inspect assembled domestic-water heaters specified to be ASME-code construction, according to 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. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 4000 "Quality Requirements" for retesting and reinspecting requirements and Section 01 7300 "Execution" for requirements for correcting the Work.
 - D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Section 03 3000 "Cast-in-Place Concrete."

1. Exception: Omit concrete bases for commercial 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. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
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 22 0523.12 "Ball Valves for Plumbing Piping," Section 22 0523.13 "Butterfly Valves for Plumbing Piping," and Section 22 0523.15 "Gate Valves for Plumbing Piping."
- C. Install gas-fired, domestic-water heaters according to NFPA 54.
1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
 2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
 3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
 4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 23 1123 "Facility Natural-Gas Piping."
- D. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 22 0548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- E. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- F. Install combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

- G. 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 domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 1119 "Domestic Water Piping Specialties."
- H. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 22 0519 "Meters and Gages for Plumbing Piping."
- I. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves specified in Section 22 0523.12 "Ball Valves for Plumbing Piping," Section 22 0523.13 "Butterfly Valves for Plumbing Piping," and Section 22 0523.15 "Gate Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section 22 0519 "Meters and Gages for Plumbing Piping."
- J. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.
- K. Fill domestic-water heaters with water.
- L. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

- A. Comply with requirements for domestic-water piping specified in Section 22 1116 "Domestic Water Piping."
- B. Comply with requirements for gas piping specified in Section 23 1123 "Facility Natural-Gas Piping."
- C. Drawings indicate general arrangement of piping, fittings, and specialties.
- D. Where installing piping adjacent to fuel-fired, 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 22 0553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 4000 "Quality Requirements" for retesting and reinspecting requirements and Section 01 7300 "Execution" for requirements for correcting the Work.
- C. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage, domestic-water heaters.

END OF SECTION

SECTION 22 4213.13 - COMMERCIAL WATER CLOSETS

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. Water closets.
 - 2. Flushometer valves.
 - 3. Toilet seats.

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 water closets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

PART 2 - PRODUCTS

2.1 FLOOR-MOUNTED WATER CLOSETS

- A. Water Closets: Floor mounted, top spud, accessible.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. American Standard America.
 - b. Crane Plumbing, L.L.C.
 - c. Kohler Co.
 - d. TOTO USA, INC.
 - e. Sloan.
 - f. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - g. Watts Water Technologies, Inc.
 2. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Height: Standard.
 - d. Rim Contour: Elongated.
 - e. Spud Size and Location: NPS 1-1/2; top.

2.2 FLUSHOMETER VALVES

- A. Battery-Powered, Solenoid-Actuator, Flushometer Valves:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Kohler Co.
 - b. Sloan Valve Company.
 - c. TOTO USA, INC.
 - d. Zurn Industries, LLC; Commercial Brass and Fixtures.
 2. Standard: ASSE 1037.
 3. Minimum Pressure Rating: 125 psig.
 4. Features: Include integral check stop and backflow-prevention device.
 5. Material: Brass body with corrosion-resistant components.
 6. Exposed Flushometer-Valve Finish: Chrome plated.
 7. Panel Finish: Chrome plated or stainless steel.
 8. Style: Exposed.
 9. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 10. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 11. Consumption: 1.28 gal. per flush.
 12. Minimum Inlet: NPS 1.
 13. Minimum Outlet: NPS 1-1/4.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Water-Closet Installation:

- 1. Install level and plumb according to 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 for handicapped/elderly, according to ICC/ANSI A117.1.

B. Support Installation:

- 1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
- 2. Use carrier supports with waste-fitting assembly and seal.
- 3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
- 4. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

C. Flushometer-Valve Installation:

- 1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
- 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
- 3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
- 4. Install actuators in locations that are easy for people with disabilities to reach.
- 5. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

- 1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
- 2. Install deep-pattern escutcheons if required to conceal protruding fittings.
- 3. Comply with escutcheon requirements specified in Section 22 0518 "Escutcheons for Plumbing Piping."

3.3 CONNECTIONS

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 22 1116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 1316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 4213.16 - COMMERCIAL URINALS

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. Urinals.
 - 2. Flushometer valves.

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 urinals.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

PART 2 - PRODUCTS

2.1 WALL-HUNG URINALS

- A. Urinals: Wall hung, top spud, washout, accessible.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. American Standard America.
 - b. Crane Plumbing, L.L.C.
 - c. Kohler Co.
 - d. TOTO USA, INC.
 - e. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - f. Sloan
2. Fixture:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Washout with extended shields.
 - d. Strainer or Trapway: Manufacturer's standard removable beehive strainer with integral trap.
 - e. Water Consumption: Water saving.
 - f. Spud Size and Location: NPS 3/4, top.
 - g. Outlet Size and Location: NPS 2, back.
 - h. Color: White.
3. Waste Fitting:
 - a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
 - b. Size: NPS 2.
4. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.

2.2 URINAL FLUSHOMETER VALVES

A. Battery, Solenoid-Actuator, Diaphragm Flushometer Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Kohler Co.
 - b. Sloan Valve Company.
 - c. TOTO USA, INC.
 - d. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed or concealed. Refer to plumbing schedule.

9. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
10. Trip Mechanism: electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
11. Consumption: 0.5 gal. per flush.
12. Minimum Inlet: NPS 1.
13. Minimum Outlet: NPS 1-1/4.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.
- B. Examine walls and floors for suitable conditions where urinals will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Urinal Installation:
 1. Install urinals level and plumb according to roughing-in drawings.
 2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
 3. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.
- B. Support Installation:
 1. Install supports, affixed to building substrate, for wall-hung urinals.
 2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
 3. Use carriers without waste fitting for urinals with tubular waste piping.
 4. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.
- C. Flushometer-Valve Installation:
 1. Install flushometer-valve water-supply fitting on each supply to each urinal.
 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
 3. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
- D. Wall Flange and Escutcheon Installation:
 1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.

2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Division 22 Section "Escutcheons for Plumbing Piping."

E. Joint Sealing:

1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to urinal color.
3. Comply with sealant requirements specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

- A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.
- B. Comply with water piping requirements specified in Division 22 Section "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Division 22 Section "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to urinals, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed urinals and fittings.
- C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 4216.13 - COMMERCIAL LAVATORIES

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. Lavatories.
 - 2. Faucets.

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 lavatories.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.
 - 1. In addition to items specified in Section 01 7823 "Operation and Maintenance Data," include the following:
 - a. Servicing and adjustments of automatic faucets.

PART 2 - PRODUCTS

2.1 VITREOUS-CHINA, COUNTER-MOUNTED LAVATORIES

- A. Lavatory: Self-rimming, vitreous china, counter mounted.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. American Standard America.
 - b. Crane Plumbing, L.L.C.
 - c. Kohler Co.
 - d. TOTO USA, INC.
 - e. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - f. Sloan.
 - 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: Self-rimming for above-counter mounting.
 - c. Faucet-Hole Location: Top.
 - d. Color: White.
 - e. Mounting Material: Sealant.
- B. Lavatory: Vitreous china, undercounter mounted.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. American Standard America.
 - b. Crane Plumbing, L.L.C.
 - c. Kohler Co.
 - d. TOTO USA, INC.
 - e. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - f. Sloan.
 - 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: For undercounter mounting.
 - c. Faucet-Hole Punching: No holes.
 - d. Faucet-Hole Location: On countertop.
 - e. Color: White.
 - f. Mounting Material: Sealant and undercounter mounting kit.

2.2 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

- A. Lavatory: Ledge back, vitreous china, wall mounted.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. American Standard America.

- b. Crane Plumbing, L.L.C.
 - c. Kohler Co.
 - d. TOTO USA, INC.
 - e. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - f. Sloan.
 - 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: For wall hanging.
 - c. Faucet-Hole Location: Top.
 - d. Color: White.
 - e. Mounting Material: Chair carrier.
 - 3. Support: ASME A112.6.1M, Type II, concealed-arm lavatory carrier with escutcheons. Include rectangular, steel uprights.
- B. Lavatory: Wheelchair, vitreous china, wall mounted.
- 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. American Standard America.
 - b. Crane Plumbing, L.L.C.
 - c. Kohler Co.
 - d. TOTO USA, INC.
 - e. Zurn Industries, LLC; Commercial Brass and Fixtures.
 - f. Sloan.
 - 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: Slab or wheelchair.
 - c. Nominal Size: Rectangular, 27 by 20 inches.
 - d. Faucet-Hole Location: Top.
 - e. Color: White.
 - f. Mounting: For concealed-arm carrier.
 - 3. Support: ASME A112.6.1M, Type II, concealed-arm lavatory carrier with rectangular, steel uprights.

2.3 SOLID-BRASS, AUTOMATICALLY OPERATED LAVATORY FAUCETS

- A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.
- A. Lavatory Faucets: Automatic-type, battery-powered, electronic-sensor-operated, mixing, solid-brass valve.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. American Standard America.
 - b. Bradley Corporation.
 - c. Chicago Faucets.
 - d. Grohe America, Inc.
 - e. Kohler Co.
 - f. Moen Incorporated.

- g. Sloan Valve Company.
- h. Speakman Company.
- i. T & S Brass and Bronze Works, Inc.
- j. TOTO USA, INC.
- k. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
3. 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.
4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
5. Body Type: Single hole.
6. Body Material: Commercial, solid brass.
7. Finish: Polished chrome plate.
8. Maximum Flow Rate: 0.5 gpm.
9. Mounting Type: Deck, concealed.
10. Spout: Rigid type.
11. Spout Outlet: Aerator.

2.4 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. 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.
- D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Loose key.
- F. Risers:
 1. NPS 1/2.
 2. Chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces riser.

2.5 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
- C. Trap:
 1. Size: NPS 1-1/2 by NPS 1-1/4.
 2. Material: 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.
 3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
- B. Examine counters and walls for suitable conditions where lavatories will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install lavatories level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-mounted lavatories.
- C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
- D. 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 22 0518 "Escutcheons for Plumbing Piping."
- E. 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 07 9200 "Joint Sealants."
- F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 22 0719 "Plumbing Piping Insulation."

3.3 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 22 1116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 1316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

- B. Adjust water pressure at faucets to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

- A. After completing installation of lavatories, inspect and repair damaged finishes.
- B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories and fittings.
- D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 4216.16 - COMMERCIAL SINKS

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 basins.
 - 2. Service sinks.
 - 3. Utility sinks.
 - 4. Handwash sinks.
 - 5. Sink faucets.
 - 6. Supply fittings.
 - 7. Waste fittings.

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 sinks.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.5 CLOSEOUT SUBMITTALS

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

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. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 SERVICE BASINS

- A. Service Basins: Terrazzo, floor mounted.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Acorn Engineering Company.
 - b. Crane Plumbing, L.L.C.
 - c. Fiat.
 2. Fixture:
 - a. Standard: IAPMO PS 99.
 - b. Shape: Square or Rectangular.
 - c. Drain: Grid with NPS 3 outlet.
 3. Mounting: On floor and flush to wall.

2.2 UTILITY SINKS

- A. Utility Sinks: Stainless steel, counter mounted.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Advance Tabco.
 - b. Eagle Group; Foodservice Equipment Division.
 - c. Elkay Manufacturing Co.
 - d. Just Manufacturing.
 2. Fixture:
 - a. Standard: ASME A112.19.3/CSA B45.4.
 - b. Type: Top mounted with rounded corners.
 - c. Number of Compartments: Refer to Schedule on Plans.
 - d. Overall Dimensions: Refer to Schedule on Plans.
 - e. Metal Thickness: 18 gauge, type 304.
 - f. Faucet(s): Refer to Schedule on Plans.
 3. Supply Fittings:
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
 - 1) Operation: Loose key.

- 2) Risers: NPS 1/2, ASME A112.18.6, braided or corrugated stainless-steel flexible hose.
4. Waste Fittings:
 - a. Standard: ASME A112.18.2/CSA B125.2.
 - b. Trap(s):
 - 1) Size: Refer to Schedule on Plans.
 - 2) Material: 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.
 - 3) Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.
 - c. Continuous Waste:
 - 1) Size: Refer to Schedule on Plans.
 - 2) Material: Chrome-plated, 0.032-inch-thick brass tube.
5. Mounting: On counter with sealant.

2.3 SINK FAUCETS

- A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet-spout materials that will be in contact with potable water.
 1. Sink Faucets: Manual type, two-lever-handle mixing valve.
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1) American Standard America.
 - 2) Bradley Corporation.
 - 3) Chicago Faucets.
 - 4) Eljer, Inc.
 - 5) Elkay Manufacturing Co.
 - 6) Just Manufacturing.
 - 7) Moen Commercial.
 - 8) T & S Brass and Bronze Works, Inc.
 - 9) Zurn Plumbing Products Group.
 2. Standard: ASME A112.18.1/CSA B125.1.
 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.

2.4 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.

- B. Standard: ASME A112.18.1/CSA B125.1.
- C. 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.
- D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Loose key.

2.5 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.
- C. Trap:
 - 1. Size: NPS 1-1/2.
 - 2. Material: Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated brass or steel wall flange.

2.6 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.
- B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install sinks level and plumb according to roughing-in drawings.

- B. Install supports, affixed to building substrate, for wall-hung sinks.
- C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
- D. Set floor-mounted sinks in leveling bed of cement grout.
- E. Install water-supply piping with stop on each supply to each sink faucet.
 - 1. Exception: Use ball, gate, or globe valves if supply stops are not specified with sink. Comply with valve requirements specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
 - 2. Install stops in locations where they can be easily reached for operation.
- F. 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 Division 22 Section "Escutcheons for Plumbing Piping."
- G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Division 07 Sections.
- H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Division 22 Section "Plumbing Piping Insulation."

3.3 CONNECTIONS

- A. Connect sinks 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 Division 22 Section "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Division 22 Section "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.
- C. As the Owner's representative, the CxA shall periodically witness the field-adjustable settings of commercial sinks performed by the installing Contractor or vendor to verify that normal operating conditions are achieved and maintained. The installing Contractor or vendor shall give written reports of the results of these commercial sink equipment adjustments to the CxA for review of accuracy and completeness.

- D. The installing Contractor or vendor shall clearly document all commercial sink equipment field-adjustable settings in a written report as part of the commercial sink equipment operation and maintenance manual.

3.5 CLEANING AND PROTECTION

- A. After completing installation of sinks, inspect and repair damaged finishes.
- B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed sinks and fittings.
- D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 4716 - PRESSURE WATER COOLERS

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 pressure water coolers and related components.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of pressure water cooler.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For pressure water coolers to include in maintenance manuals.

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 10 percent of quantity installed for each type and size indicated, but no fewer than 2 of each.

PART 2 - PRODUCTS

2.1 PRESSURE WATER COOLERS

- A. Pressure Water Coolers: Wall mounted, wheelchair accessible.
 - 1. Basis of Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

- a. Elkay Manufacturing Co.
 - b. Halsey Taylor.
 - c. Haws Corporation.
 - d. Murdock Mfg.
 - e. Oasis Corporation.
 - f. Sunroc Corp.
2. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
 3. Drain: Grid with NPS 1-1/4 tailpiece.
 4. Supply: NPS 3/8 with shutoff valve.
 5. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
 6. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
 7. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
 - 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.
 8. Support: ASME A112.6.1M, Type I water-cooler carrier.

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 according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- C. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers to mounting frames.
- D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 22 0523 "General-Duty Valves for Plumbing Piping."

- E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- F. 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 22 0518 "Escutcheons for Plumbing Piping."
- G. 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 Division 07 Section.

3.3 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 22 1116 "Domestic Water Piping."
- C. Install ball, gate, or globe shutoff valve on water supply to each fixture. Install valve upstream from filter for water cooler. Comply with valve requirements specified in Section 22 0523 "General-Duty Valves for Plumbing Piping."
- D. Comply with soil and waste piping requirements specified in Section 22 1316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust pressure water-cooler temperature settings.

3.5 CLEANING

- A. After installing fixture, 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, according to 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

SECTION 23 0513 - COMMON MOTOR REQUIREMENTS FOR HVAC 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 general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 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 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1-2016 unless otherwise indicated.
- C. Comply with IEEE 841 for severe-duty motors.
- D. Shaft Grounding:
 - 1. All motors operated on variable frequency drives shall be equipped with a maintenance free, conductive micro fiber, shaft grounding ring with a minimum of two rows of circumferential micro fibers to discharge damaging shaft voltages away from the bearings to ground.
 - 2. Application Note: Motors up to 100HP shall be provided with one shaft grounding ring installed either on the drive end or non-drive end. Motors over 100HP shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor. Grounding rings shall be provided and

installed by the motor manufacturer or contractor and shall be installed in accordance with the manufacturer's recommendations.

- E. High-Frequency Bonding: All motors operated on variable frequency drives shall be bonded from the motor foot to system ground with a high frequency ground strap made of flat braided, tinned copper with terminations to accommodate motor foot and system ground connection.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. 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.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. 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.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. 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.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. 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 shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 23 0517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

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.
 - 2. Sleeve-seal systems.
 - 3. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide "Link-Seal" as manufactured by Pipeline Seal and Insulator, Inc. or comparable product by one of the following:
 - 1. Metraflex Company (The).
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Composite

3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- 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 adequate 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 above finished floor level.
 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 1. Cut sleeves to length for mounting flush with both surfaces.
 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section.

- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

END OF SECTION

SECTION 23 0518 - ESCUTCHEONS FOR HVAC PIPING

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. Escutcheons.
 - 2. Floor plates.

1.3 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- 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 piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - f. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.

3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION

SECTION 23 0529 - HANGERS & SUPPORTS FOR HVAC PIPING & 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. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

- B. Related Sections:

1. Division 23 Section "Vibration Controls for HVAC Piping and Equipment" for vibration isolation devices.
2. Division 23 Section "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to 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.

1.5 SUBMITTALS

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

- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Pipe stands.
 - 4. Equipment supports.
- C. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Copper Pipe Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, 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.

2.3 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:

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. Cooper B-Line, Inc.
 - b. Thomas & Betts Corporation.
 - c. Unistrut Corporation; Tyco International, Ltd.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturred lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Hot-dipped galvanized.

2.4 THERMAL-HANGER SHIELD INSERTS

- 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. ERICO International Corporation.
 2. National Pipe Hanger Corporation.
 3. PHS Industries, Inc.
 4. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 5. Piping Technology & Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, 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 C 533, Type I calcium silicate with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.7 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, 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 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer.

- Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. 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.
- L. 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. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

- b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

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 because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 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.

3.5 PAINTING

- A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Section.

- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

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-69 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 copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. 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 not necessary.
 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 not necessary.
 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.
- J. 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.
- K. 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.
- L. 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-joint 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.
- M. 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.
- N. 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.
- O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-103 for metal framing system 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. Provide Type 2 Hangers (Combination Spring and Fiberglass Hangers, Refer to Section 23 0548) on suspended piping connected to isolated equipment as follows: 1" up to 4" diameter, first 3 points of support; 5" to 8" diameter, first 4 points of support; 10" diameter and over, first 6 points of support. Static deflection of first point shall be twice deflection of isolated equipment. Floor-mounted piping shall be isolated with Type 2 Spring Isolators.

END OF SECTION

SECTION 23 0553 - IDENTIFICATION FOR HVAC PIPING & 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. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.
 - 5. Valve tags.
 - 6. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- C. Valve numbering scheme.
- D. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- 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.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
 2. Letter Color: White.
 3. Background Color: Black.
 4. Maximum Temperature: Able to withstand temperatures 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 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.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: Yellow.
- 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 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. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; pipe size; and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. 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. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS

- A. Warning Tags: 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.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Painting."
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.4 VALVE-TAG INSTALLATION

- 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 HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 23 0593 - 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. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.

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 entity engaged to perform TAB Work.

1.4 SUBMITTALS

- A. Qualification Data: Within 15 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 15 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 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. Certified TAB reports.
- E. Sample report forms.
- F. 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.

1.5 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.
 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB.
 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB as a TAB technician.
- B. TAB Conference: Meet with Architect on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
 1. Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Coordination and cooperation of trades and subcontractors.
 - d. Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:
 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by Architect.
- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.6 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices 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 supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- 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 filters and verify that bearings are greased, belts are aligned and tight, 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 strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- L. Examine three-way valves for proper installation for their intended function of 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. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 - 1. Permanent electrical-power wiring is complete.
 - 2. Automatic temperature-control systems are operational.
 - 3. Equipment and duct access doors are securely closed.
 - 4. Balance, smoke, and fire dampers are open.
 - 5. Isolating and balancing valves are open and control valves are operational.
 - 6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 7. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" ASHRAE 111 NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
 - 1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary 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 Division 23 Section "Air Duct Accessories."
 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC 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) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the 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.
- L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
1. Measure total airflow.

- a. Where sufficient spaces in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 6. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 3. Re-measure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 3. Measure total system airflow. Adjust to within indicated airflow.
 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
 6. Re-measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
 7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.

8. Record final fan-performance data.

3.7 PROCEDURES FOR MOTORS

- A. Motors, 1/2 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. Efficiency rating.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.8 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
 1. Entering- and leaving-water temperature.
 2. Water flow rate.
 3. Water pressure drop.
 4. Dry-bulb temperature of entering and leaving air.
 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 6. Airflow.
 7. Air pressure drop.
- B. Measure, adjust, and record the following data for each electric heating coil:
 1. Nameplate data.
 2. Airflow.
 3. Entering- and leaving-air temperature at full load.
 4. Voltage and amperage input of each phase at full load and at each incremental stage.
 5. Calculated kilowatt at full load.
 6. Fuse or circuit-breaker rating for overload protection.
- C. Measure, adjust, and record the following data for each steam coil:
 1. Dry-bulb temperature of entering and leaving air.
 2. Airflow.
 3. Air pressure drop.
 4. Inlet steam pressure.
- D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.9 TOLERANCES

- A. Set HVAC system's air flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 2. Air Outlets and Inlets: Plus or minus 10 percent.

3.10 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 systems' balancing devices. Recommend changes and additions to systems' 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 monthly 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.
- 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 contractor.

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 and pump 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. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- 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 with coils, 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 rpm.
 - 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 air flow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. 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. Outdoor airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. 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 incho.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. Air flow 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 rpm.
 - 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 air flow 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. 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 rpm.
 - 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 rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- I. 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 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 air flow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual air flow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- J. Air-Terminal-Device Reports:
1. Unit Data:

- a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft..
 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary air flow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final air flow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
- K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.
- L. 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 rpm.
- 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.

M. 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 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
 - a. Measure airflow of at least 5 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Verify that balancing devices are marked with final balance position.
 - e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
 2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Architect.
 3. Architect shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 5 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
 4. 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."
 5. If the number of "FAILED" measurements is greater than 5 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
1. 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.
 2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the mechanical contractor's final payment.
- D. Prepare test and inspection reports.

3.13 ADDITIONAL TESTS

- A. Within 90 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

SECTION 23 0713 - DUCT INSULATION

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 insulating the following duct services:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Indoor, concealed return located in unconditioned space.
 - 4. Indoor, exposed return located in unconditioned space.
 - 5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
 - 6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
 - 7. Outdoor, concealed supply and return.
 - 8. Outdoor, exposed supply and return.
- B. Related Sections:
 - 1. Division 23 Section "Metal Ducts" for duct liners.

1.3 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. 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.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Section "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.

1.6 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.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 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 shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Armacell LLC; AP Armaflex.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type II with factory-applied

vinyl jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Owens Corning; SOFTR All-Service Duct Wrap.

H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation without factory-applied jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; Commercial Board.
 - b. Johns Manville; 800 Series Spin-Glas.
 - c. Owens Corning; Fiberglas 700 Series.

I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; CrimpWrap.
 - b. Johns Manville; MicroFlex.
 - c. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 ADHESIVES

A. Materials shall be 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. Products: Subject to compliance with requirements, provide one of the following:
 - a. Armacell LLC; Armaflex 520 Adhesive.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Eagle Bridges - Marathon Industries; 225.

- c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 - d. Mon-Eco Industries, Inc.; 22-25.
- 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 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; 739, Dow Silicone.
 - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
 - 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. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
 - b. Vimasco Corporation; 749.
 - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mildry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
 - b. Eagle Bridges - Marathon Industries; 550.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
 - d. Mon-Eco Industries, Inc.; 55-50.
 - e. Vimasco Corporation; WC-1/WC-5.
2. Water-Vapor Permeance: ASTM F 1249, 1.8 permsat 0.0625-inchdry film thickness.
 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 4. Solids Content: 60 percent by volume and 66 percent by weight.
 5. Color: White.

2.4 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
 - d. Mon-Eco Industries, Inc.; 44-05.
2. Materials shall be 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.

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
2. Materials shall be 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.

2.5 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 C 1136, Type I.

2.6 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, 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. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Speedline Corporation; SmokeSafe.
 - 2. Adhesive: As recommended by jacket material manufacturer.
 - 3. Color: Color-code jackets based on system. Color as selected by Architect.
- C. Metal Jacket:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
 - b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
 - c. RPR Products, Inc.; Insul-Mate.
 - 2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - 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.
 - d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.

2.7 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 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. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 - 2. Width: 3 inches.
 - 3. Thickness: 11.5 mils.
 - 4. Adhesion: 90 ounces force/inch width.

5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.8 FIRE RATED DUCT WRAP INSULATION

- A. Fire Barrier Duct Wrap: Non-asbestos, biosoluble, patented inorganic fire resistant blanket encapsulated with a scrim-reinforced foil, blanket thickness of 2.0 inches for kitchen exhaust grease duct applications.
1. Products: Subject to compliance with requirements, provide the following:
 - a. 3M Fire Protection Products
 2. Products to the following system design Listings for the intended application:
 - a. Ventilation Air Ducts: UL Design No. V-27 or Intertek Design No. 3MU/FRD-120-15.
 - b. Kitchen Exhaust Grease Ducts: Intertek Design Listing No's. GD 531 F, GD 547 F, GD 556 F or GD 557 F.
 - c. Firestop Listings: UL Design Nos. W-L-7180, W-J-7104, C-AJ-7096 or Intertek Design No's. FS 557 W – FS 563 W, FS 565 W – FS 574 F, FS 576 F, FS 578 F, FS 579 W.
 3. Materials: Fire resistive duct wrap insulation; 1.5" or 2" thick, 24" or 48" wide X 20 ft. or 25 ft. long rolls, fully encapsulated with a scrim-reinforced foil, marked with Manufacturer's logo and UL and Intertek markings.
 4. Tapes: High performance filament tape, 3M No. 898 1" wide. Aluminum foil tape: 3" or 4" wide (for sealing cut blanket edges and seams).
 5. Banding material: Carbon steel banding: 1/2" wide X 0.015" thick.
 6. Stainless steel banding: 1/2" wide X 0.015" thick. Consult individual listings for approved banding type.
 7. Insulation pins and clips: Copper-coated steel pins, 1/8 in. (10 ga). X 4" or 5" long;
 8. 1.5" diameter or square galvanized steel speed clips.
 9. Through-penetration firestop materials:
 - a. Packing materials: Pieces of 3M Fire Barrier Duct Wrap, or 4 pcf mineral wool.
 - b. Sealants: 3M Fire Barrier: 1000 NS non-slump silicone sealant, 1003 SL self-leveling silicone sealant, 2000+ premium non-slump silicone sealant, or CP 25WB+ premium intumescent latex caulk, as stated in firestop Design Listing.

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, 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 application and finishing.
- 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.
 - 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 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 more than 75 percent of its nominal thickness.
- 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 Division 07 Sections.

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 Division 07 Sections.

3.5 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.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket 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 50 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 over compress 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 shall 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.
- B. 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 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 over compress 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 Fat 18-foot intervals. Vapor stops shall 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 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.
- B. 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 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
 1. Flat Acrylic Finish: Two 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.

3.9 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 return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.
8. Indoor, exposed oven and warewash exhaust.
9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
11. Outdoor, concealed supply and return.
12. 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.

C. Insulation Schedule (Refer to Plans).

END OF SECTION

SECTION 23 0719 - HVAC PIPING INSULATION

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 insulating the following HVAC piping systems:
 - 1. Condensate drain piping, indoors and outdoors.
 - 2. Refrigerant suction and hot-gas piping, indoors and outdoors.
- B. Related Sections:
 - 1. Division 23 Section "Duct Insulation."

1.3 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. 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.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC 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.

1.6 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.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 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 shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Armacell LLC; AP Armaflex.
- G. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.
 - b. Johns Manville; Micro-Lok.
 - c. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

- A. Materials shall be 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. Products: Subject to compliance with requirements, provide one of the following:
 - a. Armacell LLC; Armaflex 520 Adhesive.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 - d. Mon-Eco Industries, Inc.; 22-25.
- 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.
 - d. Mon-Eco Industries, Inc.; 22-25.
 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. PVC Jacket Adhesive: Compatible with PVC jacket.

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; 739, Dow Silicone.
- b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
- c. P.I.C. Plastics, Inc.; Welding Adhesive.
- d. Speedline Corporation; Polyco VP Adhesive.

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

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. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
- b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mildry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
- b. Eagle Bridges - Marathon Industries; 550.
- c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
- d. Mon-Eco Industries, Inc.; 55-50.
- e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.4 SEALANTS

- A. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 2. Materials shall be 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.

2.5 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 C 1136, Type I.

2.6 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, 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. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Zeston.
 - b. Proto Corporation; LoSmoke.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: 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.
- C. Metal Jacket:
1. Products: Subject to compliance with requirements,;
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
 - b. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - 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.
 - d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-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.

2.7 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ABL, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 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. ABL, Ideal Tape Division; 370 White PVC tape.
 - b. Compac Corporation; 130.
 - c. Venture Tape; 1506 CW NS.
 2. Width: 2 inches.

3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch width.

2.8 SECUREMENTS

A. Bands:

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. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 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.

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.
 3. 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.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. 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 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, 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. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- 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 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.
 - 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.
 - 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, 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 pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- 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 beyond damaged areas. Adhere, staple, and seal patches similar 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. Manholes.
 5. Handholes.
 6. Cleanouts.
 7. Unions.

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 Division 07 Sections 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 Division 07 Sections for 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.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement or armaflex sheet insulation.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and

- irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover at the removable basket. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 8. Label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- 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 armafex insulation sealed vapor tight. insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 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 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 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 preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed 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.

3.7 INSTALLATION OF MINERAL-FIBER 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 factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied 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 preformed 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 mineral-fiber 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 preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed 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 preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered 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.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. 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.

B. 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.

3.9 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

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. Tests and Inspections: Schedule tests and inspections with Owner and CxA with at least seven days' advance notice.

- B. The testing agency shall conduct tests and inspections on duct insulation and shall show compliance to IECC 2006.
- C. Remove and replace insulation deficiencies and retest.
- D. Prepare test and inspection reports.
- E. The installing Contractor or vendor shall correct deficiencies in or remove and replace duct insulation that inspection and test reports indicate does not comply with specified requirements.
- F. Additional inspections and tests, at the installing Contractor's or vendor's expense, will be performed to determine compliance of corrected Work with specified requirements.

END OF SECTION

SECTION 23 0900 - INSTRUMENTATION AND CONTROL 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. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1.3 DEFINITIONS

- A. DDC: Direct digital control.
- B. BMS: Building Management System.
- C. FC: Fail closed position of control device or actuator. Device moves to closed position on loss of control signal or energy source.
- D. FO: Fail open. Device moves to open on loss of control signal or power source.
- E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- F. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.
- G. Router: Device connecting two or more networks at network layer.
- H. Server: Computer used to maintain system configuration, historical and programming database.

1.4 SYSTEM DESCRIPTION

- A. SCOPE: Furnish all labor, materials, and equipment necessary for a complete and operating Building Management System (BMS), utilizing Direct Digital Controls as shown on the drawings and as described herein. Drawings are diagrammatic only. All controllers furnished in this section shall communicate over an open protocol bus (Examples: BACnet, MODBUS).
 - 1. Only systems that utilize the Niagara 4 Framework shall satisfy the requirements of this section.

2. System architecture shall fully support a multi-vendor environment and be able to integrate third party systems via LonTalk, BACnet,SNMP and Modbus.
 3. System architecture shall provide at a minimum TLS v1.2 encrypted secure Web access using any of the current versions of Microsoft Internet Explorer, Mozilla Firefox, or Google Chrome browsers from any computer on the owner's LAN.
 4. All control devices furnished with this Section shall be programmable directly from the Niagara 4 Workbench embedded toolset upon completion of this project. The use of configurable or programmable controllers or software tools and applications that require a specific Niagara 4 license brand to operate for post-installation maintenance shall not be acceptable.
 5. The BMS Server shall host all graphic files for the control system.
 6. A Technician Service Tool shall be provided on a laptop computer licensed for the necessary engineering software for BMS support; including engineering/programming software for the BMS Server, NACs, graphical user interface modification/creation, and field devices.
 7. Owner shall receive all Administrator level login and passwords for engineering toolset at first training session. The Owner shall have full licensing and full access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the BMS.
 8. OPEN NIC STATEMENTS - All Niagara 4 software licenses shall have the following NiCS: "accept.station.in=*"; "accept.station.out=*" and "accept.wb.in=*"and "accept.wb.out=*". All open NIC statements shall follow Niagara Open NIC specifications.
 9. All JACE hardware licenses and certificates shall be stored on local MicroSD memory card employing encrypted Ósafe boot technology.
 10. To ensure quality the integrator will supply all JACE 8000 hardware products used on this project from the Tridium Richmond, VA shipping facility. JACE 8000 hardware products not meeting this requirement will not be allowed.
- B. All products of the BMS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided on request, with the submittal package. Systems or products not currently offering the following approvals are not acceptable.
1. Federal Communications Commission (FCC), Rules and Regulations, Volume II - July 1986 Part 15 Class A Radio Frequency Devices.
 2. FCC, Part 15, Subpart B, Class B
 3. FCC, Part 15, Subpart C
 4. FCC, Part 15, Subpart J, Class A Computing Devices.
 5. UL 504 - Industrial Control Equipment.
 6. UL 506 - Specialty Transformers
 7. UL 910 - Test Method for Fire and Smoke Characteristics of Electrical and Optical-Fiber Cables Used in Air-Handling Spaces
 8. UL 916 - Energy Management Systems All
 9. UL 1449 - Transient Voltage Suppression
 10. Standard Test for Flame Propagation Height of Electrical and Optical - Fiber Cables Installed Vertically in Shafts.
 11. EIA/ANSI 232-E - Interface Between Data Technical Equipment and Data Circuit Terminal Equipment Employing Serial Binary Data Interchange.
 12. EIA 455 - Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices
 13. IEEE C62.41- Surge Voltages in Low-Voltage AC Power Circuits

14. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems
 - a. NEMA 250 - Enclosures for Electrical Equipment
15. NEMA ICS 1 - Industrial Controls and Systems
16. NEMA ST 1 - Specialty Transformers
17. NCSBC Compliance, Energy: Performance of control system shall meet or surpass the requirements of ASHRAE/IESNA 90.1-1999
18. CE 61326
19. C-Tick
20. cUL

1.5 SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:
 1. Graphic Display: Display graphic with minimum 50 dynamic points with current data within 10 seconds.
 2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
 3. Object Command: Reaction time of less than five seconds between operator command of a binary object and device reaction. Analog objects shall start to adjust within 10 seconds of being commanded to change.
 4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
 5. B-BC, B-AAC, & B-ASC shall be able to execute control loops at a selectable frequency at least 1 time every second. The controller shall scan and update the process value and output generated by this calculation at this same frequency at a minimum.
 6. Alarm Response Time: Annunciate alarm at workstation within 20 seconds. Multiple workstations must receive alarms within five seconds of each other.
 7. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
 8. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
 9. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - a. Water Temperature: Plus or minus 1 deg F.
 - b. Water Flow: Plus or minus 5 percent of full scale.
 - c. Water Pressure: Plus or minus 2 percent of full scale.
 - d. Space Temperature: Plus or minus 1 deg F.
 - e. Ducted Air Temperature: Plus or minus 1 deg F.
 - f. Outside Air Temperature: Plus or minus 2 deg F.
 - g. Dew Point Temperature: Plus or minus 3 deg F.
 - h. Temperature Differential: Plus or minus 0.25 deg F.
 - i. Relative Humidity: Plus or minus 2 percent.
 - j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
 - k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
 - l. Airflow (Terminal): Plus or minus 10 percent of full scale.
 - m. Air Pressure (Space): Plus or minus 0.01-inch wg.
 - n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
 - o. Carbon Monoxide: Plus or minus 50 ppm
 - p. Carbon Dioxide: Plus or minus 50 ppm.

- q. Nitrogen Dioxide: Plus or minus 50 ppm.
- r. Electrical: Plus or minus 0.5 percent of reading.

1.6 SEQUENCE OF OPERATION

- A. See Sequence of Operations, Control Diagrams, and Point Lists in Plan Set.

1.7 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
 - 4. Open NiC Statement for all Niagara 4 licenses indicating that the licenses comply with Niagara Open NIC specifications.
- B. Submit documentation of integrator qualifications, including those indicated in "Quality Assurance" if requested by the A-E
- C. Shop drawings of the entire control system shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers' catalog data sheets and installation instructions. Submit in printed electronic format. Samples of written Controller Checkout Sheets and Performance Verification Procedures for applications similar in scope shall be included for approval.
- D. Shop drawings shall also contain complete wiring and schematic diagrams, sequences of operation, control system bus layout and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings.
- E. Submitted sequences of operation shall be written as intended to be programmed. Note instances in which the sequences to be programmed differ from the design sequences and note the reason for the differences. Copy and pasting or transcribing the design sequences in to the submittal word-for-word is not acceptable.
- F. Upon completion of the work, provide complete sets of ' as-built' drawings and other project-specific documentation in 3-ring hard-backed binders and in digital format
- G. Any deviations from these specifications or the work indicated on the drawings shall be clearly identified in the Submittals
- H. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
 - 2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 - 3. Wiring Diagrams: Power, signal, and control wiring.
 - 4. Details of control panel faces, including controls, instruments, and labeling.
 - 5. Written description of sequence of operation.

6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. DDC System Hardware:
 - a. Wiring diagrams for control units with termination numbers.
 - b. Schematic diagrams and floor plans for field sensors and control hardware.
 - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
10. Controlled Systems:
 - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - c. Written description of sequence of operation including schematic diagram.
 - d. Points list.
- I. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.
- J. Software and Firmware Operational Documentation: Include the following:
 1. Software operating and upgrade manuals.
 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 3. Device address list.
 4. Printout of software application and graphic screens.
 5. Software license required by and installed for DDC workstations and control systems.
- K. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- L. Field quality-control test reports.
- M. As Built Control Drawings:
 1. Furnish three (3) copies of as-built drawings for each control system. The documents shall be submitted for approval prior to final completion.
 2. Furnish one (1) stick set of applicable control system prints for each mechanical system for wall mounting. The documents shall be submitted for approval prior to final completion.
 3. Furnish one (1) CD-ROM in CAD DWG and/or .DXF format for the drawings noted in subparagraphs above.
- N. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 1. Maintenance instructions and lists of spare parts for each type of control device.
 2. Interconnection wiring diagrams with identified and numbered system components and devices.

3. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
4. Calibration records and list of set points.
5. Electronic copies of all control sequences and points lists in Owner preferred format.

1.8 QUALITY ASSURANCE

- A. The Control System Contractor shall have a full service DDC office within 50 miles of the job site. This office shall be staffed with applications engineers, software engineers and field technicians. This office shall maintain parts inventory and shall have all testing and diagnostic equipment necessary to support this work, as well as staff trained in the use of this equipment. Emergency service shall be available on a 24-hour, 7-day-a-week basis.
- B. Single Source Responsibility of Supplier: The Control System Contractor shall be responsible for the complete installation and proper operation of the control system. The Control System Contractor shall exclusively be in the regular and customary business of design, installation, and service of computerized building management systems similar in size and complexity to the system specified. The Control System Contractor shall be the manufacturer of the primary DDC system components or shall have been the authorized representative for the primary DDC components manufacturer for at least 5 years. All control panels shall be assembled by the Control System Contractor in a UL-Certified 508A panel shop.
- C. Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in the production and installation of HVAC control systems. Products shall be manufacturer's latest standard design and have been tested and proven in actual use.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with ASHRAE 135 for DDC system components.
- F. In order to ensure the stability and availability of future service, the installer shall have at least 10 years of experience as a licensed contractor in the state in which the project is located.
- G. In order to ensure proper oversight, an employee with no less than 10 years of experience for this type of facility and shall supervise the overall engineering, installation, programming and startup of the Facility Management System. This employee will be an engineer or project manager actively involved in the project.

1.9 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

- B. Coordinate equipment with Division 26 Section "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system and refer to plans for additional requirements.
- C. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system and refer to plans for additional requirements.
- D. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
- E. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces and refer to plans for additional requirements.
- F. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices and refer to plans for additional requirements.
- G. Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices and refer to plans for additional requirements.

1.10 WARRANTY

- A. Equipment: The control system components shall be free from defects in material and workmanship under normal use and service. If within one year from the date of completion any control system equipment is found to be defective, it will be replaced, repaired or adjusted at the option of the control system installer free of charge. The control system installer is not responsible for the removal or reinstallation of any components that were originally installed by others, such as valves, dampers, wells, airflow stations, etc.
- B. Installation: The control system shall be free from defects in installation workmanship for a period of one year from acceptance. This includes defective mounting, wiring, piping, adjustment, calibration, programming, startup and commissioning. The control system installer shall correct any defects in workmanship at no cost to the owner.
- C. Controls and Instrumentation subcontractor shall be responsible for temporary operations and maintenance of the control systems during the construction period until final commissioning, training of facility operators and acceptance of the project.

1.11 DELIVERY, STORAGE AND HANDLING

- A. Maintain integrity of shipping cartons for each piece of equipment and control device through shipping, storage and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Tridium Niagara Framework version N4.
- B. Requests for substitutions will be considered in accordance with the provisions described in Division 1.
- C. Qualifications of installer/contractor:
 - 1. The system shall be installed by an experienced firm regularly engaged in the installation.
 - 2. The contractor's firm must have a minimum five (5) years' experience in design, installation, and testing of Tridium Niagara Framework version N4.
- D. Approved Contractors:
 - 1. Automated Building Systems
 - 2. ES2
 - 3. Harrison Energy Partners

2.2 GENERAL DESCRIPTION

- A. The Building Management System (BMS) shall be comprised of a network of interoperable, stand-alone digital controllers, network area controllers, graphics and programming and other control devices for a complete system as specified herein.
- B. The installed system shall provide secure strong password access to all features, functions and data contained in the overall BMS.
- C. Latest encryption technologies (TLS v1.2) shall be provided for NAC to NAC communications; NAC to BMS Server communications and client user communications.
- D. System integrator shall coordinate security policies with the owner's IT (Information Technology) department.
- E. Include all engineering, programming, controls and installation materials, installation labor, commissioning and start-up, training, final project documentation and warranty.
 - 1. The Building Management System (BMS) shall be comprised of Java application control engine or controllers (JACE) within each facility.
 - 2. The BMS shall be based on the Niagara 4 framework, a Java-based framework and comprised of a network of interoperable, stand-alone digital controllers, a computer system, graphical user interface software, network devices and other devices as specified herein, and must integrate with the Niagara BMS System.
 - 3. The installed system shall provide secure passwords access to all features, functions and data contained in the overall BMS. The owner shall control/set all passwords and security levels for all operators.
 - 4. Each operator shall automatically be logged off the system if no keyboard or mouse activity is detected.
 - 5. The direct-digital control system(s) shall consist of high-speed, peer-to-peer network of DDC controllers, a control system server, and an Engineering Control Center. Provide a remote user using a standard web browser to access the

control system graphics and change adjustable setpoints with the proper password.

2.3 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURE

- A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system utilizing open protocols to create an automation infrastructure
- B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. Physical connection of any BACnet control equipment, such as chillers, shall be via BACnet IP. If BACnet IP is not available for a particular piece of equipment, BACnet MS/TP shall be acceptable. BACnet Ethernet or BACnet Arcnet communications are not acceptable for NAC, BMS Server or field device communication.
- C. All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. With the exception of any previously installed legacy systems which cannot be updated to current open communication technologies, components or controllers requiring "polling" by a host to pass data shall not be acceptable.
- D. The supplied system shall incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins.
- E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.

2.4 BMS SERVER HARDWARE

- A. Minimum Computer Configuration (Hardware Independent).
 - 1. Processor: Intel®Xeon®CPU E5-2640 x64 (or better), compatible with dual- and quad-core processors.
 - 2. Operating System: Windows 10, 64-bit Windows 8.1 Enterprise, 2012 R2 Standard, RHEL-7.
 - 3. Memory: 4 GB minimum
 - 4. Mass storage as required for system operation and data archiving.
 - 5. Display: Video card and monitor capable of displaying 1024 x 768 pixel resolution or greater.
 - 6. Network Support: Ethernet adapter (10/100 Mb with RJ-45 connector).
 - 7. Connectivity: Full-time high-speed ISP connection recommended for remote site access and IPv6 compliant.
- B. Standard Client: The thin-client Web Browser BMS GUI shall be Microsoft Internet Explorer (10.0 or later) running on Microsoft 7+. No special software shall be required to be installed on the PCs used to access the BMS via a web browser.
- C. Owner may choose to provide a virtual environment that meets the minimum specification above.

2.5 NETWORK AREA CONTROLLER (NAC)

- A. Manage communications between the programmable equipment controllers (PEC), application specific controllers (ASC) and unitary controllers (UC) which are connected to its communications trunks, manage communications between itself and other system network controllers (NAC) and with any operator workstations (OWS) that are part of the BMS, and perform control and operating strategies for the system based on information from any controller connected to the BMS.
- B. The controllers shall be fully programmable to meet the unique requirements of the facility it shall control.
- C. The controllers shall be capable of peer-to-peer communications with other NAC's and with any OWS connected to the BMS, whether the OWS is directly connected, connected via cellular modem or connected via the Internet.
- D. The NAC shall employ a device/point count capacity license model that supports expansion capabilities.
- E. The NAC shall be enabled to support and shall be licensed to include the following Open protocol drivers (client and server) by default:
 - 1. BACnet
 - 2. MODBUS
 - 3. SNMP
 - 4. KNX
- F. The NAC shall be capable of executing application control programs to provide:
 - 1. Calendar Functions
 - 2. Scheduling
 - 3. Trending
 - 4. Alarm monitoring and routing
 - 5. Time synchronization.
 - 6. Niagara Analytics
 - 7. Integration of BACnet, and MODBUS controller data.
 - 8. Network management functions for all NAC, PEC, UC and ASC based devices.
- G. Certifications - All NACs shall be listed under with the following agencies at the certification levels appropriate to them:
 - 1. UL 916
 - 2. CE EN 61326-1
 - 3. FCC Part 15 Subpart B, Class B
 - 4. FCC Part 15 Subpart C
 - 5. C-UL listed to Canadian Standards Association (CSA) C22.2 No. 205-M1983 "Signal Equipment"
 - 6. 1999/5/EC R&TTE Directive
 - 7. CCC
 - 8. SRRC
 - 9. RSS
 - 10. ROHS
 - 11. IEEE802.11a/b/g/n
 - 12. IEEE802.11n HT20 @ 2.4 GHz
 - 13. IEEE802.11n HT20/HT40 @ 5 GHz
 - 14. Configurable radio (Off, WAP, or Client)

15. WPAPSK/WPA2PSK.
 - H. Minimum Specifications:
 1. Operating temperature: -20-60 deg C
 2. Storage temperature: -40-85 deg C
 3. Humidity: 5%-95% - Non condensing
 4. Shipping and vibration: ASTM D4169, Assurance Level II
 5. MTF: 10 years +
 6. Batteryless operation
 - I. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.
 - J. The NAC shall provide alarm recognition, storage, routing, management and analysis to supplement distributed capabilities of equipment or application specific controllers.
 - K. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via cellular modem, or wide-area network.
 1. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but not limited to:
 - a. Alarm
 - b. Return to normal
 - c. To default
 2. Alarms shall be annunciated in any of the following manners as defined by the user:
 - a. Screen message text.
 - b. Email of complete alarm message to multiple recipients.
 - c. Pagers via paging services that initiate a page on receipt of email message.
 - d. Graphics with flashing alarm object(s).
 3. The following shall be recorded by the NAC for each alarm (at a minimum):
 - a. Time and date
 - b. Equipment (tag, access way, etc).
 - c. Acknowledge time, date, and user who issued acknowledgement.
 - L. Programming software and all controller "Setup Wizards" shall be embedded into the NAC.
 - M. The NAC shall support the following security functions.
 1. Module code signing to verify the author of programming tool and confirm that the code has not been altered or corrupted.
 2. Role-Based Access Control (RBAC) for managing user roles and permissions.
 3. Require users to use strong credentials.
 4. Data in Motion and Sensitive Data at Rest be encrypted.
 5. LDAP and Kerberos integration of access management.
 6. A CPU that incorporates secure boot technologies.
 - N. The NAC shall support the data modeling structures provide with Niagara 4 to utilize Search; Hierarchy; Template; and Permission functionality:
 1. Metadata: Descriptive tags to define the structure of properties.
 2. Tagging: Process to apply metadata to components
 3. Tag Dictionary

- O. The NAC shall employ template functionality. Templates are a containerized set of configured data tags, graphics, histories, alarms... that are set to be deployed as a unit based upon manufacturer's controller and relationships. All lower level communicating controllers (PEC, UC, AVAV, VFD |) shall have an associated template file for reuse on future project additions.
- P. The NAC shall be provided with a 5 Year Software Maintenance license. Labor to implement not included.

2.6 PROGRAMMABLE EQUIPMENT CONTROLLER (PEC)

- A. HVAC control shall be accomplished using BACnet based devices where the application has BTL Listed PICS defined. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara 4 Framework, that allow standard and customizable control solutions required in executing the "Sequence of Operation".
- B. Minimum Requirements:
 - 1. The controller shall be fully programmable with full functionality on any Niagara 4 brand platform.
 - a. Support downloads to the controller from any brand of Niagara 4 platform.
 - b. Support uploads from the controller to any brand of Niagara 4 platform.
 - c. Support simulation/debug mode of the controller.
 - d. Maintain native GUI.
 - e. Native function-block programming software and all controller ÓSetup Wizards shall be embedded within the Niagara 4 environment.
- C. All PECs shall be application programmable and shall at all times maintain their certification. All control sequences within or programmed into the PEC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained.
- D. The PEC shall provide LED indication of communication and controller performance to the technician, without cover removal.
- E. The PEC shall not require any external configuration tool or programming tool. All configuration and programming tasks shall be accomplished and accessible from within the Niagara 4 environment.
- F. The following integral and remote Inputs/Outputs shall be supported per each PEC:
 - 1. Eight integral dry contact digital inputs
 - 2. Any two digital inputs may be configured as pulse counters with a maximum pulse read rate of 15 Hz.
 - 3. Eight integral analog inputs (configurable as 0-10V, 0-10,000 ohm or, 20K NTC).
 - 4. Six integral 4-20 ma analog outputs.
 - 5. Eight integral 24 Vac Triac digital outputs, configurable as maintained or floating motor control outputs.
 - 6. One integral 20 Vdc, 65-mA power supply for auxiliary devices.
 - 7. If a 20 Vdc 65-mA power supply terminal is not integral to the PEC, provide at each PEC a separate, fully isolated, enclosed, current limited and regulated UL listed auxiliary power supply for power to auxiliary devices.

- G. Each PEC shall have expansion ability to support additional I/O requirements through the use of remote input/output modules.
- H. PEC Controllers shall support at minimum the following control techniques:
 - 1. General-purpose control loops that can incorporate Demand Limit Control strategies, Set point reset, adaptive intelligent recovery, and time of day bypass.
 - 2. General-purpose, non-linear control loops.
 - 3. Start/stop Loops.
 - 4. If/Then/Else logic loops.
 - 5. Math Function loops (MIN, MAX, AVG, SUM, SUB, SQRT, MUL, DIV, ENTHALPY).

2.7 UNITARY CONTROLLER (UC)

- A. The unitary controller (UC) platform shall be designed specifically to control HVAC - ventilation, filtration, heating, cooling, humidification, and distribution. Equipment includes: constant volume air handlers, VAV air handlers, packaged RTU, heat pumps, unit vents, fan coils, natural convection units and radiant panels. The control shall use BACnet based devices where the application has a BTL Listed PICS defined. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara 4 Framework, that allow standard and customizable control solutions required in executing the "Sequence of Operation".
- B. Minimum Requirements:
 - 1. The controller shall be fully programmable with full functionality on any Niagara 4 brand platform.
 - a. Support downloads to the controller from any brand of Niagara 4 platform.
 - b. Support uploads from the controller to any brand of Niagara 4 platform.
 - c. Support simulation/debug mode of the controller.
 - d. Maintain native GUI.
 - e. Native function-block programming software and all controller ÓSetup Wizards shall be embedded within the Niagara 4 environment.
 - 2. The controller shall be capable of either integrating with other devices or stand-alone operation.
 - 3. The controller shall have two microprocessors. The Host processor contains on-chip FLASH program memory, FLASH information memory, and RAM to run the main HVAC application. The second processor for network communications. Controller memory minimum requirements include:
 - a. FLASH Memory Capacity: 60 Kilobytes with 8 Kilobytes for application program.
 - b. FLASH Memory settings retained for ten years.
 - c. RAM: 2 Kilobytes
 - 4. The controller shall have an internal time clock with the ability to automatically revert from a master time clock on failure.
 - a. Operating Range: 24 hour, 365 day, multi-year calendar including day of week and configuration for automatic day-light savings time adjustment to occur on configured start and stop dates.
 - b. Accuracy: ±1 minute per month at 77 degrees F 25 degrees C.
 - c. Power Failure Backup: 24 hours at 32 degrees to 122 degrees F (0 degrees to 50 degrees C).

5. The controller shall have Significant Event Notification, Periodic Update capability, and Failure Detect when network inputs fail to be detected within their configurable time frame
6. The controller shall have an internal DC power supply to power external sensors.
7. The controller shall have a visual indication (LED) of the status of the device:
 - a. Controller operating normally.
 - b. Controller in process of download.
 - c. Controller in manual mode under control of software tool.
 - d. Controller lost its configuration.
 - e. no power to controller, low voltage, or controller damage.
 - f. processor and/or controller are not operating.
8. The minimum controller Environmental ratings:
 - a. Operating Temperature Ambient Rating: -40 degrees to 150 degrees F (-40 degrees to 65.5 degrees C).
 - b. Storage Temperature Ambient Rating: -40 degrees to 150 degrees F (-40 degrees to 65.5 degrees C).
 - c. Relative Humidity: 5% to 95% non-condensing.
9. The controller shall have the additional approval requirements, listings, and approvals:
 - a. L/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.
 - b. CSA (LR95329-3) Listed.
 - c. Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
 - d. Meets Canadian standard C108.8 (radiated emissions).
 - e. Conforms requirements European Consortium standard EN 61000-6-1; 2001 (EU Immunity).
 - f. Conforms requirements European Consortium standard EN 61000-6-3; 2001 (EU Emission).
10. The controller housing shall be UL plenum rated mounting to either a panel or DIN rail (standard EN50022; 7.5mm x 35mm).
11. The controller shall have a mix of digital inputs (DI), digital Triac outputs (DO), analog outputs (AO), and universal inputs (UI).
 - a. Analog outputs (AO) shall be capable of being configured as digital outputs (DO).
 - b. Input and Output wiring terminal strips shall be removable from the controller without disconnecting wiring.
 - c. Input and Output wiring terminals shall be designated with color coded labels.
 - d. Universal inputs shall be capable of being configured as binary inputs, resistive inputs, voltage inputs (0-10 VDC), or current inputs (4-20 mA).
12. The controller shall provide "continuous" automated loop tuning with an Adaptive Integral Algorithm Control Loop.
13. The controller platform shall have standard HVAC application programs that are modifiable to support both the traditional and specialized "sequence of operations" as outlined in Section 4.
 - a. Discharge air control and low limit.
 - b. Pressure-dependent dual duct without flow mixing.
 - c. Variable air volume with return flow tracking.
 - d. Economizer with differential enthalpy.
 - e. Minimum airflow coordinated with CO2.
 - f. Unit ventilator cycle (1, 2, 3) 2-pipe.
 - g. Unit ventilator cycle (1, 2, 3) 2-pipe with face/bypass.

- h. Unit ventilator cycle (1, 2, 3) 4-pipe.
- i. Unit ventilator cycle (1, 2, 3) 4-pipe with EOC valve.

2.8 VARIABLE AIR VOLUME CONTROLLER (VAV)

- A. The VAV controller platform shall be designed specifically for room-level VAV control - pressure-independent air flow control, pressure dependent damper control, supply and exhaust pressurization/de-pressurization control; temperature, humidity, complex CO₂, occupancy, and emergency control. Equipment includes: VAV terminal unit, VAV terminal unit with reheat, Series fan powered terminal unit, Parallel fan powered terminal unit, Supply and Exhaust air volume terminals and Constant volume dual-duct terminal unit. Control shall be accomplished using BACnet based devices where the application has a BTL Listed PICS defined. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara 4 Framework, that allow standard and customizable control solutions required in executing the "Sequence of Operation".
- B. Minimum Requirements:
 - 1. The controller shall be fully programmable with full functionality on any Niagara 4 brand platform.
 - a. Support downloads to the controller from any brand of Niagara 4 platform.
 - b. Support uploads from the controller to any brand of Niagara 4 platform.
 - c. Support simulation/debug mode of the controller.
 - d. Maintain native GUI.
 - e. Native function-block programming embedded software and all controller ÓSetup Wizards shall be embedded within the Niagara 4 environment.
 - 2. The controller shall be capable of either integrating with other devices or stand-alone room-level control operation.
 - 3. The controller shall have an internal velocity pressure sensor.
 - a. Sensor Type: Microbridge air flow sensor with dual integral restrictors.
 - b. Operating Range: 0 to 1.5 inch H₂O to 374 Pa.
 - c. Accuracy: ±2% of full scale at 32 degrees to 122 degrees F (0 degrees to 50 degrees C); ±1% of full scale at null pressure.
 - 4. The controller shall have two microprocessors. The Host processor contains on-chip FLASH program memory, FLASH information memory, and RAM to run the main HVAC application. The second processor for network communications.
 - a. FLASH Memory Capacity: 60 Kilobytes with 8 Kilobytes for application program.
 - b. FLASH Memory settings retained for ten years.
 - c. RAM: 2 Kilobytes.
 - 5. The controller shall have an internal time clock with the ability to automatically revert from a master time clock on failure.
 - a. Operating Range: 24 hour, 365 day, multi-year calendar including day of week and configuration for automatic day-light savings time adjustment to occur on configured start and stop dates
 - b. Accuracy: ±1 minute per month at 77 degrees F 25 degrees C
 - c. Power Failure Backup: 24 hours at 32 degrees to 122 degrees F (0 degrees to 50 degrees C).
 - 6. The controller shall have Significant Event Notification, Periodic Update capability and Failure Detect when network inputs fail to be detected within their configurable time frame.

7. The controller shall have an internal DC power supply to power external sensors
 - a. Power Output: 20 VDC \pm 10% at 75 mA.
8. The controller shall have a visual indication (LED) of the status of the device:
 - a. Controller operating normally.
 - b. Controller in process of download.
 - c. Controller in manual mode under control of software tool.
 - d. Controller lost its configuration.
 - e. No power to controller, low voltage, or controller damage.
9. The minimum controller Environmental ratings
 - a. Operating Temperature Ambient Rating: 32 degrees to 122 degrees F (0 degrees to 50 degrees C).
 - b. Storage Temperature Ambient Rating: 32 degrees to 122 degrees F (0 degrees to 50 degrees C).
 - c. Relative Humidity: 5% to 95% non-condensing.
10. The controller shall have the additional approval requirements, listings, and approvals:
 - a. UL/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.
 - b. CSA (LR95329-3) Listed.
 - c. Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
11. The controller housing shall be UL plenum rated mounting to either a panel or DIN rail (standard EN50022; 7.5mm x 35mm).
12. The controller shall provide an integrated actuator option.
 - a. Actuator type: Series Floating.
 - b. Rotation stroke: 95 degrees \pm 3 degrees for CW or CCW opening dampers.
 - c. Torque rating: 44 lb-inch **5 Nm**.
 - d. Run time for 90 degrees rotation: 90 seconds at 60 Hz.
13. The controller shall have digital inputs (DI), digital Triac outputs (DO), three analog outputs (AO), and universal inputs (UI).
 - a. Analog outputs (AO) shall be capable of being configured as digital outputs (DO).
 - b. Input and Output wiring terminal strips shall be removable from the controller without disconnecting wiring.
 - c. Input and Output wiring terminals shall be designated with color coded labels.
14. The controller shall provide "continuous" automated loop tuning with an Adaptive Integral Algorithm Control Loop.
15. The controller shall have a loop execution response time of 1 second.
16. The controller platform shall have standard HVAC application programs that are modifiable to support both the traditional and specialized "sequence of operations" as outlined in Section 4.
 - a. VAV terminal unit.
 - b. VAV terminal unit fan speed control.
 - c. Series fan.
 - d. Paralled fan. Regulated air volume (room pressurization/de-pressurization).
 - e. CV dual-duct
 - f. Room CO2 control.
 - g. Room Humidity.
 - h. TOD occupancy sensor stand-by set points.

2.9 OTHER CONTROL SYSTEM HARDWARE

- A. Motorized control dampers that will not be integral to the equipment shall be furnished by the Control System Contractor. Control damper frames shall be constructed of galvanized steel, formed into channels and welded or riveted. Dampers shall be galvanized, with nylon bearings. Blade edge seals shall be vinyl. Blade edge and tip seals shall be included for all dampers. Blades shall be 16-gauge minimum and 6 inches wide maximum and frame shall be of welded channel iron. Damper leakage shall not exceed 10 CFM per square foot, at 1.5 inches water gauge static pressure.
- B. Control damper actuators shall be furnished by the Control System Contractor. Two-position or proportional electric actuators shall be direct-mount type sized to provide a minimum of 5 in-lb torque per square foot of damper area. Damper actuators shall be spring return type. Operators shall be heavy-duty electronic type for positioning automatic dampers in response to a control signal. Motor shall be of sufficient size to operate damper positively and smoothly to obtain correct sequence as indicated. All applications requiring proportional operation shall utilize truly proportional electric actuators.
- C. Wall Mount Room Temperature sensors: Each room temperature sensor shall provide temperature indication to the digital controller, provide the capability for a software-limited occupant set point adjustment (warmer-cooler slider bar or switch) and limited operation override capability. Room Temperature Sensors shall be 20,000-ohm thermistor type with a temperature range of -40 to 140 degrees F (-38 to 60 degrees C). The sensor shall be complete with a decorative cover and suitable for mounting over a standard electrical utility box. These devices shall have an accuracy of 0.5 degrees F (.024 degrees C) over the entire range.
- D. Duct-mounted and Outside Air Temperature Sensors: 20,000-ohm thermistor temperature sensors with an accuracy of \pm 0.2 degrees C. Outside air sensors shall include an integral sun shield. Duct-mounted sensors shall have an insertion measuring probe of a length appropriate for the duct size, with a temperature range of -40 to 160 degrees F (-38 to 71 degrees C) The sensor shall include a utility box and a gasket to prevent air leakage and vibration noise. For all mixed air and preheat air applications, install bendable averaging duct sensors with a minimum 8 feet 2438 mm long sensor element. These devices shall have accuracy of 0.5 degrees F (.024 degrees C) over the entire range.
- E. Humidity sensors shall be thin-film capacitive type sensor with on-board nonvolatile memory, accuracy to plus or minus two percent (2%) at 0 to 90% RH, 12 - 30 VDC input voltage, analog output (0 - 10 VDC or 4 - 20mA output). Operating range shall be 0 to 100% RH and 32 to 140 degrees F 0 to 60 degrees C. Sensors shall be selected for wall, duct or outdoor type installation as appropriate.
- F. Carbon Dioxide Sensors (CO₂): Sensors shall utilize Non-dispersive infrared technology (N.D.I.R.), repeatable to plus or minus 20 PPM. Sensor range shall be 0 - 2000 PPM. Accuracy shall be plus or minus five percent (5%) or 75 PPM, whichever is greater. Response shall be less than one minute. Input voltage shall be 20 to 30 VAC or DC. Output shall be 0 - 10 VDC. Sensor shall be wall or duct mounted type, as appropriate for the application, housed in a high impact plastic enclosure.
- G. Current Sensitive Switches: Solid state, split core current switch that operates when the current level (sensed by the internal current transformer) exceeds the adjustable trip

point. Current switch to include an integral LED for indication of trip condition and a current level below trip set point.

- H. Differential Analog (duct) Static Pressure Transmitters Provide a pressure transmitter with integral capacitance type sensing and solid-state circuitry. Accuracy shall be plus or minus 1% of full range; range shall be selected for the specific application. Provide zero and span adjustment capability. Device shall have integral static pickup tube.
- I. Differential Air Pressure Switches: Provide SPDT type, UL-approved, and selected for the appropriate operating range where applied. Switches shall have adjustable set points and barbed pressure tips
- J. Water Flow Switches: Provide a SPST type contact switch with bronze paddle blade, sized for the actual pipe size at the location. If installed outdoors, provide a NEMA-4 enclosure. Flow switch shall be UL listed.
- K. Temperature Control Panels: Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. All electrical devices within a control panel shall be factory wired. Control panel shall be assembled by the BMS in a UL-Certified 508A panel shop. A complete set of 'as-built' control drawings (relating to the controls within that panel) shall be furnished within each control panel.
- L. Pipe and Duct Temperature sensing elements: 20,000-ohm thermistor temperature sensors with and accuracy of $\pm 1\%$ accuracy. Their range shall be -5 to 250 degrees F (-20 to 121 degrees C). Limited range sensors shall be acceptable provided they are capable of sensing the range expected for the point at the specified accuracy. Thermal wells with heat conductive gel shall be included.
- M. Low Air Temperature Sensors: Provide SPST type switch, with 15 to 55 degrees F (-9 to 13 degrees C), range, vapor-charged temperature sensor.
- N. Variable Frequency Drives: The variable frequency drive (VFD) shall be designed specifically for use in Heating, Ventilation, and Air Conditioning (HVAC) applications in which speed control of the motor can be applied. The VFD, including all factory installed options, shall have UL & CSA approval. VFD's shall include communications capability with DDC BMS via built-in interface card (MODBUS or BACnet). VFD's shall include user selectable Hand/Auto/Bypass control on enclosure. All VFDs in the project shall be provided by the same manufacturer.
- O. Relays: Start/stop relay model shall provide either momentary or maintained switching action as appropriate for the motor being started. All relays shall be plugged in, interchangeable, mounted on a sub base and wired to numbered terminals strips. Relays installed in panels shall all be DPDT with indicating lamp. Relays installed outside of controlled devices shall be enclosed in a NEMA enclosure suitable for the location. Relays shall be labeled with UR symbol. RIB-style relays are acceptable for remote enable/disable.
- P. Emergency Stop Switches: Provide toggle-type switch with normally-closed contact. Switch shall be labeled "AIR HANDLER EMERGENCY SHUTOFF, NORMAL - OFF.
- Q. Transducers: Differential pressure transducers shall be electronic with a 4-20 mA output signal compatible to the Direct Digital Controller. Wetted parts shall be stainless steel. Unit shall be designed to operate in the pressure ranges involved.

- R. Control Power Transformers: Provide step-down transformers for all DDC controllers and devices as required. Transformers shall be sized for the load, but shall be sized for 50 watts, minimum. Transformers shall be UL listed Class 2 type, for 120 VAC/24 VAC operation.

- S. Line voltage protection: All DDC system control panels that are powered by 120 VAC circuits shall be provided with surge protection. This protection is in addition to any internal protection provided by the manufacturer. The protection shall meet UL, ULC 1449, IEEE C62.41B. A grounding conductor, (minimum 12 AWG), shall be brought to each control panel.

- T. Duct Air Flow Measuring Stations:
 - 1. Acceptable Manufacturers
 - a. EBTRON, Inc. model GTx116-P+ is the basis of design.
 - b. Approved performance equal
 - 2. General
 - a. Airflow measurement devices shall use the principle of thermal dispersion and provide one self-heated bead-in-glass thermistor and one zero power bead-in-glass thermistor at each sensing node.
 - 1) Thermal dispersion devices that indirectly heat a thermistor are not acceptable.
 - 3. Substitution requests for acceptance less than 60 days prior to bid date or products submitted in non-conformance with the requirements of this specification will not be considered.
 - a. For any product to be considered for substitution, a written document shall be submitted to the engineer detailing exceptions and compliance, section-by-section with supporting documentation, before an approval will be considered.
 - b. Any product submitted as an equal shall be expected to comply with all performance capabilities and functional aspects of this specification.
 - 4. Excluded devices
 - a. Fan Inlet airflow measurement devices.
 - b. Measurement technologies using "chip-in-glass", "chip-in-epoxy" or other "chip" type thermistors for the heated sensor component are not acceptable.
 - c. Pitot tubes, Pitot arrays, Piezo rings and other differential pressure based devices are not acceptable.
 - d. Vortex shedding devices are not acceptable.
 - 5. Required product performance
 - 6. Airflow Measurement Devices (AMD) with Temperature Output and Airflow Alarming Capability
 - 7. General
 - a. Provide one AMD for each measurement location provided on the plans, schedules and/or control diagrams to determine the average airflow rate and temperature at each measurement location.
 - b. Each AMD shall be provided with a microprocessor-based transmitter and one or more sensor probes.
 - 1) Devices that have electronic signal processing components on or in the sensor probe are not acceptable.
 - c. Airflow measurement shall be field configurable to determine the average Actual or Standard mass airflow rate.

- 1) Actual airflow rate calculations shall have the capability of being corrected by the transmitter for altitudes other than sea level.
- d. Temperature measurement shall be field configurable with velocity weighted average as the default, or manual selection of arithmetic average temperature.
8. Sensor Probes
 - a. Sensor probes shall be constructed of gold anodized, 6063 aluminum alloy tube, 316 stainless steel tube are available when required.
 - b. Sensor probe mounting brackets shall be constructed of 304 stainless steel.
 - c. Probe internal wiring between the connecting cable and sensor nodes shall be Kynar coated copper.
 - 1) PVC jacketed internal wiring is not acceptable.
 - d. Probe internal wiring connections shall consist of solder joints and spot welds.
 - 1) Internal wiring connections shall be sealed and protected from the elements. They shall be capable of direct exposure to water without affecting instrument operation.
 - 2) Connectors of any type within the probe are not acceptable.
 - 3) Printed circuit boards within the probe are not acceptable.
 - e. Each sensor probe shall be provided with an integral, FEP jacket, plenum rated CMP/CL2P, UL/cUL Listed cable rated for exposures from -67° F to 392° F (-55° C to 200° C) and continuous and direct UV exposure.
 - 1) Plenum rated PVC jacket cables are not acceptable.
 - f. Each sensor probe cable shall be provided with a connector plug with gold plated pins for connection to the transmitter.
 - g. Each sensor probe shall contain one or more independently wired sensing nodes.
 - h. Sensor node airflow and temperature calibration data shall be stored in a serial memory chip in the cable connecting plug and not require matching or adjustments to the transmitter in the field.
 - i. Each sensor node shall be provided with two bead-in-glass, hermetically sealed thermistors potted in a marine grade waterproof epoxy with sensor housings constructed of glass-filled polypropylene. Upon request, the manufacture shall provide a written independent laboratory test result of 100% survival rate in a 30 day saltwater and acid vapor test.
 - 1) Devices that use epoxy or glass encapsulated chip thermistors are not acceptable.
 - 2) Devices with exposed leads are not acceptable.
 - j. Each thermistor shall be individually calibrated at a minimum of 3 temperatures to NIST-traceable temperature standards.
 - k. Each sensor node shall be individually calibrated at 16 measurement points to airflow standards directly calibrated at NIST to the NIST Laser Doppler Anemometer (LDA) primary velocity standard and have an accuracy of $\pm 2\%$ of reading over the entire calibrated airflow range of 0 to 5,000 FPM 25.4 m/s.
 - 1) Upon request the manufacture shall submit for AMD approval a copy of the NIST report of calibration used for the reference standard used.
 - a) Devices claiming NIST traceability to third party laboratories and not directly to NIST are not acceptable.
 - b) Devices calibrated against standards other than the NIST LDA are not acceptable.

- l. Accuracy shall include the combined uncertainty of the sensor nodes and transmitter.
 - m. The installed airflow accuracy shall be:
 - 1) Ducts - $\pm 3\%$ of reading when installed in accordance with the manufactures recommended placement guidelines.
 - 2) Non-ducted Outdoor Air intakes – better than or equal to $\pm 5\%$ of reading when installed in accordance with the manufactures recommended placement guidelines.
 - n. Devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter shall demonstrate compliance with this requirement over the entire operating range.
 - o. Each sensing node shall have a temperature accuracy of $\pm 0.15^\circ\text{F}$ (0.08°C) over an operating range of -20°F to 160°F . (-28.9°C to 71.1°C) and humidity range of 0 to 100% RH.
9. Transmitter
- a. A remotely located microprocessor-based transmitter shall be provided for each measurement location.
 - b. The transmitter shall be comprised of a main circuit board and interchangeable interface card.
 - c. All printed circuit board interconnects, edge fingers, receptacle plug pins and PCB test points shall be gold plated.
 - d. All printed circuit boards shall be electroless nickel immersion gold (ENIG) plated.
 - e. All integrated circuitry shall be temperature rated as 'industrial-grade'. Submissions containing 'commercial-grade' integrated circuitry are not acceptable.
 - f. The transmitter shall be capable of determining the airflow rate and temperature average of all connected sensor nodes in an array for a single location.
 - 1) Separate integration buffers shall be provided for display airflow output, airflow signal output (analog and network) and individual sensor output (IR-interface).
 - g. The transmitter shall be capable of providing a high and/or low airflow alarm with user-defined set point and % of set point tolerance. Alarm shall be capable of being manually or automatically reset and low-limit cutoff value may be selected to disable the alarm. An alarm delay function shall also be field defined.
 - h. The transmitter shall be capable of identifying an AMD malfunction via the system status alarm and ignore any sensor node that is in a fault condition.
 - i. The transmitter shall be capable of field configuration, diagnostics and include Field Output Adjustment Wizard that allows for a one or two point field adjustment to factory calibration for installations that require adjustment.
 - j. The transmitter shall be provided with a 16-character, alpha-numeric, LCD display.
 - k. The transmitter shall be provided with two field selectable (0-5/0-10 VDC or 4-20mA), scalable, isolated and over-current protected analog output signals (AO1=airflow, AO2=temperature or alarm), in combination with either of the following:
 - 1) one isolated RS-485 (field selectable BACnet MS/TP or Modbus RTU) network connection

- 2) one isolated Ethernet (simultaneously supported BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) network connection
 - l. The analog signal capability shall include two output terminals: the first (AO1), shall provide the total airflow rate and the second output (AO2) shall be field configurable to provide temperature information.
 - m. The transmitter shall also be available with a single isolated LonWorks Free Topology network interface. Transmitters shall be available alternatively with one USB connection for thumb-drive data logging of sensor data. Neither of these options shall include analog output signals.
 - n. The network communications RS-485 (BACnet MS/TP or Modbus RTU) or Ethernet (BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) shall provide: the average airflow rate, temperature, hi and/or low airflow set point alarm, system status alarm, individual sensor node airflow rates and individual sensor node temperatures. Individual node airflow rates and temperatures shall NOT be available via the network with Lon.
 - o. The transmitter shall have an on-off power switch. Isolation transformers shall not be required.
 - p. The transmitter shall be powered by 24 VAC (22.8 to 26.4 under load) @20 V-A maximum and use a switching power supply that is over-current and over-voltage protected.
 - q. The transmitter shall use a "watchdog" timer circuit to ensure automatic reset after power disruption, transients and brown-outs.
 - r. Each transmitter shall have an operating temperature range of -20° F to 120° F (-28.9° C to 48.9° C) and humidity range of 5 to 95% RH.
10. Listings and Certifications
 - a. The AMD shall be UL/cUL 873 Listed as an assembly
 - 1) Devices claiming compliance with the UL Listing based on individual UL component listing are not acceptable.
 - b. All network-capable AMD models supplied with RS-485 interface and BACnet protocol shall be BTL Listed.
 - c. The AMD shall be tested for compliance with the EMC Directive's requirements and be certified to carry the CE Mark for European Union Shipments.
 11. Installation
 - a. Install in accordance with manufacturer's placement guidelines. A written report shall be submitted to the consulting mechanical engineer if any discrepancies are found.
- U. Fan Air Flow Measuring Stations:
1. Acceptable Manufacturers
 - a. EBTRON, Inc. model GTx108-F is the basis of design.
 - b. Approved performance equal
 2. General
 - a. Airflow measurement devices shall use the principle of thermal dispersion and provide one self-heated bead-in-glass thermistor and one zero power bead-in-glass thermistor at each sensing node.
 - b. Thermal dispersion devices that indirectly heat a thermistor are not acceptable.
 - c. Substitution requests for acceptance less than 60 days prior to bid date or products submitted in non-conformance with the requirements of this specification will not be considered.

- 1) For any product to be considered for substitution, a written document shall be submitted to the engineer detailing exceptions and compliance, section-by-section with supporting documentation, before an approval will be considered.
 - d. Any product submitted as an equal shall be expected to comply with all performance capabilities and functional aspects of this specification.
3. Excluded devices
 - a. Fan Inlet airflow measurement devices.
 - b. Measurement technologies using "chip-in-glass", "chip-in-epoxy" or other "chip" type thermistors for the heated sensor component are not acceptable.
 - c. Pitot tubes, Pitot arrays, Piezo rings and other differential pressure based devices are not acceptable.
 - d. Vortex shedding devices are not acceptable.
4. Required product performance
 - a. Airflow Measurement Devices (AMD) with Temperature Output and Airflow Alarming Capability
 - b. General
 - 1) Provide one AMD for each measurement location provided on the plans, schedules and/or control diagrams to determine the average airflow rate and temperature at each measurement location.
 - 2) Each AMD shall be provided with a microprocessor-based transmitter and one or more sensor probes.
 - a) Devices that have electronic signal processing components on or in the sensor probe are not acceptable.
 - 3) Airflow measurement shall be field configurable to determine the average Actual or Standard mass airflow rate.
 - a) Actual airflow rate calculations shall have the capability of being corrected by the transmitter for altitudes other than sea level.
 - c. Temperature measurement shall be field configurable with velocity weighted average as the default, or manual selection of arithmetic average temperature
5. Sensor probes
 - a. Sensor probes shall consist of one sensor node mounted on a 304 stainless steel block with two adjustable zinc plated steel rods connected to 304 stainless steel pivoting mounting feet.
 - b. Sensor node internal wiring connections shall be sealed and protected from the elements and suitable for direct exposure to water.
 - c. Each sensor probe shall be provided with an integral, FEP jacket, plenum rated CMP/CL2P, UL/cUL Listed cable rated for exposures from -67°F to 392 °F (-55° C to 200° C) and continuous and direct UV exposure.
 - 1) Plenum rated PVC jacket cables are not acceptable.
 - d. Each sensor probe cable shall be provided with a connector plug with gold plated pins for connection to the transmitter.
 - e. Sensor node airflow and temperature calibration data shall be stored in a serial memory chip in the cable connecting plug and not require matching or adjustments to the transmitter in the field.
 - f. Each sensor node shall be provided with two bead-in-glass, hermetically sealed thermistors potted in a marine grade waterproof epoxy with sensor housings constructed of glass-filled polypropylene. Upon request, the

- manufacture shall provide a written independent laboratory test result of 100% survival rate in a 30 day saltwater and acid vapor test.
- 1) Devices that use epoxy or glass encapsulated chip thermistors are not acceptable.
 - 2) Devices with exposed leads are not acceptable.
- g. Each thermistor shall be individually calibrated at a minimum of 3 temperatures to NIST-traceable temperature standards.
- h. Each sensor node shall be individually calibrated at 16 measurement points to airflow standards directly calibrated at NIST to the NIST Laser Doppler Anemometer (LDA) primary velocity standard and have an accuracy of $\pm 2\%$ of reading over the entire calibrated airflow range of 0 to 10,000 FPM 5.8 m/s .
- 1) Upon request the manufacture shall submit for AMD approval a copy of the NIST report of calibration used for the reference standard used.
 - a) Devices calibrated against standards other than the NIST LDA or against NIST temperature standards only are not acceptable.
 - 2) Accuracy shall include the combined uncertainty of the sensor nodes and transmitter.
 - 3) Devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter shall demonstrate compliance with this requirement over the entire operating range.
- i. Each sensing node shall have a temperature accuracy of $\pm 0.15^\circ \text{ F}$ (0.08° C) over an operating range of -20° F to 160° F (-28.9° C to 71.1° C) and humidity range of 0 to 100% RH.
- j. The number of independent sensor nodes provided shall be as follows:
- 1) SWSI and DWDI fans: 2 probes x 1 sensor node/per probe in each fan inlet
 - 2) Fan Arrays (1 to 8 fans): 2 probes x 1 sensor node probe in each fan inlet
6. Transmitter
- a. A remotely located microprocessor-based transmitter shall be provided for each measurement location.
 - b. The transmitter shall be comprised of a main circuit board and interchangeable interface card.
 - c. All printed circuit board interconnects, edge fingers, and test points shall be gold plated.
 - d. All printed circuit boards shall be electroless nickel immersion gold (ENIG) plated.
 - e. All integrated circuitry shall be temperature rated as 'industrial-grade'. Submissions containing 'commercial-grade' integrated circuitry are not acceptable.
 - f. The transmitter shall be capable of determining the airflow rate and temperature of each fan
 - 1) Separate integration buffers shall be provided for display airflow output, airflow signal output (analog and network) and individual sensor output (IR-interface).
 - g. The transmitter shall have startup firmware to facilitate setup of multiple fans and fan areas.
 - h. The transmitter shall be capable of providing a low and/or high airflow set point alarm.
 - i. The transmitter shall be capable of providing individual fan alarming on fan array configurations.

- j. The transmitter shall be capable of identifying an AMD malfunction via the system status alarm and ignore any sensor node that is in a fault condition.
 - k. The transmitter shall be capable of field configuration, diagnostics and include Field Output Adjustment Wizard that allows for a one or two point field adjustment to factory calibration for installations that require adjustment.
 - l. The transmitter shall be provided with a 16-character, alpha-numeric, LCD display.
 - m. The transmitter shall be provided with two field selectable (0-5/0-10 VDC or 4-20mA), scalable, isolated and over-current protected analog output signals (AO1=airflow, AO2=temperature or alarm), in combination with either of the following:
 - 1) one isolated RS-485 (field selectable BACnet MS/TP or Modbus RTU) network connection
 - 2) one isolated Ethernet (simultaneously supported BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) network connection
 - n. Analog signal capability shall include two output terminals: the first (AO1), shall provide the total airflow rate; while the second output (AO2) shall be field configurable to provide temperature.
 - o. The transmitter shall also be available with a single isolated LonWorks Free Topology network interface. Transmitters shall be available alternatively with one USB connection for thumb-drive data logging of sensor data. Neither of these options shall include analog output signals.
 - p. Network communications RS 485 (BACnet MS/TP or Modbus RTU) or Ethernet (BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) shall provide: the average airflow rate, temperature, hi and/or low airflow set point alarm, system status alarm, individual sensor node airflow rates and individual sensor node temperatures. Individual node airflow rates and temperatures shall be available via the network with Lon.
 - q. The transmitter shall have an on-off power switch. Isolation transformers shall not be required.
 - r. The transmitter shall be powered by 24 VAC (22.8 to 26.4 under load) @16 V-A maximum and use a switching power supply that is over-current and over-voltage protected.
 - s. The transmitter shall use a "watchdog" timer circuit to ensure automatic reset after power disruption, transients and brown-outs.
 - t. Each transmitter shall have an operating range of -20° F to 120° F (-28.9° C to 48.9° C) and humidity range of 5 to 95% RH.
7. Listing and Certifications
- a. The AMD shall be UL/cUL 873 Listed as an assembly
 - 1) Devices claiming compliance with the UL Listing based on individual UL component listing are not acceptable.
 - b. All network-capable AMD models supplied with RS-485 interface and BACnet protocol shall be BTL Listed
8. Installation
9. Install in accordance with manufacturer's placement guidelines. A written report shall be submitted to the consulting mechanical engineer if any discrepancies are found.

2.10 BMS SERVER & WEB BROWSER GUI - SYSTEM OVERVIEW

- A. The BMS Contractor shall provide system software based on server/thin-client architecture, designed around the open standards of web technology. The BMS Server shall communicate using Ethernet and TCP. Server shall be accessed using a web browser over Owner intranet and remotely over the Internet.
- B. The intent of the thin-client architecture is to provide the operator(s) complete access to the BMS system via a web browser. The thin-client web browser Graphical User Interface (GUI) shall be browser and operating system agnostic, meaning it will support HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. Microsoft, Firefox, and Chrome browsers (current released versions), and Windows as well as non-Windows operating systems.
- C. The BMS Server software shall support at least the following server platforms (Windows 7, 8.1, 10, Server 12). The BMS Server software shall be developed and tested by the manufacturer of the system stand-alone controllers and network controllers/routers.
- D. The web browser GUI shall provide a completely interactive user interface and shall provide a HTML5 experience that supports the following features as a minimum:
 - 1. Trending
 - 2. Scheduling.
 - 3. Electrical demand limiting.
 - 4. Duty cycling
 - 5. Downloading memory to field devices
 - 6. Real time 'live' Graphic Programs.
 - 7. Tree navigation.
 - 8. Parameter change of properties.
 - 9. Set point adjustments.
 - 10. Alarm / event information.
 - 11. Configuration of operators.
 - 12. Execution of global commands.
 - 13. Add, delete, and modify graphics and displayed data.
- E. Software Components: All software shall be the most current version. All software components of the BMS system software shall be provided and installed as part of this project. BMS software components shall include
 - 1. Server Software, Database and Web Browser Graphical User Interface.
 - 2. 5 Year Software Maintenance license. Labor to implement not included.
 - 3. Embedded System Configuration Utilities for future modifications to the system and controllers.
 - 4. Embedded Graphical Programming Tools.
 - 5. Embedded Direct Digital Control software.
 - 6. Embedded Application Software.
 - 7. Analytic Services
- F. BMS Server Database: The BMS Server software shall utilize a Java Database Connectivity (JDBC) compatible database such as: MS SQL 8.0, Oracle 8i or IBM DB2. BMS systems written to Non-Standard and/or Proprietary databases are NOT acceptable
- G. Thin Client - Web Browser Based: The GUI shall be thin client or browser based and shall meet the following criteria:

1. Web Browser's for PC's: Only the current released browser (Explorer/Firefox/Chrome) will be required as the GUI and a valid connection to the server network. No installation of any custom software shall be required on the operator's GUI workstation/client. Connection shall be over an intranet or the Internet.
2. Encrypted communication between the Web Browser GUI and BMS Server shall use Secure Socket Layer TLS v1.2 as a minimum accept level of encryption.

2.11 WEB BROWSER GRAPHICAL USER INTERFACE

- A. Web Browser Navigation: The Thin Client web browser GUI shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to "feel" like a single application, and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using a web browser to accomplish requirements of this specification. The Web Browser GUI shall (as a minimum) provide for navigation, and for display of animated graphics, schedules, alarms/events, live graphic programs, active graphic set point controls, configuration menus for operator access, reports and reporting actions for events.
- B. Login: On launching the web browser and selecting the appropriate domain name or IP address, the operator shall be presented with a login page that will require a login name and strong password. Navigation in the system shall be dependent on the operator's role-based application control privileges.
- C. Navigation: Navigation through the GUI shall be accomplished by clicking on the appropriate level of a navigation tree (consisting of an expandable and collapsible tree control like Microsoft's Explorer program) and/or by selecting dynamic links to other system graphics. Both the navigation tree and action pane shall be displayed simultaneously, enabling the operator to select a specific system or equipment and view the corresponding graphic. The navigation tree shall as a minimum provide the following views: Geographic, Network, Groups and Configuration.
 1. Geographic View shall display a logical geographic hierarchy of the system including: cities, sites, buildings, building systems, floors, equipment and objects.
 2. Groups View shall display Scheduled Groups and custom reports.
 3. Configuration View shall display all the configuration categories (Operators, Schedule, Event, Reporting and Roles).
- D. Action Pane: The Action Pane shall provide several functional views for each subsystem specified. A functional view shall be accessed by clicking on the corresponding button.
 1. Graphics: Using graphical format suitable for display in a web browser, graphics shall include aerial building/campus views, color building floor-plans, equipment drawings, active graphic set point controls, web content and other valid HTML elements. The data on each graphic page shall automatically refresh.
 2. Dashboards: User customizable data using drag and drop HTML5 elements. Shall include Web Charts, Gauges, and other custom developed widgets for web browser. User shall have ability to save custom dashboards.
 3. Search: User shall have multiple options for searching data based upon Tags. Associated equipment, real time data, Properties, and Trends shall be available in result.
 4. Properties: Shall include graphic controls and text for the following: Locking or overriding objects, demand strategies, and any other valid data required for

- setup. Changes made to the properties pages shall require the operator to depress an 'accept/cancel' button.
5. Schedules: Shall be used to create, modify/edit and view schedules based on the systems hierarchy (using the navigation tree).
 6. Alarms: Shall be used to view alarm information geographically (using the navigation tree), acknowledge alarms, sort alarms by category, actions and verify reporting actions.
 7. Charting: Shall be used to display associated trend and historical data, modify colors, date range, axis and scaling. User shall have ability to create HTML charts through web browser without utilizing chart builder. User shall be able to drag and drop single or multiple data points, including schedules, and apply status colors for analysis.
 8. Logic - Live Graphic Programs: Shall be used to display 'live' graphic programs of the control algorithm, (micro block programming) for the mechanical/electrical system selected in the navigation tree.
 9. Other actions such as Print, Help, Command, and Logout shall be available via a drop-down window.
- E. Color Graphics: The Web Browser GUI shall make extensive use of color in the graphic pane to communicate information related to set points and comfort. Animated .gifs or .jpg, vector scalable, active set point graphic controls shall be used to enhance usability. Graphics tools used to create Web Browser graphics shall be non-proprietary and conform to the following basic criteria:
1. Display Size: The GUI workstation software shall graphically display in a minimum of 1024 by 768 pixels 24 bit True Color.
 2. General Graphic: General area maps shall show locations of controlled buildings in relation to local landmarks.
 3. Color Floor Plans: Floor plan graphics shall show heating and cooling zones throughout the buildings in a range of colors, as selected by Owner. Provide a visual display of temperature relative to their respective set points. The colors shall be updated dynamically as a zone's actual comfort condition changes.
 4. Mechanical Components: Mechanical system graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Animation shall be used for rotation or moving mechanical components to enhance usability.
 5. Minimum System Color Graphics: Color graphics shall be selected and displayed via a web browser for the following:
 - a. Each piece of equipment monitored or controlled including each terminal unit.
 - b. Each building
 - c. Each floor and zone controlled.
- F. Hierarchical Schedules: Utilizing the Navigation Tree displayed in the web browser GUI, an operator (with proper access credentials) shall be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room, or choose to apply a hierarchical schedule to the entire system, site or floor area. For example, Independence Day 'Holiday' for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Tree. No further operator intervention would be required and every control module in the system with would be automatically downloaded with the 'Independence Day' Holiday. All

schedules that affect the system/area/equipment highlighted in the Navigation Tree shall be shown in a summary schedule table and graph.

1. Schedules: Schedules shall comply with the BACnet standards, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on.
 - a. Types of schedule shall be Normal, Holiday or Override
 - b. A specific date
 - c. A range of dates
 - d. Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any).
 - e. Wildcard (example, allow combinations like second Tuesday of every month).
 2. Schedule Categories: The system shall allow operators to define and edit scheduling categories (different types of "things" to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories shall include: name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.
 3. Schedule Groups: In addition to hierarchical scheduling, operators shall be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the operator shall be able to define an ' individual tenant' group - who may occupy different areas within a building or buildings. Schedules applied to the ' tenant group' shall automatically be downloaded to control modules affecting spaces occupied by the ' tenant group'.
 4. Intelligent Scheduling: The control system shall be intelligent enough to automatically turn on any supporting equipment needed to control the environment in an occupied space. If the operator schedules an individual room in a VAV system for occupancy, for example, the control logic shall automatically turn on the VAV air handling unit, chiller, boiler and/or any other equipment required to maintain the specified comfort and environmental conditions within the room.
 5. Partial Day Exceptions: Schedule events shall be able to accommodate a time range specified by the operator (ex: board meeting from 6 pm to 9 pm overrides Normal schedule for conference room).
 6. Schedule Summary Graph: The schedule summary graph shall clearly show Normal versus Holiday versus Override Schedules and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level shall apply.
- G. Alarms: Alarms associated with a specific system, area, or equipment selected in the Navigation Tree, shall be displayed in the Action Pane by selecting an ' Alarms' view. Alarms, and reporting actions shall have the following capabilities:
1. Alarms View: Each Alarm shall display an Alarms Category (using a different icon for each alarm category), date/time of occurrence, current status, alarm report and a bold URL link to the associated graphic for the selected system, area or equipment. The URL link shall indicate the system location, address and other pertinent information. An operator shall easily be able to sort events, edit event templates and categories, acknowledge or force a return to normal in the Events View as specified in this section.
 2. Alarm Categories: The operator shall be able to create, edit or delete alarm categories such as HVAC, Maintenance, Fire, or Generator. An icon shall be

- associated with each alarm category, enabling the operator to easily sort through multiple events displayed.
3. Alarm Templates: Alarm template shall define different types of alarms and their associated properties. As a minimum, properties shall include a reference name, verbose description, severity of alarm, acknowledgement requirements, and high/low limit and out of range information.
 4. Alarm Areas: Alarm Areas enable an operator to assign specific Alarm Categories to specific Alarm Reporting Actions. For example, it shall be possible for an operator to assign all HVAC Maintenance Alarm on the 1st floor of a building to email the technician responsible for maintenance. The Navigation Tree shall be used to setup Alarm Areas in the Graphic Pane.
 5. Alarm Time/Date Stamp: All events shall be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.
 6. Alarm Configuration: Operators shall be able to define the type of Alarm generated per object. A 'network' view of the Navigation Tree shall expose all objects and their respective Alarm Configuration. Configuration shall include assignment of Alarm, type of Acknowledgement and notification for return to normal or fault status.
 7. Alarm Summary Counter: The view of Alarm in the Graphic Pane shall provide a numeric counter, indicating how many Alarms are active (in alarm), require acknowledgement and total number of Alarms in the BMS Server database.
 8. Alarm Auto-Deletion: Alarms that are acknowledged and closed shall be auto-deleted from the database and archived to a text file after an operator defined period.
 9. Alarm Reporting Actions: Alarm Reporting Actions specified shall be automatically launched (under certain conditions) after an Alarm is received by the BMS Server software. Operators shall be able to easily define these Reporting Actions using the Navigation Tree and Graphic Pane through the web browser GUI. Reporting Actions shall be as follows:
 - a. Print: Alarm information shall be printed to the BMS Server's PC or a networked printer.
 - b. Email: Email shall be sent via any POP3-compatible e-mail server (most Internet Service Providers use POP3). Email messages may be copied to several email accounts. Note: Email reporting action shall also be used to support alphanumeric paging services, where email servers support pagers.
 - c. File Write: The ASCII File write reporting action shall enable the operator to append operator defined alarm information to any alarm through a text file. The alarm information that is written to the file shall be completely definable by the operator. The operator may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).
 - d. Write Property: The write property reporting action updates a property value in a hardware module.
 - e. SNMP: The Simple Network Management Protocol (SNMP) reporting action sends an SNMP trap to a network in response to receiving an alarm.
 - f. Run External Program: The Run External Program reporting action launches specified program in response to an event.
- H. Trends: As system is engineered, all points shall be enabled to trend. Trends shall both be displayed and user configurable through the Web Browser GUI. Trends shall

comprise analog, digital or calculated points simultaneously. A trend log's properties shall be editable using the Navigation Tree and Graphic Pane.

1. Viewing Trends: The operator shall have the ability to view trends by using the Navigation Tree and selecting a Trends button in the Graphic Pane. The system shall allow y- and x-axis maximum ranges to be specified and shall be able to simultaneously graphically display multiple trends per graph.
 2. Local Trends: Trend data shall be collected locally by Multi-Equipment/Single Equipment general-purpose controllers, and periodically uploaded to the BMS Server if historical trending is enabled for the object. Trend data, including run time hours and start time date shall be retained in non-volatile module memory. Systems that rely on a gateway/router to run trends are NOT acceptable.
 3. Resolution. Sample intervals shall be as small as one second. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for displays that have different trend intervals, the system will automatically scale the axis.
 4. Dynamic Update. Trends shall be able to dynamically update at operator-defined intervals.
 5. Zoom/Pan. It shall be possible to zoom-in on a particular section of a trend for more detailed examination and 'pan through' historical data by simply scrolling the mouse.
 6. Numeric Value Display. It shall be possible to pick any sample on a trend and have the numerical value displayed.
 7. Copy/Paste. The operator shall have the ability to pan through a historical trend and copy the data viewed to the clipboard using standard keystrokes (i.e. CTRL+C, CTRL+V).
- i. Security Access: Systems that Security access from the web browser GUI to BMS Server shall require a Login Name and Strong Password. Access to different areas of the BMS system shall be defined in terms of Role-Based Access Control privileges as specified:
1. Roles: Roles shall reflect the actual roles of different types of operators. Each role shall comprise a set of 'easily understood English language' privileges. Roles shall be defined in terms of View, Edit and Function Privileges.
 - a. View Privileges shall comprise: Navigation, Network, and Configuration Trees, Operators, Roles and Privileges, Alarm/Event Template and Reporting Action.
 - b. Edit Privileges shall comprise: Set point, Tuning and Logic, Manual Override, and Point Assignment Parameters.
 - c. Function Privileges shall comprise: Alarm/Event Acknowledgement, Control Module Memory Download, Upload, Schedules, Schedule Groups, Manual Commands, Print and Alarm/Event Maintenance.
 2. Geographic Assignment of Roles: Roles shall be geographically assigned using a similar expandable/collapsible navigation tree. For example, it shall be possible to assign two HVAC Technicians with similar competencies (and the same operator defined HVAC Role) to different areas of the system.

2.12 GRAPHICAL PROGRAMMING

- A. The system software shall include a Graphic Programming Language (GPL) for all DDC control algorithms resident in all control modules. Any system that does not use a drag and drop method of graphical icon programming shall not be accepted. All systems shall use a GPL method used to create a sequence of operations by assembling

graphic microblocks that represent each of the commands or functions necessary to complete a control sequence. Microblocks represent common logical control devices used in conventional control systems, such as relays, switches, high signal selectors etc., in addition to the more complex DDC and energy management strategies such as PID loops and optimum start. Each microblock shall be interactive and contain the programming necessary to execute the function of the device it represents.

- B. Graphic programming shall be performed while on screen and using a mouse; each microblock shall be selected from a microblock library and assembled with other microblocks necessary to complete the specified sequence. Microblocks are then interconnected on screen using graphic "wires," each forming a logical connection. Once assembled, each logical grouping of microblocks and their interconnecting wires then forms a graphic function block which may be used to control any piece of equipment with a similar point configuration and sequence of operation.
- C. Graphic Sequence: The clarity of the graphic sequence shall be such that the operator has the ability to verify that system programming meets the specifications, without having to learn or interpret a manufacturer's unique programming language. The graphic programming shall be self-documenting and provide the operator with an understandable and exact representation of each sequence of operation.
- D. GPL Capabilities: The following is a minimum definition of the capabilities of the Graphic Programming software:
 - 1. Function Block (FB): Shall be a collection of points, microblocks and wires which have been connected together for the specific purpose of controlling a piece of HVAC equipment or a single mechanical system.
 - 2. Logical I/O: Input/Output points shall interface with the control modules in order to read various signals and/or values or to transmit signal or values to controlled devices.
 - 3. Microblocks: Shall be software devices that are represented graphically and may be connected together to perform a specified sequence. A library of microblocks shall be submitted with the system integrator's bid.
 - 4. Wires: Shall be Graphical elements used to form logical connections between microblocks and between logical I/O.
 - 5. Reference Labels: Labels shall be similar to wires in that they are used to form logical connections between two points. Labels shall form a connection by reference instead of a visual connection, i.e. two points labeled 'A' on a drawing are logically connected even though there is no wire between them.
 - 6. Parameter: A parameter shall be a value that may be tied to the input of a microblock.
 - 7. Properties: Dialog boxes shall appear after a microblock has been inserted which has editable parameters associated with it. Default parameter dialog boxes shall contain various editable and non-editable fields, and shall contain 'push buttons' for the purpose of selecting default parameter settings.
 - 8. Icon: An icon shall be graphic representation of a software program. Each graphic microblock has an icon associated with it that graphically describes its function.
 - 9. Live Graphical Programs: The Graphic Programming software shall support a 'live' mode, where all input/output data, calculated data and set points shall be displayed in a 'live' real-time mode.
 - 10. Menu-bar Icon: Shall be an icon that is displayed on the menu bar on the GPL screen, which represents its associated graphic microblock.

2.13 LONWORKS NETWORK MANAGEMENT.

- A. Systems requiring the use of third-party LonWorks network management tools shall not be accepted.
- B. Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.
- C. The Network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices and to view health and status counters within devices.
- D. These tools shall provide the ability to "learn" an existing LonWorks network, regardless of what network management tool(s) were used to install the existing network, so that existing LonWorks devices and newly added devices are part of a single network management database.
- E. The network management database shall be resident in the Network Area Controller (NAC), ensuring that anyone with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times and within the control system shall not be accepted.

2.14 BMS DATA MODEL AND SEMANTIC TAGGING

- A. The BMS will represent all of the data, regardless of communication protocol or integration method, as common human and machine interpretable meta data. Examples of the meta data include but are not limited to buildings, floors, air handlers, meters and zones, among other commonly understood terminology of the building operators and building managers. Data will be represented in a hierarchical format such as Buildings > Floors > Equipment.
- B. The BMS will also have the ability to create tags that represent location and descriptive data that have nothing to do with the application of the particular data or group of data. Examples of this tagging may include operators' names, room names, etc. These tags shall be free form text in nature and shall be searchable by the user interface.
- C. The BMS will have the ability to use a Niagara Framework, Haystack or Custom tagging dictionaries or a combination of these dictionaries as well as any future tag dictionaries.

2.15 ANALYTICS

- A. The BMS will support sequences, actions and routines to be programmed to execute against the data model. The execution of each analytics sequence shall be by; a scheduled trigger; interval based trigger, or an event based trigger. The analytics sequences shall be definable and customizable by the owner or the integrator without the requirement to use line code programming. The programming and creation of the rules shall be in a wire sheet framework where objects are added to the wire sheet and connected together. Each of the sequences shall have the ability to execute independently or with dependency on other sequences.

- B. A separate programming language for analytic algorithm development or service will not be allowed. The analytic software shall use the historical data and/or real time BMS data without having to first store the data in a database that is separate from the BMS data.
- C. The analytic algorithms shall be supported on both the BMS Server and NACs to provide data analysis in real time within the limits of NACs and the BMS Server data communication and resources as well as historical based on the BMS Server historian.
- D. The specification calls for analytics of both historical and real time data for reporting, diagnostics and event notification.
- E. For energy and equipment optimization analytics, the analytic software shall change set point values and commands as analytic results dictate.

2.16 SOFTWARE ANALYSIS AND REPORTING TOOLS

- A. Accessing the system shall be via a web browser or mobile devices including IOS, Windows Mobile and Android. In general the system shall enable the user to:
 - 1. Access and view data from all smart meters from a central dashboard.
 - 2. Analyze utility usage patterns
 - 3. Measure its CO2 footprint
 - 4. Assess energy performance of buildings.
 - 5. Identify variances using KPIs, targets, comparisons to historical patterns, etc.
 - 6. Investigate the time, duration and cause of variances.
 - 7. Generate time-of-use consumption and peak loads (e.g. peak, shoulder and off peak kWh and KvA).
 - 8. Calculate tenant usage by meter and generate invoices.
 - 9. Modify the system and reports to reflect changes in building operations.
 - 10. Apportion utilities to various building users.
 - 11. Use algorithms for the analysis of gas and water leakages (based on volume or flow).
 - 12. Tools to set-up new meters.
 - 13. Configure dashboards
 - 14. Use a variety of common reporting formats (e.g. txt, csv, pdf, and xml).
 - 15. Print reports via a local printer (with appropriate page management) and to email reports.
 - 16. Easily understand the meter hierarchy and distinguish virtual meters.
 - 17. Generate aggregated or discrete reports at any point in the hierarchy.
 - 18. Customize meter groupings for reporting.
 - 19. Set up reporting schedules and mailing lists for automated report sending.
 - 20. Perform consumption and scenario forecasting.

2.17 SYSTEM NAVIGATION

- A. System navigation shall be via a standardized navigation tree with hyperlinked for each user, given access to specific areas of the data model. Each user's navigation will dynamically update based on the permissions given in the data model.
- B. In addition, the user shall be able to access a system, a building or group of buildings by navigating via a Campus Map, Site Plan, or building floor plan.

- C. Each user shall have the ability to modify their own dashboard as the need arises by simply saving the current Dashboard session.

2.18 BASIC ANALYTIC DASHBOARDS

- A. Dashboards as a minimum shall contain (for each building group, building, area, switchboard, or grouping in the metering tree) graphics showing live and historical utilities usage, loads and CO2 emissions. Specifically dashboards shall show:
 - 1. Utility usage for default period.
 - 2. Profile of usage for default period.
 - 3. Contribution of child nodes for default period.
 - 4. CO2 emissions.

2.19 ANALYTIC GRAPHICAL DATA OUTPUTS

- A. Time-series daily load profiles displayed with time, in intervals of an hour or less, along the horizontal axis and load along the vertical axis.
- B. Overlay plots displaying multiple daily profiles on a single 24-hour time-series graph.
- C. Viewing of multiple time series data points on the same graph.
- D. Calendar profile: View up to an entire month of consumption profiles on a single screen as one long time series.
- E. X-Y scatter plots: X-Y scatter plots for visualizing correlations between two variables.
- F. Intuitive graphical axes that are scaled and labeled.

2.20 ANALYTICAL DATA OUTPUTS

- A. Basic statistical analysis such as mean, median, standard deviation, correlation, and regression.
- B. Benchmarking against set building energy standards.
- C. Intra/inter-facility comparisons against the building's historical data or across multiple buildings.
- D. Aggregate data among multiple data points. Integrate different energy units using energy conversions.
- E. Data mining (data slice/drill-down) time series data by monthly, weekly, daily, hourly, or trended interval.
- F. Normalization of energy usage or demand by factors such as building area, number of occupants, outside air temperature, and cooling or heating degree-days (CDD, HDD) to make a fair comparison between buildings.
- G. Hierarchical summary of usage and cost information by different levels.

- H. A comprehensive and simple graphical programming tool allowing the users to create their own views, graphs, charts, gauges, and other widgets for viewing live or historical data. Dashboards shall be capable of export to printers or PDF, CSV, Excel or image formats for use in reports, spreadsheets or as live media to display systems.
- I. Utility Outputs
- J. Energy cost breakdown using energy tariff and usage data to calculate daily or hourly energy cost breakdown and validate utility bills.
- K. Real-time cost tracking to calculate electricity costs daily or hourly using real-time meter reading and rate tariffs.
- L. End-use cost allocation to tenants using user-defined parameters and algorithms to estimate end-use energy consumption from whole-building energy.

2.21 ANALYTIC FORECASTING AND ESTIMATING

- A. The software shall offer an accessible programming environment such that complex calculations and formulas can be created using the stored data. For example, the software must be able to calculate greenhouse gas equations or create a water leak detection model that can be used to generate alerts, or generate load profiles, peak demand prediction and other energy demand management functions. Note that systems that require an external controller to be deployed to provide this capability are not acceptable.
- B. Data shall be stored for review and later manipulation using built-in energy analysis tools for load collection and reconciliation to the utility meters, load profiling, load duration, rollup (into varying periods), load base-lining (period comparison), comparison and rating of building performance, identification of cyclic loads, abnormal loads, service outage events, load contribution from each meter, cost comparison, tariff modeling, normalization to parameters such as Gross Floor Area (GFA) and Ambient conditions (e.g. Degree Days).

2.22 BMS INTEGRATION AND MANUAL DATA ENTRY

- A. The software shall feature a rich set of enterprise data integration tools. This will allow the system to export data to SQL databases (such as Oracle or SQL Server) or spreadsheets. The system must offer open SQL data connectivity (such as ODBC) in addition to export of CSV files.
- B. The software must be capable of user-friendly import of meter data either by meter or in bulk by defining a data structure and method for users to input ad-hoc data or historical utility data.

2.23 ALARMS

- A. The BMS shall provide functionality to set alarm for thresholds on each individually metered value and send alert notifications for corrective action via SMS, SNMP and Email.

- B. Alarm thresholds levels shall be displayed in dashboards using color. An alarm console shall be included allowing users to view, prioritize, acknowledge and archive alarms. The user shall be able to quickly view the historical performance of the alarm source as well as any related data to the alarm source from the alarm console.

2.24 WORKFLOW

- A. The system shall provide functionality that allows users to create workflows based on triggered events (such as alarms).
 - 1. Examples:
 - a. in the event of a water leak alarm, the system may create a water leak report and email it automatically to relevant personnel for action.
 - b. the creation of energy reports (e.g. csv files) which are automatically exported to a carbon reporting system on a daily, or weekly or monthly frequency.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that conditioned power supply is available to control units and operator workstation.

3.2 GENERAL

- A. BMS component locations are the responsibility of the System Contractor. All control system components shall be installed in locations as required to properly sense the controlled medium.
- B. BMS Installation shall be performed by professionals in a workmanlike manner and in compliance with the Contract Documents, Division 26 Project Electrical System Specifications, the National Electric Code (NEC), and any/all applicable local codes and/or Authorities Having Jurisdiction (AHJ) and the following:
 - 1. Complete BMS installation including all DDC Devices, Enclosures, wiring, equipment, control devices and sensors shall be installed in accordance with the manufacturers' recommended installation procedures and as specified.
 - 2. All control devices are to be provided and installed with all required gaskets, seals, flanges, connection enclosures, thermal compounds, insulation, piping, fittings and valves as required for design operation, isolation, equalization, purging and calibration.
 - 3. Strap-on control devices shall not be permitted except as explicitly called out.
 - 4. All control devices mounted outdoors shall be protected by a weather-shield, integral outdoor enclosure, from ambient elements in such a manner as to not impede design functionality and/or sensing.
 - 5. BMS installation shall be such that it provides sufficient clearance for system maintenance by maintaining sufficient access for equipment, device and/or component service, calibration, removal, repair or replacement.
 - 6. BMS installation shall not interfere with required clearance for mechanical and/or electrical equipment maintenance.

7. Penetrations through and mounting holes in the building exterior associated with the BMS installation shall be sealed and made water-tight.
 8. Dielectric isolation shall be provided where dissimilar metals are used in installation for connection and support.
 9. Installation, wiring and material shall be protected from damage by and during BMS installation by BMS Contractor.
- C. The Contractor shall be responsible for his/her work and equipment until finally inspected, tested and accepted. The Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on site that is not immediately installed.
- D. After completion of installation, calibrate and commission all components provided as part of the Control System and demonstrate proper sequence of operation in compliance with the specifications. BMS components not operating correctly shall be field corrected or replaced.

3.3 ENCLOSURES & SUB-PANELS

- A. All system components not designed for or required to be field installed shall be mounted in a control enclosure. Those components shall be sub panel mounted except components that are mounted on the panel face. Provide on/off power switch with over-current protection for control power sources in each local enclosure.
- B. All control enclosures shall be located so that visual observation and adjustment can be accomplished while standing flatfooted on the floor in a convenient location adjacent to the equipment served. Install all equipment in readily accessible location as defined by Chapter 1 Article 100 Part A of the NEC.
- C. Label all control system components.
- D. A copy of the "As-built application engineering for the system served shall be laminated in clear plastic, shall be legible and suspended within enclosure.
- E. All B-BC shall be mounted in an enclosure.

3.4 INSTALLATION

- A. Install software in control units. Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- B. Connect and configure equipment and software to achieve sequence of operation specified.
- C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.
 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- D. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

- E. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- F. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

3.5 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. General

- 1. It shall be the System Contractor's responsibility to provide all wiring required for a complete Control System.
- 2. Control system wiring and cabling installed for this project shall be performed by professionals in a workmanlike manner and in accordance with the Contract Documents, Division 26 Project Electrical System Specifications, the National Electric Code (NEC), and any/all applicable local codes and/or Authorities Having Jurisdiction (AHJ) and shall include but may not be limited to the following:
 - a. All power wiring required not indicated on the electrical plans and specifications.
 - b. Power to all actuators and sensors.
 - c. Provide all wiring and cabling for network communications except for owner provided LAN's/WAN's.
 - d. All sensor and control device input and output wiring.
 - e. All interconnecting cabling between and amongst network devices, PCs printers, etc.
 - f. Interlock wiring between devices, variable frequency drives and between motor starters.
 - g. All other necessary wiring for fully complete and functional system as specified.
 - h. Install piping, wiring/cabling routed parallel to or at right angles with the structure, properly supported every six (6) feet at a minimum and installed in a workmanlike manner.
- 3. Maximum allowable voltage for control wiring shall be 120-volts.
- 4. All wiring shall be installed as continuous links. Any required splices shall be made only within an approved junction box or other approved protective device with a maximum fill of 50%.
 - a. BACnet network cabling shall not be field spliced.
- 5. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- 6. This Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

B. Power Wiring and Cabling

- 1. Power wiring for all enclosures and controls equipment, including branch circuit wiring from circuit breaker panels shall be the responsibility of the System Contractor unless specifically shown on the Plans or Specifications to be provided under Division 26.
- 2. All B-AWS equipment shall be served from isolated ground receptacles via UPS by dedicated branch circuits.

3. All other enclosures, sensor and control devices shall be fed from separate circuits in the electrical distribution panels and shall not be served from the typical floor receptacle or lighting circuits.
- C. Network Wiring and Cabling
1. Network installation shall strictly adhere to the manufacturer's networking installation instructions and procedures.
 2. Network installation shall conform to standards for the LAN types and cabling types selected. Specific network rules inherent to the ANSI/AHRAE Standard 135-1995, BACnet shall be followed. Those include but are not limited to:
 - a. Only one path can exist from any BACnet device to another.
 - b. Each BACnet device connected to an internetwork LAN must have a unique device instance (0 - 4,194,303).
 - c. Each internetwork LAN must have a unique Network Number (1 - 65,545).
 3. Primary LAN Network wire and cable shall be run separately from all other wiring.
 4. Other LAN Network wire and cabling shall be installed separate from any wiring over thirty (30) volts.
 5. All communications shielding shall be grounded as per Networked System manufacturer's recommendations.
- D. The entire control system shall be installed in a workmanlike manner in accordance with the manufacturer's wiring diagrams. The control system installer shall provide all wiring, conduit, outlet boxes, junction boxes, panels, and similar devices necessary for a complete installation.
- E. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
- F. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- G. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 2. Wiring in mechanical/electrical rooms and concealed spaces shall be in conduit.
 3. Exposed wiring shall only be allowed in concealed accessible locations. Wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines.
 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
 8. All wiring shall be installed in accordance with local code requirements.

- H. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- I. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.6 ANALOG SENSORS

A. Temperature

- 1. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor readings.
- 2. Install and properly support all enclosures and sensing elements as much as possible in the center of duct cross section and in straight duct runs. In condensing environments use stainless steel flanges to support sensing elements.
- 3. Sensors mounted on air ducts having exterior insulation shall be provided with handy-box mounting with insulating material firmly fitted around handy-box.
- 4. Averaging type sensors: provide a minimum of 1 linear foot of sensor per 4 square feet of duct/coil area or equal to duct/coil width where installed, whichever is longer. Averaging sensing tubing shall serpentine vertically across airstream and be supported firmly by mechanical clips.
- 5. Temperature sensors installed in piping or tanks shall be in separable thermowells. Sensors shall be inserted into thermowells with conductive paste. Assembly shall allow removal of sensor without loss of fluid.
- 6. At a minimum one outside air temperature sensor shall be installed. It shall be mounted outside on a northern exposure as high as serviceable on the building. The sensor shall be mounted within a ventilated enclosure to shield the sensor from the effects of the sun. The sensor location shall be selected such that it may not be affected by artificial and/or mechanical airstreams (i.e., building exhaust, building relief, etc.).
- 7. Terminal Unit Sensors shall be provided one per terminal unit device.
 - a. They shall be wall mounted in the space served 60" above finished floor and located as shown on drawings.
 - b. Provide a minimum of 16' of coiled temperature sensor control wiring for equipment with space sensor not located on the Drawings.
- 8. In all areas where terminal unit sensor locations are not known at the time of building startup, sensors shall be hung approximately 24 inches from the ceiling in the area of the controlled zone and connected. Control wiring shall be neatly coiled and attached to ceiling grid.
- 9. Zone temperature sensors shall not be located on perimeter walls. Where explicitly indicated on drawings to do so and/or in locations near exterior walls and/or subject to drafts sensors shall have insulated mounting bases to prevent false room temperature readings.
- 10. Where wall sensors are mounted in an area subject to damage provide suitable protective guard.
- 11. Where wall sensors are mounted in public spaces with adjustable set points provide suitable security guard.

B. Wet Bulb

- 1. For outside air mount same as outside air temperature sensor.
- 2. For duct mounting execute same as duct mounted temperature sensor.

C. Pressure

1. Orient static pressure sensing taps faced directly down-stream in the airflow so as to eliminate velocity pressure effects. Locate pressure transducers within 10' of sensing point and use tubing sized such as to prevent signal phase lag.
 - a. Final location of static/differential pressure sensing taps shall be pursuant with Contract Documents and as indicated on drawings. Where not explicitly indicated on drawings, pressure sensing taps shall be located as follows:
 - 1) Duct static pressure control sensor tap shall be located 2/3 distance from the Air Handling Unit of the total duct length in a straight section of ductwork with a minimum of four (4) duct diameters in both directions.
 - 2) Positive static high-pressure safety cut-outs shall be located at Air Handling Unit immediately downstream of fan section.
 - 3) Mixed-Air static and/or differential sensor tap shall be located in mixing box section.
 - 4) Negative static pressure safety cut-outs shall be located immediately upstream of fan section.
 - 5) Filter differential pressure taps shall be installed on both filter inlet and outlet.
 - b. Mount air differential pressure taps so that true differential is sensed.
2. Water gauge taps shall include snubbers and isolation valves.
3. Water differential pressure sensors shall be piped through a five-valve bypass assembly with snubbers.

3.7 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 2. Test and adjust controls and safeties.
 3. Test each point through its full operating range to verify that safety and operating control set points are as required.
 4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 5. Test each system for compliance with sequence of operation.
 6. Test software and hardware interlocks.
- C. DDC Verification:
 1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
 2. Check instruments for proper location and accessibility.
 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 4. Check instrument tubing for proper fittings, slope, material, and support.
 5. Check installation of air supply for each instrument.

6. Check flow instruments. Inspect tag number and line and bore size and verify that inlet side is identified and that meters are installed correctly.
 7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
 8. Check temperature instruments and material and length of sensing elements.
 9. Check control valves. Verify that they are in correct direction.
 10. Check DDC system as follows:
 - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
 - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
 - d. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.8 CALIBRATION, COMMISSIONING, DEMONSTRATION AND ACCEPTANCE

- A. Commissioning, Calibrating and Adjusting:
1. As a part of this contract, the BMS Contractor shall fully commission the entire BMS. All commissioning shall be fully documented, and all documentation shall be submitted prior to Demonstration and Acceptance testing. Commissioning shall include a "point-to-point" check-out of the following at a minimum:
 - a. Verify that all Temperature Control Panels (TCP), BMS equipment, controllers, devices and sensors are installed and operational according to the specifications, submittals and manufacturer's installation and application instructions.
 - b. Calibrate all inputs by comparing the actual site condition with the B-OWS point display.
 - c. Verify all outputs from B-OWS command to observed response of controlled device.
 - d. Verify failure response and fail-safe conditions of all devices and safeties.
 - e. Each control program shall be fully commissioned and tested for complete design intent compliance and functionality.
 - f. Verify overall network performance of BMS for complete design intent compliance and functionality with all devices on-line, communicating and fully-operational.
 - g. Subsystems not directly controlled by the BMS but associated with the ATC shall also be fully tested and commissioned as to design intent compliance and functionality.
 2. Calibrate instruments.
 3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
 4. Control System Inputs and Outputs:
 - a. Check analog inputs at 0, 50, and 100 percent of span.
 - b. Check analog outputs at 0, 50, and 100 percent output.
 - c. Check digital inputs using jumper wire.
 - d. Check digital outputs using ohmmeter to test for contact making or breaking.

- e. Check resistance temperature inputs at 0, 50, and 100 percent of span.
 5. Flow:
 - a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
 - b. Manually operate flow switches to verify that they make or break contact.
 6. Pressure:
 - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
 - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
 7. Temperature:
 - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span.
 - b. Calibrate temperature switches to make or break contacts.
 8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
 9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
 10. Provide diagnostic and test instruments for calibration and adjustment of system.
 11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- B. Adjust initial temperature and humidity set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.
- 3.9 TRAINING
- A. Refer to Section 017900 "Demonstration and Training."
 - B. Provide 24 hours training onsite.
 - C. Provide classroom training for one person, one class at BMS Manufacturer's factory training facility. Provide transportation cost to facility.
 - D. As a part of this contract, the BMS Contractor shall provide instruction on the adjustment, operation and maintenance of the BMS as installed including all hardware and software provided by a manufacturer-trained, competent application engineer and/or technician with sufficient experience in the installation, programming and operation of the BMS. All training equipment and material shall be provided by this Contractor.
 - E. Training shall cover the entire execution of the complete BMS and components. Training shall be performed on the Owner's ATC/BMS and shall include:
 1. Location of all TCP's, Control Enclosures, controllers, devices, sensors, etc.
 2. Equipment Layout.
 3. Sequences of Operation.

4. Maintenance and Repair.
5. Troubleshooting.
6. Preventative Maintenance.
7. Sensor Calibration.
8. Proper Use of Service Tools and Materials.

END OF SECTION

SECTION 23 1123 - FACILITY NATURAL-GAS PIPING

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. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Valves.
 - 5. Pressure regulators.
 - 6. Gas Valve Cabinets
 - 7. Concrete bases.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Piping specialties.
 - 2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 3. Pressure regulators. Indicate pressure ratings and capacities.
 - 4. Dielectric fittings.
- B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the

same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/4 inch per foot.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

1.9 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Panels."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

2.2 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.3 ACCEPTABLE MANUFACTURERS

- A. Jenkins, Nibco-Scott, Walworth, Crane, Grinnell, or approved equal. WHERE LISTED OTHERWISE BELOW, PROVIDE VALVES ONLY BY THE MANUFACTURERS NOTED.
- B. Provide valves of same manufacturer throughout where possible.
- C. Provide valves with material suitable for intended service.
- D. Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.

2.4 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. See "General-Duty Valves for HVAC" for additional supplemental requirements.

- C. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
1. CWP Rating: 125 psig Insert pressure.
 2. Threaded Ends: Comply with ASME B1.20.1.
 3. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 4. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- D. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
1. CWP Rating: 125 psig Insert pressure.
 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 3. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- E. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Crane
 - d. Lyall, R. W. & Company, Inc.
 - e. McDonald, A. Y. Mfg. Co.
 - f. Nibco-Scott
 2. Body: Bronze, complying with ASTM B 584.
 3. Ball: Chrome-plated bronze.
 4. Stem: Bronze; blowout proof.
 5. Seats: Reinforced TFE; blowout proof.
 6. Packing: Threaded-body packnut design with adjustable-stem packing.
 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 8. CWP Rating: 600 psig.
 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. Bronze Plug Valves: MSS SP-78.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Lee Brass Company.
 - b. McDonald, A. Y. Mfg. Co.
 2. Body: Bronze, complying with ASTM B 584.
 3. Plug: Bronze.

4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 5. Operator: Square head or lug type with tamperproof feature where indicated.
 6. Pressure Class: 125 psig.
 7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- G. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. McDonald, A. Y. Mfg. Co.
 - b. Mueller Co.; Gas Products Div.
 - c. Xomox Corporation; a Crane company.
 2. Body: Cast iron, complying with ASTM A 126, Class B.
 3. Plug: Bronze or nickel-plated cast iron.
 4. Seat: Coated with thermoplastic.
 5. Stem Seal: Compatible with natural gas.
 6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 7. Operator: Square head or lug type with tamperproof feature where indicated.
 8. Pressure Class: 125 psig.
 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- H. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flowserve.
 - b. Homestead Valve; a division of Olson Technologies, Inc.
 - c. McDonald, A. Y. Mfg. Co.
 - d. Milliken Valve Company.
 - e. Mueller Co.; Gas Products Div.
 - f. R&M Energy Systems, A Unit of Robbins & Myers, Inc.
 2. Body: Cast iron, complying with ASTM A 126, Class B.
 3. Plug: Bronze or nickel-plated cast iron.
 4. Seat: Coated with thermoplastic.
 5. Stem Seal: Compatible with natural gas.
 6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 7. Operator: Square head or lug type with tamperproof feature where indicated.
 8. Pressure Class: 125 psig.

9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 PRESSURE REGULATORS

- A. Manufacturers: Fisher, Rockwell, Maxitrol or approved equal.
- B. General Requirements: Single seated pressure reducing valve for balanced, dead end or continuous service. Full port and straight-way body design. Select springs for the required pressure and capacity.
 1. Single stage and suitable for natural gas.
 2. Steel jacket and corrosion-resistant components.
 3. Elevation compensator.
 4. End Connections: Threaded for regulators NPS 2 1/2 and smaller; flanged for regulators NPS 3 and larger.
- C. Appliance Pressure Regulators: Comply with ANSI Z21.18.
 1. Body and Diaphragm Case: Die-cast aluminum.
 2. Springs: Zinc-plated steel; interchangeable.
 3. Diaphragm Plate: Zinc-plated steel.
 4. Seat Disc: Nitrile rubber.
 5. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 6. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
 7. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

2.6 DIELECTRIC FITTINGS

- A. Dielectric Unions:
 1. Minimum Operating-Pressure Rating: 150 psig.
 2. Combination fitting of copper alloy and ferrous materials.
 3. Insulating materials suitable for natural gas.
 4. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.
- B. Dielectric Flanges:
 1. Minimum Operating-Pressure Rating: 150 psig.
 2. Combination fitting of copper alloy and ferrous materials.
 3. Insulating materials suitable for natural gas.
 4. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.7 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

2.8 GAS VALVE CABINETS

- A. 8"x8"x4" minimum size, 16 gage stainless steel valve cabinet for recessed wall mounting, as manufactured by Acudor Products, Inc. or equal.
- B. Fully enclosed cabinet shall have vision panel in door, engraved identification plate and thumb turn latch for quick access to valve.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- B. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 Site Work for excavating, trenching, and backfilling.
 - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
- D. Install fittings for changes in direction and branch connections.

- E. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.4 INDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. 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.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Verify final equipment locations for roughing-in.
- K. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- L. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- M. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- N. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

- O. Connect branch piping from top or side of horizontal piping.
- P. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- Q. Do not use natural-gas piping as grounding electrode.
- R. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- S. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."
- T. Install sleeves for piping penetrations of walls, ceilings, and floors.
- U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23.
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23.

3.5 VALVE INSTALLATION

- A. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- B. Install anode for metallic valves in underground PE piping.

3.6 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.

2. Bevel plain ends of steel pipe.
 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.8 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

- A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.

3.10 PAINTING

- A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.

- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel (flat).
 - d. Color: Gray.
- C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex (flat).
 - d. Color: Gray.
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 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 the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Use 3000-psi, 28-day, compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.12 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.13 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping shall be the following:
 1. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
- B. Aboveground natural-gas piping shall be one of the following:
 1. Steel pipe with malleable-iron fittings and threaded joints.
 2. Steel pipe with wrought-steel fittings and welded joints.

3.14 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES 5 PSIG OR LESS

- A. Aboveground, piping shall be one of the following:
 1. Steel pipe with malleable-iron fittings and threaded joints.
 2. Steel pipe with steel welding fittings and welded joints.
- B. Underground, below building, piping shall be the following:
 1. Steel pipe with wrought-steel fittings and welded joints.
- C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.
- D. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.15 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:
 1. Two-piece, full-port, bronze ball valves with bronze trim.
 2. Bronze plug valve.
- B. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
 1. Two-piece, full-port, bronze ball valves with bronze trim.
 2. Bronze plug valve
 3. Cast-iron, lubricated plug valve.

- C. Valves in branch piping for single appliance shall be one of the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.

3.16 CATHODIC PROTECTION REQUIREMENTS

- A. All underground service and distribution lines shall be protected by maintaining a minimum voltage of negative 0.85 to a copper-copper sulfate reference electrode.
- B. Cathodic protection current sources shall be five-pound magnesium or zinc sacrificial anodes packaged in suitable anode backfill manufactured for this specific service.
- C. The anode shall be buried deeper than the piping to be protected.
- D. Anode lead wires shall be attached to the piping to a suitable above-ground location by one of the following methods:
 - 1. Thermite welding--limited to a 15-gram cartridge; brazing by any other method is prohibited.
 - 2. Soldering.
 - 3. Conventional ground-water connections.
 - 4. Insulation:
 - a. General:
 - 1) No piping system shall be allowed to contact electrically any other metallic structure or object.
 - 2) Where piping goes through concrete walls or floors, it shall be protected by a nonmetallic sleeve.
 - b. Underground Piping:
 - 1) Dielectric insulation shall be installed at the meter or distribution line, whichever will isolate all of the underground gas distribution system.
 - 2) The steel piping shall be isolated by a dielectric fitting above ground level where it enters the building.

END OF SECTION

SECTION 23 2300 - REFRIGERANT PIPING

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. Refrigerant pipes and fittings.
 - 2. Refrigerant piping valves and specialties.
 - 3. Refrigerants.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of valve, refrigerant piping, and piping specialty.
 - 1. Include pressure drop, based on manufacturer's test data, for the following:
 - a. Thermostatic expansion valves.
 - b. Solenoid valves.
 - c. Hot-gas bypass valves.
 - d. Filter dryers.
 - e. Strainers.
 - f. Pressure-regulating valves.
- B. Shop Drawings:
 - 1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
 - 2. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
 - 3. Show interface and spatial relationships between piping and equipment.
 - 4. Shop Drawing Scale: 1/4 inch equals 1 foot.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.7 PRODUCT STORAGE AND HANDLING

- A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-134a:
 - 1. Suction Lines for Air-Conditioning Applications: 115 psig.
 - 2. Suction Lines for Heat-Pump Applications: 225 psig.
 - 3. Hot-Gas and Liquid Lines: 225 psig.
- B. Line Test Pressure for Refrigerant R-407C:
 - 1. Suction Lines for Air-Conditioning Applications: 230 psig.
 - 2. Suction Lines for Heat-Pump Applications: 380 psig.
 - 3. Hot-Gas and Liquid Lines: 380 psig.
- C. Line Test Pressure for Refrigerant R-410A:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
 - 2. Suction Lines for Heat-Pump Applications: 535 psig.
 - 3. Hot-Gas and Liquid Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B 280, Type ACR.

- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8/A5.8M.
- F. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
 - 4. Working Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250 deg F.

2.3 REFRIGERANTS

- A. ASHRAE 34, R-134a: Tetrafluoroethane.
- B. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.
- C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Suction Lines, Hot-Gas, and Liquid Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 08 31 13 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- L. Install refrigerant piping in protective conduit where installed belowground.
- M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- N. Slope refrigerant piping as follows:
 - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - 2. Install horizontal suction lines with a uniform slope downward to compressor.
 - 3. Install traps and double risers to entrain oil in vertical runs.
 - 4. Liquid lines may be installed level.
- O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- Q. Identify refrigerant piping and valves according to Section 23 0553 "Identification for HVAC Piping and Equipment."
- R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 0517 "Sleeves and Sleeve Seals for HVAC Piping."

- S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 23 0517 "Sleeves and Sleeve Seals for HVAC Piping."
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 23 0518 "Escutcheons for HVAC Piping."

3.3 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.
- F. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

3.4 HANGERS AND SUPPORTS

- A. Comply with requirements for pipe hangers and supports specified in Section 23 0529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

- C. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:
 - 1. NPS 1/2: Maximum span, 60 inches; minimum rod, 1/4 inch.
 - 2. NPS 5/8: Maximum span, 60 inches; minimum rod, 1/4 inch.
 - 3. NPS 1: Maximum span, 72 inches; minimum rod, 1/4 inch.
 - 4. NPS 1-1/4: Maximum span, 96 inches; minimum rod, 3/8 inch.
 - 5. NPS 1-1/2: Maximum span, 96 inches; minimum rod, 3/8 inch.
 - 6. NPS 2: Maximum span, 96 inches; minimum rod, 3/8 inch.
 - 7. NPS 2-1/2: Maximum span, 108 inches; minimum rod, 3/8 inch.
- D. Support multifloor vertical runs at least at each floor.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.
- B. Prepare test and inspection reports.

3.6 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 - 4. Charge system with a new filter-dryer core in charging line.

3.7 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 - 1. Open shutoff valves in condenser water circuit.
 - 2. Verify that compressor oil level is correct.
 - 3. Open compressor suction and discharge valves.
 - 4. Open refrigerant valves except bypass valves that are used for other purposes.
 - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 23 3113 - METAL DUCTS

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. 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 Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 SUBMITTALS

- A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

- B. 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 of ducts.
5. Dimensions of main 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 and vibration isolation.
- C. 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. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 2. Suspended ceiling components.
 3. Structural members to which duct will be attached.
 4. Size and location of initial access modules for acoustical tile.
 5. Penetrations of smoke barriers and fire-rated construction.
 6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.

1.4 QUALITY ASSURANCE

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, "Systems and Equipment" and "Construction and System Start-Up."
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 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.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) 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."

- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," 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."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "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."

2.2 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

- 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. McGill AirFlow LLC.
 - 2. SEMCO Incorporated.
- B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.
- C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) 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."
- E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," 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."
- F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 - 2. Coat insulation with antimicrobial coating.
 - 3. Cover insulation with polyester film complying with UL 181, Class 1 or provide CertainTeed ToughGard R Duct Liner or equal.
- G. Inner Duct: Minimum 0.028-inch-perforated galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent.
- H. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) 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."

- I. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," 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," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise 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. McGill AirFlow LLC.
 - b. SEMCO Incorporated.
- B. 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).
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," 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 Inches in Diameter: Flanged.
- D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," 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 flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "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 DOUBLE-WALL ROUND AND FLAT OVAL DUCTS AND FITTINGS

- 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. McGill AirFlow LLC.
 2. SEMCO Incorporated.
- B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," 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."
 - a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
 2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," 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."
 - a. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
 3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "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."
- C. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch diameter perforations, with overall open area of 23 percent.
- D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 2. Coat insulation with antimicrobial coating.
 3. Cover insulation with polyester film complying with UL 181, Class 1.

2.5 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 shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60 minimum for interior ductwork; G90 minimum for exterior ductwork.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G60.
 - 2. Minimum Thickness for Factory-Applied PVC Coating: 4 milsthick on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 milthick 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 A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- E. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- F. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- G. Reinforcement Shapes and Plates: ASTM A 36/A 36M, 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.
- H. 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.

2.6 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. 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.
10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-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.

2.7 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

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 according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. 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.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the 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 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.4 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

- A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.
- B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings.
- C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "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.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2,

"Minimum Hanger Sizes for Round Duct," 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.

3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 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 Division 09 painting Sections.

3.8 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel unless as otherwise indicated.
- B. Supply Ducts:
 - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: C.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
 - 2. Ducts Connected to Constant-Volume Air-Handling Units/RTU:

- a. Minimum 18 gauge duct construction for first 15 feet of duct run.
 - b. Pressure Class: Positive 2-inch wg.
 - c. Minimum SMACNA Seal Class: A.
 - d. SMACNA Leakage Class for Rectangular: 6.
 - e. SMACNA Leakage Class for Round and Flat Oval: 6.
3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 6-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 3.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.
- C. Return Ducts:
1. Ducts Connected to Fan Coil Units, and Terminal Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
 2. Ducts Connected to Air-Handling Units/RTU:
 - a. Minimum 18 gauge duct construction for first 15 feet of duct run.
 - b. Pressure Class: Positive or negative 2-inch wg.
 - c. Minimum SMACNA Seal Class: A.
 - d. SMACNA Leakage Class for Rectangular: 6.
 - e. SMACNA Leakage Class for Round and Flat Oval: 6.
 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 3.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.
- D. Exhaust Ducts:
1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 6.

3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.
 - a. Exposed to View: Type 304, stainless-steel sheet, No. 4 or No. 3 finish.
 - b. Concealed: Type 304, stainless-steel sheet, No. 2D finish or Carbon-steel sheet.
 - c. Welded seams and joints.
 - d. Pressure Class: Positive or negative 2-inch wg.
 - e. Airtight/Watertight.

4. Ducts Connected to Dishwasher Hoods:
 - a. Type 304, stainless-steel sheet.
 - b. Exposed to View: No. 4 or No. 3 finish.
 - c. Concealed: No. 2D finish.
 - d. Welded seams and flanged joints with watertight EPDM gaskets.
 - e. Pressure Class: Positive or negative 2-inch wg.
 - f. Airtight/Watertight.

- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.

 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.

 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 3.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.

- F. Intermediate Reinforcement:
 1. Galvanized-Steel Ducts: Galvanized steel.

 2. Stainless-Steel Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Galvanized.

- G. Double-Wall Duct Interstitial Insulation:

1. Supply Air Ducts: 1 inches thick, unless noted otherwise on plans.
2. Return Air Ducts: 1 inches thick, unless noted otherwise on plans.

H. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "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) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Welded.

I. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees."
 - a. Pressure Class 2-inch wg Conical tap.
 - b. Pressure Class 6-inch wg: 45-degree lateral.

END OF SECTION

SECTION 23 3300 - AIR DUCT ACCESSORIES

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. Backdraft and pressure relief dampers.
2. Barometric relief dampers.
3. Manual volume dampers.
4. Control dampers.
5. Fire dampers.
6. Combination fire and smoke dampers.
7. Flange connectors.
8. Duct silencers.
9. Turning vanes.
10. Remote damper operators.
11. Duct-mounted access doors.
12. Flexible connectors.
13. Flexible ducts.
14. Duct accessory hardware.

- B. Related Sections:

1. Division 28 Section "Addressable Fire Alarm Systems" for duct-mounted fire and smoke detectors.

1.3 SUBMITTALS

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

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

- a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - e. Wiring Diagrams: For power, signal, and control wiring.
- C. Coordination Drawings: Reflected ceiling plans, 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.
- D. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. 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 shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 1. Galvanized Coating Designation: G60.
 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

- G. 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.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Nailor Industries Inc.
 - 3. Ruskin Company.
 - 4. SEMCO Incorporated.
 - 5. Vent Products Company, Inc.
 - 6. United Enertech.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 2000 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: 0.052-inch-thick, galvanized sheet steel, with welded corners.
- F. Blades: Multiple single-piece blades, center-pivoted, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: Felt.
- I. Blade Axles:
 - 1. Material: Nonferrous metal.
 - 2. Diameter: 0.20 inch.
- J. Tie Bars and Brackets: Galvanized steel.
- K. Return Spring: Adjustable tension.
- L. Bearings: Steel ball or synthetic pivot bushings.
- M. Accessories:
 - 1. Adjustment device to permit setting for varying differential static pressure.
 - 2. Counterweights and spring-assist kits for vertical airflow installations.
 - 3. Screen Mounting: Rear mounted.
 - 4. Screen Material: Galvanized steel.
 - 5. Screen Type: Insect.
 - 6. 90-degree stops.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Greenheck Fan Corp.
 - b. McGill AirFlow LLC.
 - c. Nailor Industries Inc.
 - d. Ruskin Company.
 - e. Vent Products Company, Inc.
 - f. United Enertech.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
 - a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized-steel, 0.064 inchthick.
6. Blade Axles: Galvanized steel.
7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel.

B. Jackshaft:

1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.4 CONTROL DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Arrow United Industries; a division of Mestek, Inc.
 2. Greenheck Fan Corporation.
 3. McGill AirFlow LLC.
 4. Metal Form Manufacturing, Inc.
 5. Nailor Industries Inc.
 6. Ruskin Company.
 7. Vent Products Company, Inc.
 8. Young Regulator Company.
 9. United Enertech.
- B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- C. Frames:
1. Hat shaped.
 2. Galvanized-steel channels, 0.064 inch thick.
 3. Mitered and welded corners.
- D. Blades:
1. Multiple blade with maximum blade width of 8 inches.
 2. Parallel- and opposed-blade design.
 3. Galvanized steel.
 4. 0.064 inchthick.
 5. Blade Edging: Closed-cell neoprene edging.
 6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
- E. Blade Axles: 1/2-inch-diameter; stainless steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From minus 40 to plus 200 deg F.
- F. Bearings:
1. Oil-impregnated bronze, Molded synthetic or Stainless-steel sleeve.
 2. Dampers in ducts with pressure classes of 3-inch wgor less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 3. Thrust bearings at each end of every blade.

2.5 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following::
1. Arrow United Industries; a division of Mestek, Inc.
 2. Greenheck Fan Corporation.

3. McGill AirFlow LLC.
 4. Nailor Industries Inc.
 5. Ruskin Company.
 6. Vent Products Company, Inc.
 7. United Enertech.
- B. Type: Static and dynamic; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wgstatic pressure class and minimum 2000-fpmvelocity. Fire dampers located in medium pressure ductwork shall have minimum 3000-fpm velocity rating.
- D. Fire Rating: 1-1/2 and 3 hours.
- E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable, 165 deg F rated fusible links.

2.6 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Air Balance Inc.; a division of Mestek, Inc.
 2. Cesco Products; a division of Mestek, Inc.
 3. Greenheck Fan Corporation.
 4. Nailor Industries Inc.
 5. Ruskin Company.
 6. United Enertech.
- B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
- C. Closing rating in ducts up to 4-inch wgstatic pressure class and minimum 2000-fpm. Fire dampers located in medium pressure ductwork shall have minimum 3000-fpm velocity rating.

- D. Fire Rating: 1-1/2 and 3 hours.
- E. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.
- F. Smoke Detector: Integral, factory wired for single-point connection.
- G. Blades: Roll-formed, horizontal, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
- H. Leakage: Class I.
- I. Rated pressure and velocity to exceed design airflow conditions.
- J. Mounting Sleeve: Factory-installed, 0.052-inch-thick, galvanized sheet steel; length to suit wall or floor application.
- K. Damper Motors: Modulating or two-position action.
- L. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 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. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC." Division 26 Sections.
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
 - 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
 - 6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
 - 7. Electrical Connection: 115 V, single phase, 60 Hz.
- M. Accessories:
 - 1. Test and reset switches, damper mounted.

2.7 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.

2. Nexus PDQ; Division of Shilco Holdings Inc.
 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.8 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
 2. METALAIRE, Inc.
 3. SEMCO Incorporated.
 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- D. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.9 REMOTE POWERED DAMPER OPERATORS

- A. Basis of Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Pottorff; a division of PCI Industries, Inc.
 2. Ventfabrics, Inc.
 3. Young Regulator Company.
 4. United Enertech.
- B. Description: Remote powered regulator system designed for remote manual damper adjustment.
- C. Wall-Box Mounting: Recessed, 2 inches deep or Surface.
- D. Wall-Box Cover-Plate Material: Steel.

2.10 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Warming and Ventilating; a division of Mestek, Inc.
 2. Ductmate Industries, Inc.
 3. Flexmaster U.S.A., Inc.
 4. Greenheck Fan Corporation.
 5. McGill AirFlow LLC.
 6. Nailor Industries Inc.
 7. Ventfabrics, Inc.
 8. United Enertech.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 InchesSquare: No hinges and two sash locks.
 - b. Access Doors up to 18 InchesSquare: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
 - d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.11 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
 2. Flame Gard, Inc.
 3. 3M.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.
- D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.

- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.12 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. Ventfabrics, Inc.
 - 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd..
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F
- E. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
 - 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 - 2. Outdoor 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. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 - 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.13 DUCT SILENCERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Industrial Noise Control, Inc.
 - 2. McGill AirFlow LLC.
 - 3. Ruskin Company.
 - 4. Vibro-Acoustics.

- B. General Requirements:
 - 1. Factory fabricated.
 - 2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
 - 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

- C. Shape:
 - 1. Rectangular straight with splitters or baffles.
 - 2. Round straight with center bodies or pods.
 - 3. Rectangular elbow with splitters or baffles.
 - 4. Round elbow with center bodies or pods.
 - 5. Rectangular transitional with splitters or baffles.

- D. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, G90, galvanized sheet steel, 0.034 inch thick.

- E. Round Silencer Outer Casing: ASTM A 653/A 653M, G90, galvanized sheet steel.
 - 1. Sheet Metal Thickness for Units up to 24 Inches in Diameter: 0.034 inch thick.
 - 2. Sheet Metal Thickness for Units 26 through 40 Inches in Diameter: 0.040 inch thick.
 - 3. Sheet Metal Thickness for Units 42 through 52 Inches in Diameter: 0.05 inch thick.
 - 4. Sheet Metal Thickness for Units 54 through 60 Inches in Diameter: 0.064 inch thick.

- F. Inner Casing and Baffles: ASTM A 653/A 653M, G90 galvanized sheet metal, 0.034 inch thick, and with 1/8-inch-diameter perforations.

- G. Special Construction:
 - 1. High transmission loss.

- H. Connection Sizes: Match connecting ductwork unless otherwise indicated.

- I. Principal Sound-Absorbing Mechanism:
 - 1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
 - 2. Dissipative or Film-lined type with fill material.
 - a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 15 percent compression.
 - b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.
 - 3. Lining: Mylar or Fiberglas cloth.

- J. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
 - 1. Joints: Lock formed and sealed, continuously welded, or flanged connections.
 - 2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.

3. Reinforcement: Cross or trapeze angles for rigid suspension.

K. Accessories:

1. Factory-installed end caps to prevent contamination during shipping.
2. Removable splitters.

L. Source Quality Control: Test according to ASTM E 477.

2.14 FLEXIBLE DUCTS

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. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Noninsulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.

1. Pressure Rating: 10-inch wgpositive and 1.0-inch wgnegative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.

C. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene aluminized vapor-barrier film.

1. Pressure Rating: 10-inch wgpositive and 1.0-inch wgnegative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.

D. Flexible Duct Connectors:

1. Clamps: Nylon strap in sizes 3 through 18 inches, to suit duct size.

2.15 DUCT ACCESSORY HARDWARE

A. 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
- D. Set dampers to fully open position before testing, adjusting, and balancing.
- E. Install test holes at fan inlets and outlets and elsewhere as indicated.
- F. Install fire dampers according to UL listing.
- G. Connect ducts to duct silencers 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 shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 7. At each change in direction and at maximum 50-footspacing.
 - 8. Upstream or downstream from duct silencers.
 - 9. Control devices requiring inspection.
 - 10. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.
 - 2. Two-Hand Access: 12 by 6 inches.
 - 3. Head and Hand Access: 18 by 10 inches.
 - 4. Head and Shoulders Access: 21 by 14 inches.
 - 5. Body Access: 25 by 14 inches.
 - 6. Body plus Ladder Access: 25 by 17 inches.
- K. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- L. Install flexible connectors to connect ducts to equipment.

- M. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- N. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- O. Connect flexible ducts to metal ducts with draw bands.
- P. Install duct test holes where required for testing and balancing purposes.
- Q. 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.

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 purpose of access door can be performed.
 - 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 - 4. Inspect turning vanes for proper and secure installation.
 - 5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

SECTION 23 3423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Centrifugal roof ventilators.

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on actual Project site elevations.
- B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Roof curbs.
 - 7. Fan speed controllers.
- B. Shop Drawings: 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. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Roof framing and support members relative to duct penetrations.
 - 2. Ceiling suspension assembly members.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

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. Belts: One set(s) for each belt-driven unit.

1.8 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. UL Standard: Power ventilators shall comply with UL 705.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.10 COORDINATION

- A. Coordinate size and location of structural-steel support members.

- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.11 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Acme Engineering & Mfg. Corp.
 - 2. Twin City Fan Company
 - 3. Carnes Company HVAC.
 - 4. Greenheck.
 - 5. Loren Cook Company.
 - 6. PennBarry.
- B. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
 - 1. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
 - 1. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
 - 2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 4. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 - 5. Fan and motor isolated from exhaust airstream.
- E. Accessories:
 - 1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
 - 2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.

- F. 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: Built-in cant and mounting flange.
 - 2. Overall Height: 13.5 inches.
 - 3. Sound Curb: Curb with sound-absorbing insulation matrix.
 - 4. Pitch Mounting: Manufacture curb for roof slope.
 - 5. Metal Liner: Galvanized steel.

2.2 MOTORS

- A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- B. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.
- C. Install units with clearances for service and maintenance.
- D. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. 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.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. 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.
 - 5. Adjust belt tension.
 - 6. Adjust damper linkages for proper damper operation.
 - 7. Verify lubrication for bearings and other moving parts.
 - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 10. Shut unit down and reconnect automatic temperature-control operators.
 - 11. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

END OF SECTION

SECTION 23 3713 - DIFFUSERS, REGISTERS, AND GRILLES

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. Round ceiling diffusers.
2. Rectangular and square ceiling diffusers.
3. Perforated diffusers.
4. Linear slot diffusers.
5. Plenum slot diffusers.
6. Linear floor diffuser plenums.
7. Drum louvers.
8. Adjustable bar grilles.
9. Fixed face grilles.
10. Linear bar grilles.
11. Security grilles.
12. Fixed, extruded aluminum HVAC louvers.

- B. Related Sections:

1. Section 23 3300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 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

A. Round Ceiling Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carnes Company.
 - b. Krueger.
 - c. METALAIRE, Inc.
 - d. Nailor Industries Inc.
 - e. Price Industries.
 - f. Titus.
 - g. Tuttle & Bailey.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel.
4. Finish: Baked enamel, color selected by Architect.
5. Face Style: Two cone.
6. Mounting: Duct connection.
7. Pattern: Two-position horizontal.
8. Accessories:
 - a. Plaster ring.

B. Rectangular and Square Ceiling Diffusers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carnes Company.
 - b. Krueger.
 - c. METALAIRE, Inc.
 - d. Nailor Industries Inc.
 - e. Price Industries.
 - f. Titus.
 - g. Tuttle & Bailey.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel or Aluminum, refer to drawings.
4. Finish: Baked enamel, white.
5. Face Style: Three cone or Plaque.
6. Mounting: Surface and T-bar.
7. Pattern: Fixed.

8. Accessories:
 - a. Plaster ring.

C. Perforated Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carnes Company.
 - b. Krueger.
 - c. METALAIRE, Inc.
 - d. Nailor Industries Inc.
 - e. Price Industries.
 - f. Titus.
 - g. Tuttle & Bailey.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel backpan and pattern controllers, with steel or aluminum face, refer to drawings.
4. Finish: Baked enamel, white.
5. Duct Inlet: Round.
6. Face Style: Flush.
7. Mounting: Surface and T-bar.
8. Pattern Controller: Four louvered deflector patches.
9. Accessories:
 - a. Plaster ring.

2.2 CEILING LINEAR SLOT OUTLETS

A. Linear Slot Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carnes Company.
 - b. Krueger.
 - c. METALAIRE, Inc.
 - d. Nailor Industries Inc.
 - e. Price Industries.
 - f. Titus.
 - g. Tuttle & Bailey.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material - Shell: Steel, insulated.
4. Material - Pattern Controller and Tees: Aluminum.
5. Finish - Face and Shell: Baked enamel, White.
6. Finish - Pattern Controller: Baked enamel, black.
7. Finish - Tees: Baked enamel, white.

B. Plenum Slot Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carnes Company.

- b. Krueger.
 - c. METALAIRE, Inc.
 - d. Nailor Industries Inc.
 - e. Price Industries.
 - f. Titus.
 - g. Tuttle & Bailey.
2. Devices shall be specifically designed for variable-air-volume flows.
 3. Material - Shell: Steel, insulated.
 4. Material - Pattern Controller and Tees: Aluminum.
 5. Finish - Face and Shell: Baked enamel, White.
 6. Finish - Pattern Controller: Baked enamel, black.
 7. Finish - Tees: Baked enamel, white.
 8. Accessories: Center T-bar, T-bar on both sides, T-bar clip on one side.

2.3 HIGH-CAPACITY DIFFUSERS

A. Drum Louver:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carnes Company.
 - b. Krueger.
 - c. METALAIRE, Inc.
 - d. Nailor Industries Inc.
 - e. Price Industries.
 - f. Titus.
 - g. Tuttle & Bailey.
2. Airflow Principle: Extended distance for high airflow rates.
3. Material: Aluminum, heavy gage extruded.
4. Finish: White baked acrylic.
5. Border: 1-1/4-inch width with countersunk screw holes.
6. Gasket between drum and border.
7. Body: Drum shaped; adjustable vertically.
8. Blades: Individually adjustable horizontally.
9. Mounting: Surface to duct or wall.
10. Accessories:
 - a. Opposed-blade steel damper.
 - b. Duct-mounting collars with countersunk screw holes.

2.4 REGISTERS AND GRILLES

A. Adjustable Bar Grille:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carnes Company.
 - b. Krueger.
 - c. METALAIRE, Inc.

- d. Nailor Industries Inc.
 - e. Price Industries.
 - f. Titus.
 - g. Tuttle & Bailey.
2. Material: Steel or Aluminum, refer to drawings.
 3. Finish: Baked enamel, white.
 4. Face Blade Arrangement: Horizontal spaced 3/4 inch apart.
 5. Core Construction: Integral.
 6. Rear-Blade Arrangement: Vertical spaced 3/4 inch apart.
 7. Frame: 1-1/4 inches wide.
 8. Mounting: Concealed.
- B. Fixed Face Grille:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carnes Company.
 - b. Krueger.
 - c. METALAIRE, Inc.
 - d. Nailor Industries Inc.
 - e. Price Industries.
 - f. Titus.
 - g. Tuttle & Bailey.
 2. Material: Steel or Aluminum, refer to drawings.
 3. Finish: Baked enamel, white.
 4. Face Blade Arrangement: Horizontal spaced 3/4 inch apart.
 5. Core Construction: Integral.
 6. Frame: 1-1/4 inches wide.
 7. Mounting: Concealed.
- C. Linear Bar Grille:
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. Carnes Company.
 - b. Krueger.
 - c. METALAIRE, Inc.
 - d. Nailor Industries Inc.
 - e. Price Industries.
 - f. Titus.
 - g. Tuttle & Bailey.
 2. Material: Aluminum.
 3. Finish: Anodized Aluminum.
 4. Face Arrangement: Linear bar core with support bars.
 5. Frame: 1 inch wide.
 6. Mounting Frame: Heavy duty frame for floor applications.
 7. Mounting: Concealed.
- D. Security Grille:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carnes.
 - b. Krueger.
 - c. METALAIRE, Inc.
 - d. Nailor Industries Inc.
 - e. Price Industries.
 - f. Titus.
 - g. Tuttle & Bailey.
2. Security Level: Maximum and suicide deterrent.
3. Material: Steel or Aluminum, refer to drawings.
4. Finish: Baked enamel, white.
5. Face Arrangement:
 - a. Shape: Square or Rectangular.
 - b. Design: Perforated.
 - c. Frame: Yes.
 - d. Deflection: Zero degrees.
 - e. Core: None.
 - f. 3/16-inch-thick perforated faceplate with 5/16-inch-diameter holes spaced 7/16 inch o.c., staggered at 60 degrees.
6. Wall Sleeve: 3/16 inch welded to face.
7. Mounting: 1-1/2-by-1-1/2-by-3/16-inch retaining angle frame.

2.5 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Drainable-Blade Louver:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Airolite Company, LLC (The).
 - b. Arrow United Industries; a division of Mestek, Inc.
 - c. Dowco Products Group; Safe Air of Illinois.
 - d. Greenheck Fan Corporation.
 - e. NCA Manufacturing, Inc.
 - f. Ruskin Company; Tomkins PLC.
 - g. United Enertech.
2. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
3. Mullion Type: Exposed.
4. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
5. Louver Screens
 - a. General: Provide screen at each exterior louver.
 - b. Screen Location for Fixed Louvers: Interior face.
 - c. Screening Type: Bird screening.
 - d. Bird Screening: Aluminum, 1/2-inch-square mesh, 0.063-inch wire.

2.6 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: 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, as much as practical. 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, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
- D. Louver Installation.
 - 1. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
 - 2. Form closely fitted joints with exposed connections accurately located and secured.
 - 3. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
 - 4. Protect unpainted galvanized and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
 - 5. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.
- B. Restore louvers damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
 - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION

SECTION 23 3716 – FABRIC AIR-DISTRIBUTION 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 continuous, tubular, fabric air-distribution devices.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Provide detailed installation instructions for components to be installed.
 - 3. Provide warranty and maintenance documentation.
- B. Shop Drawings: For fabric air-distribution devices.
 - 1. Include plans, elevations, sections, and suspension and attachment details.
 - 2. Provide detailed drawings confirming configuration of Fabric Tensioning System (components, support locations, segment lengths) and Textile Dispersion System (diameter, lengths, airflow, pressure, and textile permeability).
- C. Diffuser Schedule: Use same designations indicated on Drawings. Indicate room location, quantity, model number, size, and accessories furnished.

1.4 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. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 4. Source quality-control reports

1.5 QUALITY ASSURANCE:

- A. Building Codes and Standards:
 - 1. Product must be Classified by Underwriter's Laboratories in accordance with the 25/50 flame spread / smoke developed requirements of NFPA 90-A and UL 2518.
 - 2. All product sections must be labeled with the logo and classification marking of Underwriter's Laboratories.
- B. Design & Quality Control
 - 1. Manufacturer must have documented design support information including duct sizing; vent, orifice, and/or nozzle location; vent, orifice, and/or nozzle sizing; length; and suspension. Parameters for design, including maximum air temperature, velocity, pressure and textile permeability, shall be considered and documented.

1.6 WARRANTY:

- A. Manufacturer must provide a 20 Year Product Warranty for products supplied for the fabric portion of this system as well as a Design and Performance Warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide DuctSox Corporation or comparable product by one of the following:
 - 1. Fabric Air

2.2 PERFORMANCE REQUIREMENTS

- A. Continuous tubular diffuser materials shall be listed and labeled as complying with UL 2518 and NFPA 90A.
- B. Air permeability of fabric will comply with ASTM D737.

2.3 TEXTILE AIR DISPERSION SYSTEM:

- A. SkeleCore FTS (Fabric Tensioning System): Air diffusers shall be constructed with internal tensioning frame.
 - 1. System shall cylindrically tension textile along the entire length of textile duct, including all fittings(crosses, elbows, reducers and tees).
 - 2. Tensioning system shall include full 360 degree tensioning and intermediate rings with quick connection spacer tubes concealed inside the fabric system.
 - 3. Interior structure to include multiple mechanically adjustable tension devices. To provide proper textile tensioning, structural and textile system shall be configured in segments of no more than 45 feet.
 - 4. Textile components supported solely by metal cylindrical rings.
 - 5. Each cylindrical ring shall require a vertical metal to metal cable safety attachment.

- a. Vertical supports are Galvanized steel with available lengths of 5' (standard), 10', 15', & 30'.
6. Available for diameters from 8" – 84".

B. Accessories:

1. Quick-connect joint.
2. Snap hooks.
3. Cleanout zipper.
4. Condensate drain.
5. Fabric damper.
6. End cap.
7. Draw cords.
8. Removable support hoops.
9. Elbows.

C. TEXTILE

1. Sedona-Xm

- a. Textile Construction: Filament/filament twill polyester treated with a machine washable anti-microbial agent by the fabric manufacturer, fire retardant in accordance with UL 2518.
- b. Air Permeability: 2 (+2/-1) CFM/ft² per ASTM D737, Frazier
 1. The air permeability of the fabric must NOT be created by perforating the fabric.
 2. The air permeability must be confirmed by third party testing to eliminate the formation of condensate on the fabric.
- c. Weight: 6.8 oz. /yd² per ASTM D3776
- d. Warranty: 10 years

2. Textile Color

- a. Standard: blue, white, tan, red, green, silver, black

D. TEXTILE SYSTEM FABRICATION REQUIREMENTS:

1. Textile system to be constructed in modular lengths (zippered) with proper radial securing clips along the length of the system.
2. Integrated air dispersion shall be specified and approved by manufacturer. (select only those that apply)
 - a. Linear Vents
 1. Air dispersion accomplished by linear vent and permeable fabric. Linear vents must be sized in 1 CFM per linear foot increments (based on .5" SP), starting at 1 CFM through 90 CFM per linear foot. Linear vent is to consist of an array of open orifices rather than a mesh style vent to reduce maintenance requirements of mesh style vents. Linear vents should also be designed to minimize dusting on fabric surface.

2. Size of vent openings and location of linear vents to be specified and approved by manufacturer.
 - b. Orifices – 2" & 3" SG's
 1. Air dispersion and extended throws are accomplished by reinforced orifices and permeable fabric. Reinforced orifices are to be installed to keep the integrity of opening and withstand laundry processes.
 2. Diameter, quantity, and location of reinforced orifices to be specified and approved by manufacturer.
 - c. Fixed Nozzles
 - a) Air dispersion accomplished by using conical aerodynamic nozzles and permeable fabric. Diameter of nozzles height to be minimum ½". Due to exact requirements of throw and maximum level of noise alternative flow models are not acceptable.
 - b) Color of nozzles must match color of fabric. Unless otherwise specifically mentioned on drawings or otherwise in this specification, suppliers standard table is used for selection of color.
 - c) Location and number of nozzles to be specified and approved by manufacturer.
 - d. Adjustable Nozzles
 1. Air dispersion accomplished by adjustable ball nozzles and permeable fabric. Adjustable ball nozzles to have multi-axial rotation to redirect airflow to desired area. Adjustable ball nozzles are able to completely close off airflow without adding caps or plugs. Adjustable ball nozzles should lock into place once set, preventing constant adjustment. Adjustable ball nozzle should have inset design to be a condensation resistant product.
 2. Colors of adjustable nozzles available are white and black. With white material receiving white adjustable nozzles and all other material colors receiving black adjustable nozzles unless otherwise specifically mentioned on drawings or otherwise in the specification.
 3. Quantity and location of adjustable ball nozzles to be specified and approved by manufacturer.
3. Inlet connection to metal duct via fabric draw band with anchor patches as supplied by manufacturer. Anchor patches to be secured to metal duct via zip screw fastener – supplied by contractor.
4. Inlet connection includes zipper for easy removal / maintenance.
5. Lengths to include required intermediate zippers as specified by manufacturer.
6. System to include Adjustable Flow Devices to balance turbulence, airflow and distribution as needed. Flow restriction device shall include ability to adjust the airflow resistance from 0.06 – 0.60 in w.g. static pressure.
7. End cap includes zipper for easy maintenance.

8. Each section of the textile shall include identification labels documenting order number, section diameter, section length, piece number, code certifications and other pertinent information.
- E. DESIGN PARAMETERS:
1. Textile air diffusers shall be designed from 0.25" water gage minimum to 3.1" maximum, with 0.5" as the standard.
 2. Textile air diffusers shall be limited to design temperatures between 0 degrees F and 180 degrees F (-17.8 degrees C and 82 degrees C).
 3. System overall design; diameter, length, airflow, operating static pressure and dispersion shall be designed or approved by the manufacturer.
 4. Do not use textile diffusers in concealed locations.
 5. Use textile air dispersion systems only for positive pressure air distribution components of the mechanical ventilation system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

3.2 INSTALLATION OF TEXTILE AIR DISPERSION SYSTEM:

- A. Install chosen suspension system in accordance with the requirements of the manufacturer. Instructions for installation shall be provided by the manufacturer with the product.

3.3 CLEANING AND PROTECTION:

- A. Clean air handling unit and ductwork prior to the DuctSox system unit-by-unit as it is installed. Clean external surfaces of foreign substance which may cause corrosive deterioration of facing.
- B. Temporary Closure: At ends of ducts which are not connected to equipment or distribution devices at time of ductwork installation, cover with polyethylene film or other covering which will keep the system clean until installation is completed.
- C. If DuctSox systems become soiled during installation, they should be removed and cleaned following the manufacturers standard terms of laundry.

END OF SECTION

SECTION 23 7416.13 - PACKAGED ROOFTOP AIR-CONDITIONING UNITS

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 packaged, small-capacity, rooftop air-conditioning units (RTUs) with the following components and accessories:
 - 1. Casings.
 - 2. Fans.
 - 3. Motors.
 - 4. Coils.
 - 5. Refrigerant circuit components.
 - 6. Air filtration.
 - 7. Gas furnaces.
 - 8. UV germicidal irradiation section.
 - 9. Dampers.
 - 10. Electrical power connections.
 - 11. Controls.
 - 12. Accessories.
 - 13. Roof curbs.

1.3 DEFINITIONS

- A. DDC: Direct digital controls.
- B. ECM: Electronically commutated motor.
- C. MERV: Minimum efficiency reporting value.
- D. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, large capacity rooftop air-conditioning units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- E. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- F. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.4 ACTION SUBMITTALS

- A. Product Data: For each RTU.
 - 1. Include manufacturer's technical data.
 - 2. Include rated capacities, dimensions, required clearances, characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: 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 to which RTUs will be attached.
 - 2. Roof openings.
 - 3. Roof curbs and flashing.
- B. Field quality-control reports.
- C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

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. Fan Belts: One set(s) for each belt-driven fan.
 - 2. Filters: One set(s) of filters for each unit.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of RTUs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.

2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 10 years.
3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
4. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. AHRI Compliance:

1. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs.
2. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs.
3. Comply with AHRI 270 for testing and rating sound performance for RTUs.

B. AMCA Compliance:

1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
2. Damper leakage tested according to AMCA 500-D.
3. Operating Limits: Classify according to AMCA 99.

C. ASHRAE Compliance:

1. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
2. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES Compliance: Comply with applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. NFPA Compliance: Comply with NFPA 90A or NFPA 90B.

F. UL Compliance: Comply with UL 1995.

G. 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 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AAON
2. Trane
3. York
4. Daikin

2.3 CONSTRUCTION

- A. General Fabrication Requirements for Casings: Formed and reinforced insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Exterior Casing Material: G-60 galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
- C. Inner Casing Fabrication Requirements:
 - 1. Inside Casing: G90-coated galvanized steel, 0.034 inch thick.
- D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - 1. Materials: ASTM C 1071, Type I.
 - 2. Liner materials shall have airstream surface coated with erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
 - 3. Liner Adhesive: Comply with ASTM C 916, Type I.
- E. Plastic Condensate Drain Pans: Fabricated using rigid heavy plastic polymer, and complying with ASHRAE 62.1 for design and construction of drain pans.
- F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.4 FANS

- A. Supply-Air Fans: Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
 - 1. Direct-Driven Supply-Air Fans: Motor shall be resiliently mounted in the fan inlet.
 - 2. Belt-Driven Supply-Air Fans: Motors shall be installed on an adjustable fan base resiliently mounted in the casing.
- B. Condenser-Coil Fan: Variable-speed propeller, mounted on shaft of permanently lubricated motors.

2.5 MOTORS

- A. Comply with NEMA MG 1, Design B, medium induction motor, unless otherwise indicated.
- B. 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.
- C. Duty: Continuous duty at ambient temperature of 104 deg F and at altitude of 3300 feet above sea level.

- D. 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.
- E. Efficiency: Energy efficient, as defined in NEMA MG 1.
- F. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements.

2.6 COILS

- A. Supply-Air Refrigerant Coil:
 - 1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
 - 2. Polymer strip shall prevent all copper coils from contacting steel coil frame or condensate pan.
- B. Hot-Gas Reheat Refrigerant Coil:
 - 1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
 - 2. Polymer strip shall prevent all copper coils from contacting steel coil frame or condensate pan.
- C. Condenser Coil(s):
 - 1. Air-Cooled Condenser
 - a. Condenser fans shall be vertical discharge, axial flow, direct drive fans.
 - b. Coils shall be designed for use with R-410A refrigerant. Coils shall be multi-pass and fabricated from aluminum microchannel tubes.
 - c. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.

2.7 REFRIGERANT CIRCUIT COMPONENTS

- A. Compressor: Hermetic, variable capacity scroll on lead circuit(s) which shall be capable of modulation from 10-100% of its total capacity, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.
- B. Refrigeration Specialties:
 - 1. Refrigerant: R-410A.
 - 2. Expansion valve with replaceable thermostatic element.
 - 3. Refrigerant filter/dryer.
 - 4. Manual-reset high-pressure safety switch.
 - 5. Automatic-reset low-pressure safety switch.
 - 6. Minimum off-time relay – adjustable through controls.
 - 7. Automatic-reset compressor motor thermal overload.
 - 8. Brass service valves installed in compressor suction and liquid lines.

9. Low-ambient kit high-pressure sensor.
10. Modulating hot-gas reheat solenoid valve modulating with a replaceable magnetic coil.

2.8 AIR FILTRATION

- A. Minimum arrestance and MERV according to ASHRAE 52.2.

2.9 GAS FURNACE

- A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47/CSA 2.3 and NFPA 54.
 1. CSA Approval: Designed and certified by and bearing label of CSA.
- B. Burners: Aluminized steel.
 1. Fuel: Natural gas.
 2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
- C. Heat-Exchanger and Drain Pan: Stainless steel.
- D. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve with vertical extension.
- E. Gas Valve Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.10 DAMPERS

- A. Leakage Rate: Comply with ASHRAE/IES 90.1.
- B. Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge and end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Damper assembly shall be controlled by spring return enthalpy activated fully modulating. Unit shall include outside air opening bird screen, outside air hood and barometric relief dampers.

2.11 ELECTRICAL POWER CONNECTIONS

- A. RTU shall have a single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.12 CONTROLS

A. DDC Unit Controls:

1. Single Zone VAV
 - a. Unit shall utilize a variable capacity compressor system and a variable speed fan system to modulate cooling and airflow as required in meeting the space temperature needs and to save unit operating energy. Unit fan speed shall modulate based on space temperature, not supply air pressure.
 - b. Units with modulating gas heat shall be capable of modulating fan speed in both the heating and cooling mode.
 - c. With modulating hot gas reheat, unit shall modulate cooling and hot gas reheat as efficiently as possible, to meet space humidity loads and prevent supply air temperature swings and overcooling of the space.
 - d. Unit shall be provided with supply air temperature control. Mixing boxes and bypass ducts shall not be required for operation as a single zone VAV system.
2. Variable Air Volume Controller
 - a. Unit shall utilize a variable capacity compressor system and a variable speed supply fan system to modulate cooling and airflow as required to meet space temperature cooling loads and to save operating energy. Supply fan speed shall modulate based on supply air duct static pressure. Cooling capacity shall modulate based on supply air temperature.
 - b. Unit shall modulate heating with constant airflow to meet space temperature heating loads.
3. Constant Volume Controller
 - a. Unit shall modulate cooling with constant airflow to meet space temperature cooling loads.
 - b. With modulating hot gas reheat, unit shall modulate cooling and hot gas reheat as efficiently as possible, to meet space humidity loads and prevent supply air temperature swings and overcooling of the space.
 - c. Unit shall modulate heating with constant airflow to meet space temperature heating loads. With staged heating, capacity shall modulate based on space temperature. With modulating heating, capacity shall modulate based on supply air temperature.
4. Wireless access to remotely control and monitor equipment via BACnet integral to the unit DDC controller.
5. Wall-mounted thermostat or sensor with the following features:
 - a. Heat-cool-off switch.
 - b. Fan on-auto switch.
 - c. Fan-speed switch.
 - d. Automatic changeover.
 - e. Adjustable deadband.
 - f. Exposed set point.
 - g. Exposed indication.
 - h. Degree F indication.

- i. Unoccupied-period-override push button.
 6. Safety Control Operation:
 - a. Remote safety shutdown terminals shall be provided for field installed smoke detectors.
- B. Electronic Controller:
1. Controller shall have volatile-memory backup.
 2. Safety Control Operation:
 - a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire-alarm control panel.
 - b. Fire-Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in Section 28 4621.11 "Addressable Fire-Alarm Systems."
 - c. Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply-air temperature is less than 40 deg F.
 3. Scheduled Operation: Occupied and unoccupied periods on 365-day clock with a minimum of two programmable periods per day.
 4. Unoccupied Period:
 - a. Heating Setback: 10 deg F.
 - b. Cooling Setback: System off.
 - c. Override Operation: Two hours.
 5. Supply Fan Operation:
 - a. Occupied Periods: Run fan continuously.
 - b. Unoccupied Periods: Cycle fan to maintain setback temperature.
 6. Refrigerant Circuit Operation:
 - a. Occupied Periods: Cycle or stage compressors to match compressor output to cooling load to maintain room temperature and humidity. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.
 - b. Unoccupied Periods: Cycle compressors and condenser fans for heating to maintain setback temperature.
 7. Hot-Gas Reheat-Coil Operation:
 - a. Occupied Periods: Humidistat opens hot-gas valve to provide hot-gas reheat, and cycles the compressor.
 - b. Unoccupied Periods: Reheat not required.
 8. Gas Furnace Operation:
 - a. Occupied Periods: Cycle, Stage, or Modulate burner to maintain room temperature.
 - b. Unoccupied Periods: Cycle burner to maintain setback temperature.

9. Fixed Minimum Outdoor-Air Damper Operation:
 - a. Occupied Periods: Open to 25 percent.
 - b. Unoccupied Periods: Close the outdoor-air damper.

10. Economizer Outdoor-Air Damper Operation:
 - a. Morning warm-up, cool-down cycles.
 - b. Occupied Periods: Open to 10 percent fixed minimum intake, and maximum 100 percent of the fan capacity. Controller shall permit air-side economizer operation when outdoor air is less than 60 deg F. Use mixed-air temperature and select between outdoor-air and return-air enthalpy to adjust mixing dampers. Start relief-air fan with end switch on outdoor-air damper. During economizer cycle operation, lock out cooling.
 - c. Unoccupied Periods: Close outdoor-air damper and open return-air damper.

11. Carbon Dioxide Sensor Operation:
 - a. Occupied Periods: Reset minimum outdoor-air ratio down to minimum 10 percent to maintain maximum 1000-ppm concentration.
 - b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.

12. Terminal-Unit Relays:
 - a. Provide heating- and cooling-mode changeover relays compatible with terminal control system required in Section 23 3600 "Air Terminal Units" and Section 23 0923 "Direct Digital Control (DDC) System for HVAC."

2.13 ACCESSORIES

- A. Safeties:
 1. High and low pressure control.
 2. Gas furnace airflow-proving switch.

- B. Coil guards of painted, galvanized-steel wire.

- C. Outdoor-air intake weather hood.

2.14 ROOF CURBS

- A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C 1071, Type I or II.
 - b. Thickness: 1 inch.

2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C 916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.

B.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "NRCA Roofing Manual: Membrane Roof Systems." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 07 7200 "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

3.3 CONNECTIONS

- A. Comply with duct installation requirements specified in other HVAC Sections. Drawings indicate general arrangement of ducts. The following are specific connection requirements:
 1. Install ducts to termination at top of roof curb.
 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
 3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 23 3300 "Air Duct Accessories."
 4. Install return-air duct continuously through roof structure.

- B. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- C. Where installing piping adjacent to RTUs, allow space for service and maintenance.
 - 1. Gas Piping: Comply with applicable requirements in Section 23 1123 "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
 - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. RTU will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Inspect for visible damage to unit casing.
 - 3. Inspect for visible damage to furnace combustion chamber.
 - 4. Inspect for visible damage to compressor, coils, and fans.
 - 5. Inspect internal insulation.
 - 6. Verify that labels are clearly visible.
 - 7. Verify that clearances have been provided for servicing.
 - 8. Verify that controls are connected and operable.
 - 9. Verify that filters are installed.
 - 10. Clean condenser coil and inspect for construction debris.
 - 11. Clean furnace flue and inspect for construction debris.
 - 12. Connect and purge gas line.
 - 13. Remove packing from vibration isolators.
 - 14. Inspect operation of barometric relief dampers.

15. Verify lubrication on fan and motor bearings.
16. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
17. Adjust fan belts to proper alignment and tension.
18. Start unit according to manufacturer's written instructions.
 - a. Start refrigeration system.
 - b. Do not operate below recommended low-ambient temperature.
 - c. Complete startup sheets and attach copy with Contractor's startup report.
19. Inspect and record performance of interlocks and protective devices; verify sequences.
20. Operate unit for an initial period as recommended or required by manufacturer.
21. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency:
 - a. Measure gas pressure on manifold.
 - b. Inspect operation of power vents.
 - c. Measure combustion-air temperature at inlet to combustion chamber.
 - d. Measure flue-gas temperature at furnace discharge.
 - e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
 - f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
22. Calibrate thermostats.
23. Adjust and inspect high-temperature limits.
24. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
25. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
 - a. Coil leaving-air, dry- and wet-bulb temperatures.
 - b. Coil entering-air, dry- and wet-bulb temperatures.
 - c. Outdoor-air, dry-bulb temperature.
 - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
26. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
27. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Return-air volume.
 - c. Relief-air volume.
 - d. Outdoor-air intake volume.
28. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

29. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
 - a. High-temperature limit on gas-fired heat exchanger.
 - b. Low-temperature safety operation.
 - c. Filter high-pressure differential alarm.
 - d. Economizer to minimum outdoor-air changeover.
 - e. Relief-air fan operation.
 - f. Smoke and firestat alarms.

30. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 CLEANING AND ADJUSTING

- A. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

END OF SECTION

SECTION 23 8123.13 - COMPUTER-ROOM AIR-CONDITIONERS

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-room air conditioners.

1.3 DEFINITIONS

- A. COP: Coefficient of performance.
- B. EER: Energy efficiency ratio.
- C. SCR: Silicon-controlled rectifier.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include material descriptions, dimensions of individual components and profiles, and finishes for computer-room air-conditioning units.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For computer-room air conditioners.
 - 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.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, using input from installers of the items involved.
- B. Field quality-control reports.
- C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.

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. Fan Belts: One set(s) for each belt-driven fan.
 - 2. Filters: One set(s) of filters for each unit.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of computer-room air conditioners that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
 - 2. Warranty Period for Humidifiers: Manufacturer's standard, but not less than three years from date of Substantial Completion.
 - 3. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by the following:
 - 1. Liebert.
 - 2. Stulz-ATS
 - 3. Compu-Aire Inc.

2.2 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. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

D. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

2.3 FLOOR-MOUNTED UNITS

A. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls; for vertical floor mounting in upflow or downflow configuration.

B. Cabinet and Frame: Welded tubular-steel frame with removable steel panels with baked-enamel finish, insulated with 1/2 to 1-inch-thick duct liner.

1. Floor Stand: Welded tubular steel, height required for rear return option, with adjustable legs and vibration isolation pads.
2. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Supply-Air Fan: The unit is equipped with one plug fan: direct driven with backward curved blades and Electronically Commutated DC motor; commonly referred to as EC plug fan. The fan speed is variable

D. Refrigeration System:

1. Compressor: Scroll, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
2. Refrigeration Circuit Components:
 - a. Low-pressure switch.
 - b. Manually reset, high-pressure switch.
 - c. Thermal-expansion valve with external equalizer.
 - d. Sight glass with moisture indicator.
 - e. Service shutoff valves.
 - f. Charging valves.
 - g. Hot-gas bypass.
 - h. Refrigerant charge.
3. Refrigerant: R-410A.
4. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins.
5. Refrigerant line-sweat-adapter kit to permit field brazing of refrigerant lines.
 - a. Mount stainless-steel drain pan having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir under coil assembly.

6. Remote, Air-Cooled Refrigerant Condenser: Integral, copper-tube aluminum-fin coil with direct-drive, propeller fan.
 7. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.
- E. Electric-Resistance Reheat Coil:
1. Finned-tube electric elements with contactor.
 2. Dehumidification relay.
 3. High-temperature-limit switches.
 4. SCR to proportionally control the reheat elements providing precise temperature control.
- F. Filter: 2-inch-thick, disposable, glass-fiber media.
1. Filter Minimum Efficiency Reporting Value:
 - a. MERV Rating: MERV 8 according to ASHRAE 52.2.
- G. Infrared Humidifier: High-intensity quartz lamps mounted above stainless-steel evaporator pan, serviceable without disconnecting water, drain, or electrical connections; prepiped and located in bypass airstream; with flush-cycle timer and solenoid drain valve.
- H. Disconnect Switch: Non-automatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.
- I. Single point power kit permitting single electrical feed to the evaporator and condensing unit of a close-coupled system.
- J. Control System:
1. Microprocessor remote-mounted panel.
 2. Fan contactor.
 3. Compressor contactor.
 4. Compressor start capacitor.
 5. Control transformer with circuit breaker.
 6. Solid-state temperature- and humidity-control modules.
 7. Humidity contactor.
 8. Time-delay relay.
 9. Heating contactor.
 10. Smoke sensor.
 11. Filter clog switch.
 12. Alarm contacts.
 13. High-temperature thermostat.
 14. Solid-state, wall-mounted control panel with start-stop switch, adjustable humidity set point, and adjustable temperature set point.
- K. Fan Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load does not require motor to operate in service factor range above 1.0.
 - b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for hydronic piping systems to verify actual locations of piping connections before equipment installation.
- C. Examine walls, floors, and roofs for suitable conditions where computer-room air conditioners will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Layout and install computer-room air conditioners and suspension system coordinated with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- B. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances.
- C. Computer-Room Air-Conditioner Mounting: Install using elastomeric pads
 1. Minimum Deflection: 1/4 inch.
- D. Air-Cooled Refrigerant Condenser Mounting: Install on roof mounted support frame/stand.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other heating, ventilating, and air-conditioning Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Where installing piping adjacent to computer-room air conditioners, allow space for service and maintenance.
- C. Water and Drainage Connections: Comply with applicable requirements in Section 221116 "Domestic Water Piping." Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.
- D. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Provide shutoff valves and piping.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
 - 1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Computer-room air conditioners will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.
- D. After startup service and performance test, change filters and flush humidifier.

3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain computer-room air conditioners.

END OF SECTION

SECTION 23 8126 - SPLIT-SYSTEM AIR-CONDITIONERS

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 split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: 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. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

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. Filters: One set(s) for each air-handling unit.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 03 3000 "Cast-in-Place Concrete."
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. For Compressor: Five year(s) from date of Substantial Completion.
 - b. For Parts: One year(s) from date of Substantial Completion.
 - c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. LG.
 2. Mitsubishi
 3. Panasonic
 4. Daikin
 5. Toshiba.
 6. Trane.
 7. York.

2.2 INDOOR UNITS (5 TONS OR LESS)

- A. Wall-Mounted, Evaporator-Fan Components:
1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
 2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
 3. Fan: Direct drive, centrifugal.
 4. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 23 0513 "Common Motor Requirements for HVAC Equipment."
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - c. Enclosure Type: Totally enclosed, fan cooled.
 - d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
 - e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 - f. Mount unit-mounted disconnect switches on interior of unit.
 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 6. Condensate Drain Pans:
 - a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - b. Single-wall, galvanized-steel sheet.
 - c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.
 - 1) Minimum Connection Size: NPS 1.

- d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
- 7. Air Filtration Section:
 - a. General Requirements for Air Filtration Section:
 - 1) Comply with NFPA 90A.
 - 2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
 - 3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
 - b. Disposable Panel Filters:
 - 1) Factory-fabricated, viscous-coated, flat-panel type.
 - 2) Thickness: 1 inch.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

- 1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
- 2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Scroll.
 - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - c. Refrigerant Charge: R-410A.
 - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
- 3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
- 4. Fan: Aluminum-propeller type, directly connected to motor.
- 5. Motor: Permanently lubricated, with integral thermal-overload protection.
- 6. Low Ambient Kit: Permits operation down to 15 deg F.
- 7. Mounting Base: Polyethylene.

2.4 ACCESSORIES

- A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
- B. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

1. Compressor time delay.
 2. 24-hour time control of system stop and start.
 3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
 4. Fan-speed selection including auto setting.
- C. Automatic-reset timer to prevent rapid cycling of compressor.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on equipment supports or platform. Anchor units to supports with removable, cadmium-plated fasteners.
- D. Equipment Mounting:
 1. Comply with requirements for vibration isolation devices specified in Section 23 0548.13 "Vibration Controls for HVAC."
- E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- C. Duct Connections: Duct installation requirements are specified in Section 23 3113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 23 3300 "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- 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. 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.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 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.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 23 8239.16 - PROPELLER UNIT HEATERS

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 propeller unit heaters with electric-resistance heating coils.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. PTFE: Polytetrafluoroethylene plastic.
- C. TFE: Tetrafluoroethylene plastic.

1.4 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 location and size of each field connection.
 - 4. Include details of anchorages and attachments to structure and to supported equipment.
 - 5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
 - 6. Indicate location and arrangement of piping valves and specialties.
 - 7. Indicate location and arrangement of integral controls.
 - 8. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Airtherm; a Mestek company.
 - 2. Trane.
 - 3. Qmark.
 - 4. Markel.

2.2 DESCRIPTION

- A. Assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.
- 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 UL 2021.
- D. Comply with UL 823.

2.3 PERFORMANCE REQUIREMENTS

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.4 HOUSINGS

- A. Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

2.5 COILS

- A. General Coil Requirements: Test and rate propeller unit-heater coils according to ASHRAE 33.
- B. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.
 - 1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
 - 2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

2.6 FAN AND MOTOR

- A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
- B. Motor: Permanently lubricated,. Comply with requirements in Section 23 0513 "Common Motor Requirements for HVAC Equipment."

2.7 CONTROLS

- A. Control Devices:
 - 1. Unit-mounted thermostat.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive propeller 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

- A. Install propeller unit heaters to comply with NFPA 90A.
- B. Install propeller unit heaters level and plumb.

- C. Suspend propeller unit heaters from structure with all-thread hanger rods or manufacturer's support bracket. Hanger rods and attachments to structure are specified in Section 23 0529 "Hangers and Supports for HVAC Piping and Equipment."
- D. 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.

3.3 CONNECTIONS

- A. Comply with safety requirements in UL 1995.
- B. Ground equipment according to Section 26 0526 "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Section 26 0519 "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safety devices. 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.

3.5 ADJUSTING

- A. Adjust initial temperature set points.

END OF SECTION

SECTION 26 0500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Supporting devices for electrical components.
 - 2. Concrete equipment bases.
 - 3. Cutting and patching for electrical construction.
 - 4. Touchup painting.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.
- E. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For electricity-metering equipment.
- B. Shop Drawings: Dimensioned plans and sections or elevation layouts of electricity-metering equipment.
- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
 - 1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
- C. Coordinate electrical service connections to components furnished by utility companies.
 - 1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
 - 2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.
- D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

- A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
- C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch-diameter slotted holes at a maximum of 2 inches o.c., in webs.
 - 1. Channel Thickness: Selected to suit structural loading.
 - 2. Fittings and Accessories: Products of the same manufacturer as channel supports.
- D. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
- E. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
- F. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.
- G. Expansion Anchors: Carbon-steel wedge or sleeve type.

- H. Toggle Bolts: All-steel springhead type.
- I. Powder-Driven Threaded Studs: Heat-treated steel.

2.2 CONCRETE BASES

- A. Concrete Forms and Reinforcement Materials: As specified in Division 3 Section "Cast-in-Place Concrete."
- B. Concrete: 3000-psi, 28-day compressive strength as specified in Division 3 Section "Cast-in-Place Concrete."

2.3 TOUCHUP PAINT

- A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.
- B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 WIRING INSTALLATION

- A. Install splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- B. Install wiring at outlets with at least 12 inches of slack conductor at each outlet.
- C. Connect outlet and component connections to wiring systems and to ground. 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.

3.3 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.
- B. Dry Locations: Steel materials.
- C. Support Clamps for PVC Raceways: Click-type clamp system.
- D. Selection of Supports: Comply with manufacturer's written instructions.
- E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

3.4 SUPPORT INSTALLATION

- A. Install support devices to securely and permanently fasten and support electrical components.
- B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.
- E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- F. Install 1/4-inch- diameter or larger threaded steel hanger rods, unless otherwise indicated.
- G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- I. Simultaneously install vertical conductor supports with conductors.
- J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.

- K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:
 - 1. Wood: Fasten with wood screws or screw-type nails.
 - 2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
 - 3. New Concrete: Concrete inserts with machine screws and bolts.
 - 4. Existing Concrete: Expansion bolts.
 - 5. Instead of expansion bolts, threaded studs driven by a powder charge and provided with lock washers may be used in existing concrete.
 - 6. Steel: Welded threaded studs or spring-tension clamps on steel.
 - a. Field Welding: Comply with AWS D1.1.
 - 7. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
 - 8. Light Steel: Sheet-metal screws.
 - 9. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.5 FIRESTOPPING

- A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Thermal and Moisture Protection."

3.6 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Concrete."

3.7 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

- B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.8 FIELD QUALITY CONTROL

- A. Inspect installed components for damage and faulty work, including the following:
 - 1. Raceways.
 - 2. Building wire and connectors.
 - 3. Supporting devices for electrical components.
 - 4. Electrical identification.
 - 5. Electricity-metering components.
 - 6. Concrete bases.
 - 7. Electrical demolition.
 - 8. Cutting and patching for electrical construction.
 - 9. Touchup painting.

3.9 REFINISHING AND TOUCHUP PAINTING

- A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section "Finishes."
 - 1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
 - 2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
 - 3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.10 CLEANING AND PROTECTION

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 26 0519 - 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency.
- C. Field Quality-Control Test Reports: From Contractor.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 CONDUCTORS AND CABLES

- A. Manufacturers:

1. Alcan Aluminum Corporation; Alcan Cable Div.
 2. American Insulated Wire Corp.; a Leviton Company.
 3. Encore Wire Corporation
 4. Senator Wire & Cable Company.
 5. Southwire Company.
 6. Republic
- B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.
- C. Conductor Material: Copper solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.
- D. Conductor Insulation Types: Type THHN-THWN complying with NEMA WC

2.3 CONNECTORS AND SPLICES

- A. Manufacturers:
1. AFC Cable Systems, Inc.
 2. AMP Incorporated/Tyco International.
 3. Hubbell/Anderson.
 4. O-Z/Gedney; EGS Electrical Group LLC.
 5. 3M Company; Electrical Products Division.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway
- C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Type THHN-THWN, single conductors in raceway.
- E. Exposed Branch Circuits, including in Crawlspace: Type THHN-THWN, single conductors in raceway
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- G. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.

- H. Underground Feeders and Branch Circuits: Type THHN-THWN, single conductors in raceway
- I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.
- J. Fire Alarm Circuits: Type THHN-THWN, in raceway
- K. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- L. Class 2 Control Circuits: Type THHN-THWN, in raceway.

END OF SECTION

SECTION 26 0526 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Data: For the following:
 - 1. Ground rods.
- C. Field Test Reports: Submit written test reports to include the following:
 - 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.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - 1. Comply with UL 467.
- B. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.
- C. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Grounding Conductors, Cables, Connectors, and Rods:
 - a. Apache Grounding/Erico Inc.
 - b. Boggs, Inc.
 - c. Chance/Hubbell.
 - d. Copperweld Corp.
 - e. Dossert Corp.
 - f. Erico Inc.; Electrical Products Group.
 - g. Framatome Connectors/Burndy Electrical.
 - h. Galvan Industries, Inc.
 - i. Harger Lightning Protection, Inc.
 - j. Hastings Fiber Glass Products, Inc.
 - k. Heary Brothers Lightning Protection Co.
 - l. Ideal Industries, Inc.
 - m. ILSCO.
 - n. Kearney/Cooper Power Systems.
 - o. Korns: C. C. Korns Co.; Division of Robroy Industries.
 - p. Lightning Master Corp.
 - q. Lyncole XIT Grounding.
 - r. O-Z/Gedney Co.; a business of the EGS Electrical Group.
 - s. Raco, Inc.; Division of Hubbell.
 - t. Robbins Lightning, Inc.
 - u. Salisbury: W. H. Salisbury & Co.
 - v. Superior Grounding Systems, Inc.
 - w. Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Equipment Grounding Conductors: Insulated with green-colored insulation.
- C. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- D. Grounding Electrode Conductors: Stranded cable.
- E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
- F. Bare Copper Conductors: Comply with the following:
1. Solid Conductors: ASTM B 3.

2. Assembly of Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

G. Copper Bonding Conductors: As follows:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

H. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.3 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.
- C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Sectional type; copper-clad steel.
 1. Size: 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- B. In raceways, use insulated equipment grounding conductors.
- C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.
- D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.
- E. Grounding Bus: Install and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Use insulated spacer; space 1 inch from wall and support from wall 6 inches above finished floor, unless otherwise indicated.
 2. At doors, route the bus up to the top of the door frame, across the top of the doorway, and down to the specified height above the floor.
- F. Underground Grounding Conductors: Use tinned- copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

3.2 EQUIPMENT GROUNDING CONDUCTORS

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install equipment grounding conductors in all feeders and circuits.
- C. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- E. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
- F. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- G. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

3.3 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 2. Make connections with clean, bare metal at points of contact.
 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

END OF SECTION

SECTION 26 0533 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 7 Section "Thermal and Moisture Protection" for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
 - 2. Division 26 Section "Common Work Results for Electrical" for supports, anchors, and identification products.
 - 3. Division 26 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.
- E. LFNC: Liquidtight flexible nonmetallic conduit.
- F. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- B. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 METAL CONDUIT AND TUBING

- A. Manufacturer[s]:
 - 1. AFC Cable Systems, Inc.
 - 2. Alfex Inc.
 - 3. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 4. Electri-Flex Co.
 - 5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
 - 6. LTV Steel Tubular Products Company.
 - 7. Manhattan/CDT/Cole-Flex.
 - 8. O-Z Gedney; Unit of General Signal.
 - 9. Wheatland Tube Co.
 - 10. Republic Conduit
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Aluminum Rigid Conduit: ANSI C80.5.
- D. IMC: ANSI C80.6.
- E. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.
- F. Plastic-Coated IMC and Fittings: NEMA RN 1.
- G. EMT and Fittings: ANSI C80.3.
 - 1. Fittings: Set-screw or compression type.

- H. FMC: Zinc-coated steel.
- I. LFMC: Flexible steel conduit with PVC jacket.
- J. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.3 NONMETALLIC CONDUIT AND TUBING

- A. Available Manufacturer(s):
 - 1. American International.
 - 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 3. Arco Corp.
 - 4. Cantex Inc.
 - 5. Certainteed Corp.; Pipe & Plastics Group.
 - 6. Condux International.
 - 7. ElecSYS, Inc.
 - 8. Electri-Flex Co.
 - 9. Lamson & Sessions; Carlon Electrical Products.
 - 10. Manhattan/CDT/Cole-Flex.
 - 11. RACO; Division of Hubbell, Inc.
 - 12. Spiralduct, Inc./AFC Cable Systems, Inc.
 - 13. Thomas & Betts Corporation.
- B. ENT: NEMA TC 13.
- C. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.
- D. RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.
- E. LFNC: UL 1660.

2.4 METAL WIREWAYS

- A. Manufacturers:
 - 1. Hoffman.
 - 2. Square D.
- B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
- E. Wireway Covers: Screw-cover type.
- F. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.
 - 1. Manufacturer[s]:
 - a. Airey-Thompson Sentinel Lighting; Wiremold Company (The).
 - b. Thomas & Betts Corporation.
 - c. Walker Systems, Inc.; Wiremold Company (The).
 - d. Wiremold Company (The); Electrical Sales Division.
- B. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturer[s]:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. Emerson/General Signal; Appleton Electric Company.
 - 3. Erickson Electrical Equipment Co.
 - 4. Hoffman.
 - 5. Hubbell, Inc.; Killark Electric Manufacturing Co.
 - 6. O-Z/Gedney; Unit of General Signal.
 - 7. RACO; Division of Hubbell, Inc.
 - 8. Robroy Industries, Inc.; Enclosure Division.
 - 9. Scott Fetzer Co.; Adalet-PLM Division.
 - 10. Spring City Electrical Manufacturing Co.
 - 11. Thomas & Betts Corporation.
 - 12. Walker Systems, Inc.; Wiremold Company (The).
 - 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- E. Floor Boxes: Cast metal, fully adjustable, rectangular.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- H. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.

- I. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.7 FACTORY FINISHES

- A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors:
 1. Exposed: Rigid steel or IMC.
 2. Concealed in Concrete Slab: PVC externally coated rigid steel.
 3. Underground, Single Run: RNC.
 4. Underground, Grouped: RNC.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 6. Boxes and Enclosures: NEMA 250, Type 3R.
- B. Indoors:
 1. Exposed: EMT.
 2. Concealed: EMT.
 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
 4. Damp or Wet Locations: Rigid steel conduit.
 5. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
 - a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.
- C. Minimum Raceway Size: 1/2-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

END OF SECTION

SECTION 26 0553 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Identification for raceway and metal-clad cable.
 - 2. Identification for conductors and communication and control cable.
 - 3. Underground-line warning tape.
 - 4. Warning labels and signs.
 - 5. Instruction signs.
 - 6. Equipment identification labels.
 - 7. Miscellaneous identification products.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.
- C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.145.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.2 UNDERGROUND-LINE WARNING TAPE

- A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
 - 1. Not less than 6 inches wide by 4 mils thick.
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.
 - 4. Printed legend shall indicate type of underground line.

2.3 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.
- C. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.4 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.

3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.5 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch.
2. Tensile Strength: 50 lb, minimum.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

- B. Paint: Paint materials and application requirements are specified in Division 9 painting Sections.

1. Exterior Concrete, Stucco, and Masonry (Other Than Concrete Unit Masonry):

- a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.

- 1) Primer: Exterior concrete and masonry primer.
- 2) Finish Coats: Exterior semigloss acrylic enamel.

2. Exterior Concrete Unit Masonry:

- a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.

- 1) Block Filler: Concrete unit masonry block filler.
- 2) Finish Coats: Exterior semigloss acrylic enamel.

3. Exterior Ferrous Metal:

- a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.

- 1) Primer: Exterior ferrous-metal primer.
- 2) Finish Coats: Exterior semigloss alkyd enamel.

4. Exterior Zinc-Coated Metal (except Raceways):

- a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.

- 1) Primer: Exterior zinc-coated metal primer.
- 2) Finish Coats: Exterior semigloss alkyd enamel.

5. Interior Concrete and Masonry (Other Than Concrete Unit Masonry):

- a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior concrete and masonry primer.
 - 2) Finish Coats: Interior semigloss alkyd enamel.
6. Interior Concrete Unit Masonry:
 - a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a block filler.
 - 1) Block Filler: Concrete unit masonry block filler.
 - 2) Finish Coats: Interior semigloss acrylic enamel.
7. Interior Gypsum Board:
 - a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior gypsum board primer.
 - 2) Finish Coats: Interior semigloss acrylic enamel.
8. Interior Ferrous Metal:
 - a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior ferrous-metal primer.
 - 2) Finish Coats: Interior semigloss acrylic enamel.
9. Interior Zinc-Coated Metal (except Raceways):
 - a. Semigloss Acrylic-Enamel Finish: Two finish coat(s) over a primer.
 - 1) Primer: Interior zinc-coated metal primer.
 - 2) Finish Coats: Interior semigloss acrylic enamel.
- C. 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 APPLICATION

- A. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:
 1. Fire Alarm System: Red.
 2. Fire-Suppression Supervisory and Control System: Red and yellow.
 3. Combined Fire Alarm and Security System: Red and blue.
 4. Security System: Blue and yellow.
 5. Mechanical and Electrical Supervisory System: Green and blue.
 6. Telecommunication System: Green and yellow.
 7. Control Wiring: Green and red.

- B. Power-Circuit Conductor Identification: For secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use aluminum wraparound marker labels write-on tags. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- C. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use write-on tags. Identify each ungrounded conductor according to source and circuit number.
- D. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.
- E. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- F. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
 - 1. 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.
 - 2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
- H. Instruction Signs:
 - 1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
 - 2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.
- I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance

Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where 2 lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Access doors and panels for concealed electrical items.
 - c. Electrical switchgear and switchboards.
 - d. Transformers.
 - e. Electrical substations.
 - f. Emergency system boxes and enclosures.
 - g. Motor-control centers.
 - h. Disconnect switches.
 - i. Enclosed circuit breakers.
 - j. Motor starters.
 - k. Push-button stations.
 - l. Power transfer equipment.
 - m. Contactors.
 - n. Remote-controlled switches, dimmer modules, and control devices.
 - o. Battery inverter units.
 - p. Battery racks.
 - q. Power-generating units.
 - r. Voice and data cable terminal equipment.
 - s. Master clock and program equipment.
 - t. Intercommunication and call system master and staff stations.
 - u. Television/audio components, racks, and controls.
 - v. Fire-alarm control panel and annunciators.
 - w. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
 - x. Monitoring and control equipment.
 - y. Uninterruptible power supply equipment.
 - z. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

END OF SECTION

SECTION 26 0925 – WIRELESS NETWORKED 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following lighting control devices:
 - 1. Wireless occupancy/vacancy sensors.
 - 2. Wireless controls stations.
 - 3. Wired load control modules with wireless communication inputs.
 - 4. Wireless hub(s) for centralized control, monitoring and system integration.
 - 5. Software data and analytics dashboard, including server requirements.
 - 6. Photoelectric switches.
 - 7. Power Interfaces
 - 8. Time switches.
 - 9. Switch-box occupancy sensors.
 - 10. Multipole contactors.
- B. Related Sections include the following:
 - 1. Division 26 Section "Wiring Devices" for wall-box dimmers and manual light switches.
 - 2. Division 26 Section "Dimming Controls" for architectural dimming system equipment.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Lighting plan showing location, orientation, and coverage area of each sensor.

2. Interconnection diagrams showing field-installed wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Lutron Electronics Company; Vive
 - b. Engineering Approved Alternate

2.2 WIRELESS INDOOR OCCUPANCY SENSOR

- A. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
 1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 4. Mounting:

- a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 6. Bypass Switch: Override the on function in case of sensor failure.
 7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (215 to 2150 lx); keeps lighting off when selected lighting level is present.
 8. Operational life of 10 years without the need to replace batteries when installed per manufacturer's instructions.
 9. Communicates directly to compatible RF receiving devices through use of a radio frequency communications link.
 10. Does not require external power packs, power wiring, or communication wiring.
 11. Capable of being placed in test mode to verify correct operation from the face of the unit.
- B. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
1. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of at least 36 sq. in.
 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
 3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot- high ceiling.
- C. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.
1. Detector Sensitivity: Detect a person of average size and weight moving at least 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- high ceiling.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on an 8-foot- high ceiling.
 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- high ceiling.
 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet .
- D. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on and off functions shall be 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 minimum movement of any portion of a human body that presents a target of at least 36 sq. in. and detect a person of average size and weight moving at least 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.

2.3 WIRELESS CONTROL STATIONS

- A. Type: Button quantity as indicated on drawings with custom button engraving to be confirmed with Engineer/Owner prior to ordering.
- B. Quantity: As indicated on the drawings.
- C. Communicates directly to compatible RF receiving devices through use of a radio frequency communications link.
- D. Does not require external power packs, power or communication wiring.
- E. Allows for easy reprogramming without replacing unit.
- F. Button Programming:
 1. Single action.
 2. Toggle action.
- G. Includes LED to indicate button press or programming mode status.
- H. Mounting:
 1. Capable of being mounted directly to a wall under a faceplate.
 2. Faceplates: Provide concealed mounting hardware.
- I. Power: Battery-operated with minimum ten-year battery.
- J. Finish: To be selected by Architect.

2.4 LOAD CONTROL MODULES

- A. Provide wireless load control modules as indicated or as required to control the loads as indicated.
- B. Junction Box-Mounted Modules:
 1. Plenum rated.
 2. 0-10 V Dimming Modules
 - a. Communicates via radio frequency with up to ten compatible occupancy/vacancy sensors, ten wireless control stations, and one daylight sensor.

- b. Single low voltage dimming module with Class 1 or Class 2 isolated 0-10V output signal conforming to IEC 60929 Annex E.2; source or sink automatically configures.
 - c. Selectable minimum light level.
 - d. Configurable high- and low-end trim.
 - e. Relay: Rated for 0-10 V ballasts, LED drivers, or fixtures that conform with NEMA 410.
3. Digital Ballast/LED Driver Dimming Modules:
- a. Single dimming module with Class 1 or Class 2 isolated digital output signal conforming to IEC 60929; capable of direct control without interface.
 - b. Provides direct low-voltage control of up to 32 compatible Lutron Eco-System and third party DALI digital ballasts/LED drivers as a single zone (multiple ballasts/LED drivers connected to same module will be at same light level).
 - 1) Electronically links a digital ballast/LED driver to a zone for both dimming and turning on/off.
 - 2) Electronically assigns occupancy/vacancy sensors for manual on/auto off and auto on/auto off control.
 - 3) Electronically assigns wireless control stations for manual local control.
 - 4) Electronically assigns daylight sensor for automatic daylight dimming.
 - c. Communicates via radio frequency with up to ten compatible occupancy/vacancy sensors, ten wireless control stations, and one daylight sensor.
 - d. Selectable minimum light level.
 - e. Configurable high- and low-end trim.
- C. Fixture Control Modules/Sensors:
1. Fixture Control Modules:
- a. Communicates via radio frequency with up to ten compatible occupancy/vacancy sensors, ten wireless control stations, and one daylight sensor.
 - b. Communicates via wired input with one combination occupancy/daylight or vacancy/daylight fixture sensor.
 - c. Coordination between Wired and Wireless Sensors:
 - 1) Occupancy/Vacancy Sensing: Wired and wireless sensors work in conjunction (occupancy detected by either sensor turns lights on and vacancy detected by both sensors turns lights off).
 - 2) Daylight Sensing: Wireless sensor takes precedence over wired sensor.
 - d. Selectable minimum light level.
 - e. Configurable high- and low-end trim.
 - f. Plenum rated.
 - g. Mounts to fixture or junction box through ½ inch (16 mm) trade size knockout.
 - h. Digital Ballast/LED Driver Fixture Control Modules:
 - 1) Supports reporting of energy measurement to wireless hub at accuracy of plus/minus 2 percent or 0.5 W (whichever is higher).

- 2) Single integral controller with Class 1 or Class 2 isolated digital output signal conforming to IEC 60929; capable of direct control without interface.
- 3) Provides direct low-voltage control of up to 3 compatible digital ballasts/LED drivers.
 - (a) Electronically links a digital ballast/LED driver to a zone for both dimming and turning on/off.
 - (b) Electronically assigns occupancy/vacancy sensors for manual on/auto off and auto on/auto off control.
 - (c) Electronically assigns wireless control stations for manual local control.
 - (d) Electronically assigns daylight sensor for automatic daylight dimming.
- i. 0-10 V Dimming Fixture Control Modules:
 - 1) Supports reporting of energy measurement to wireless hub at accuracy of plus/minus 2 percent or 0.5 W (whichever is higher).
 - 2) Single low voltage dimming module with Class 1 or Class 2 isolated 0-10V output signal conforming to IEC 60929 Annex E.2; source or sink automatically configures.
 - 3) Provides 0-10 V control for up to 3 ballasts/LED drivers (1 A load at 120-277 V, 6 mA max control current).
 - 4) Rated for switching 0-10 V ballasts, LED drivers, or fixtures that conform with NEMA 410.

2.5 WIRELESS HUBS

- A. Integrated multicolor LED provides feedback on what mode the hub is in for simple identification and diagnosis.
- B. Integrated processor and web server allows hub to set up and operate the system without any external connections to outside processors, servers, or the internet.
- C. Utilizes Ethernet connection for:
 1. Networking up to 64 hubs together to create a larger system.
 2. Integration with Building Management System (BMS) via native BACnet; does not require interface.
 3. Remote connectivity capabilities, including maintaining system date/time and receiving periodic firmware updates (requires internet connection).
- D. A single hub or network of hubs can operate on either a dedicated lighting control only network or can be integrated with an existing building network as a VLAN.
- E. Communicates directly to compatible *Lutron Vive* RF devices through use *Lutron Clear Connect* radio frequency communications link; does not require communication wiring; RF range of 71 feet (23 m) through walls to cover an area of 15836 square feet (1471 sq m) (device and hub must be on the same floor).
- F. Communicates directly to mobile device (smartphone or tablet) or computer using built-in Wi-Fi, 2.4 GHz 802.11b/g; wireless range of 71 feet (23 m) through walls (device and hub must be on the same floor).
 1. Does not require external Wi-Fi router for connecting to the hub.

- G. Allows for system setup, control, and monitoring from mobile device or computer using *Vive* web-based software:
 - 1. Supports paired devices up to maximum number indicated including compatible wireless sensors, wireless control stations, and wireless load devices.
 - 2. Allows for timeclock scheduling of events, both time of day and astronomic (sunrise and sunset).
 - a. Timeclock is integrated into the unit and does not require a constant internet connection.
 - b. Retains time and programming information after a power loss.
 - c. 365-day schedulable timeclock allows for:
 - 1) Scheduling of events years in advance.
 - 2) Setting of recurring events with exceptions on holidays.
 - d. Time clock events can be scheduled to:
 - 1) Send lights to a desired level and select the fade rate desired to reach that level.
 - 2) Adjust level lights go to when occupied.
 - 3) Adjust level lights go to when unoccupied.
 - 4) Enable/disable occupancy.
 - 5) Adjust timeout of sensors (requires *Model FC-SENSOR* wired fixture sensor or *Model DFCSJ-OEM-OCC* wireless fixture control dongle with integral sensing capabilities).
 - 6) Control individual devices, areas, or groups of areas. When connected to *Vive Vue* server, only areas or groups of areas can be controlled with timeclock events.

2.6 CONTROL AND MONITOR SOFTWARE:

- A. General Requirements:
 - 1. Web-based; runs on most HTML5 compatible browsers (including Internet Explorer, Chrome, and Safari).
 - 2. Supports multiple platforms and devices; runs from a tablet, desktop, laptop, or smartphone; optimized for displays of 1024 by 768 pixels or higher.
 - 3. User interface supports multi-touch gestures such as pinch to zoom, drag to pan, etc.
 - 4. Utilizes HTTPS (industry-standard certificate-based encryption and authentication for security).
 - 5. All functionality listed below must be available via a single application.
- B. System Navigation and Status Reporting:
 - 1. Performed using graphical floor plan view or a generic system layout.
 - 2. Graphical Floor Plan View: Utilizes customized CAD based drawing of the building. Pan and zoom feature allows for easy navigation; dynamically adjusts the details presented based on zoom level.
- C. Control of Lights:
 - 1. Control and monitor zone/area lights.
 - a. Area lights can be monitored for on/off status from a graphical floor plan or generic system layout.

- b. All lights in an area can be turned on/off (dimnable lights can also be dimmed up/down from current level).
- D. Occupancy:
 - 1. Area occupancy can be monitored.
 - a. Can be monitored graphically.
 - b. Can be monitored historically in space utilization reports.
 - 2. Scheduled events can be created to change occupancy parameters as described under "Scheduling" below.
- E. Load Shedding: View current load shed status (active/inactive) for each wireless hub and enable/disable load shed for the entire building/system.
- F. Scheduling: Schedule time of day and astronomic time clock events to automate functions.
 - 1. Scheduled events can control the following:
 - a. Area light levels for all dimmable lights in an area.
 - b. On/off status of all switched lights and contact-closure outputs in an area.
 - c. On/off status of all switched receptacles in an area.
 - 2. Scheduled events can be created to change the following occupancy parameters:
 - a. Enable/disable sensors.
 - b. Change occupancy mode (auto-on/auto-off versus manual-on/auto-off).
 - c. Adjust occupied and/or unoccupied level.
 - d. For compatible individual fixture sensors, sensor timeout can be adjusted.
 - 3. Easily monitor and adjust scheduled events using a weekly calendar view.
- G. Reporting: Provide reporting capability that allows the building manager to gather real-time and historical information about the system as follows:
 - 1. Energy Reports: Show a comparison of cumulative energy used over a period of time for one or more areas.
 - 2. Power Reports: Show power usage trend over a period of time for one or more areas.
 - 3. Space Utilization/Occupancy Reports: Show historical occupancy over a period of time for one or more areas using a graphical floor plan, generic system layout, and graphs and charts.
- H. Administration:
 - 1. Users: Allows new user accounts to be created and existing user accounts to be edited.
 - a. Supports Active Directory (LDAP) tying user accounts to network accounts.
 - 2. Area and feature access can be restricted based on login credentials.
 - 3. Supports up to 20 concurrent users and 10,000 user accounts.
- I. Devices/Settings Adjustment:

1. Users with appropriate permissions can navigate to the wireless hub setup screens in order to view and/or adjust specific settings for areas or devices (including load shed settings, daylighting settings, device associations and programming, occupancy settings, high-end/low-end trim settings, etc).

J. Computers:

1. Server:
 - a. Suitable for 24 hour per day, 7 day per week programming, monitoring, control, and data logging of digital-network lighting controls.
 - b. Suitable to handle client machine request in multi-computer systems.
 - c. Unless otherwise indicated, computer to be provided by lighting control system manufacturer.
 - d. Minimum Hardware Requirements:
 - 1) Processor: Quad Core Intel® Xeon®.
 - 2) 8 GB Ram.
 - 3) 250 GB hard drive (40 GB for application and database).
 - 4) Two 10/100/1000 Ethernet network interfaces - one for communication with lighting management hubs and one for communication with corporate intranet to allow access from system PCs and/or energy saving display terminals. Only one Ethernet network interface is required if all lighting management hubs and client PCs are on the same network.
 - 5) Monitor with 1280 x 1024 resolution.
 - 6) 4 USB 2.0 ports.
 - 7) Dedicated Graphics Card with 256 MB of memory (only required if running client software from the server).
 - e. Minimum Software Requirements:
 - 1) Licensed installation of US English 64-bit Microsoft® Windows® Server 2008 R2, Windows Server 2012 R1, or Windows Server 2012 R2.
 - 2) Microsoft® Internet Information Services (IIS) 7 or later.
 - 3) Microsoft® Internet Explorer 9 or later.
 - 4) Microsoft® .NET Framework 3.5.
 - 5) Microsoft® .NET Framework 4.5.
2. Computers Provided by Lighting Control System Manufacturer: Computer software to be preinstalled and tested prior to shipping.

2.7 LOW VOLTAGE LIGHTING CONTROL

- A. Relays: Operating coil shall operate from 24 VAC and the contacts shall be rated for 20A 277 VAC ballast load and 1 1/2 HP at 277 VAC. G.E. RR7P or approved equivalent.
- B. Component Cabinets: Component cabinets shall hold low voltage relays, transformers and terminal strips.
- C. Blocking Diode: Install blocking diode assembly where local control relay groups are different than the master control relay groups.

- D. Remote Control Switches: Control switches shall be SPDT, momentary contact with center return. Control switches shall match style of standard receptacle and local switching devices.
- E. Low Voltage Switching Cable: Low voltage switching cable shall be #18/3 minimum, Teflon jacketed. RockBestos or approved equivalent.
- F. Remote Control Interface: Install device which accepts maintained contact and provides momentary output contact for relay operation.
- G. ILC Enercon is an approved equivalent.

2.8 MULTIPOLE CONTACTORS

- A. Manufacturers:
 - 1. Allen-Bradley/Rockwell Automation.
 - 2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
 - 3. Cutler-Hammer; Eaton Corporation.
 - 4. Fisher Pierce.
 - 5. GE Industrial Systems; Total Lighting Control.
 - 6. Grasslin Controls Corporation.
 - 7. Hubbell Lighting Inc.
 - 8. Lithonia Lighting.
 - 9. MicroLite Corporation.
 - 10. TORK.
 - 11. Touchplate Technologies, Inc.
 - 12. Watt Stopper (The).
- B. Description: Electrically operated and mechanically held, complying with NEMA ICS 2 and UL 508.
 - 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 - 2. Control-Coil Voltage: Match control power source.

2.9 DIMMING

- A. Manufacturers:
 - 1. Lutron Electronics Company; Vive
 - 2. Engineering Approved Alternate.
- B. Compatibility:
 - 1. Dimming control components shall be compatible with luminaires, ballasts, and transformers.
- C. Dimmers and Dimmer Modules: Comply with UL 508.

1. Audible Noise and Radio-Frequency Interference Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or radio-frequency interference. Modules shall include integral or external filters to suppress audible noise and radio-frequency interference.
2. Dimmer or Dimmer-Module Rating: Not less than 125 percent of connected load unless otherwise indicated.

2.10 DIMMING CONTROLS

- A. Description: Microprocessor-based, solid-state controls consisting of master-control station(s), wall stations, and dimmer panels; and a separately mounted dimmer cabinet.
 1. Operation: Change variable dimmer settings of indicated number of zones simultaneously from one preset scene to another when a push button is operated or enabled.
 2. Each zone shall be configurable to control the following light sources:
 - a. LED lamps.
 - b. Incandescent lamps.
 - c. Cold cathode lamps.
 - d. Non-dimmed loads.
 3. Memory: Retain preset scenes and fade settings through power failures for at least 90 days by retaining physical settings of controls or by an on-board, automatically recharged battery.
- 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 47 CFR 15, Subparts A and B, for Class A digital devices.

2.11 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG, complying with Division 26 Section "Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 24 AWG, complying with Division 26 Section "Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 18 AWG, complying with Division 26 Section "Conductors and Cables."
- D. Install unshielded, twisted-pair cable for control and signal transmission conductors.

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve at least 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
- B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

- A. Prior to energization of system, certified manufacturer's representative shall review installation and perform the following field tests and inspections and prepare test reports:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 - 2. Operational Test: Verify actuation of each sensor and adjust time delays.
- B. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.

- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

END OF SECTION

SECTION 26 2413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes service and distribution switchboards rated 600 V and less.
- B. Communication network and interface modules for IEEE 802.3 data transmission protocols.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. RFI: Radio-frequency interference.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details for types other than NEMA 250, Type 1.
 - b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of switchboards and overcurrent protective devices.
 - d. Descriptive documentation of optional barriers specified for electrical insulation and isolation.

- e. Utility company's metering provisions with indication of approval by utility company.
 - f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports including the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section " Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for switchboards and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain switchboards through one source from a single manufacturer.
- B. 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.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NEMA PB 2, "Deadfront Distribution Switchboards."
- E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in sections or lengths that can be moved past obstructions in delivery path.
- B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

- C. Handle switchboards according to NEMA PB 2.1 and NECA 400.

1.7 PROJECT 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: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.
- C. Service Conditions: NEMA PB 2, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.
- 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 Owner no fewer than 14 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 Owner's written permission.

1.8 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 MANUFACTURED UNITS

- A. Manufacturers:
 - 1. Eaton Corporation; Cutler-Hammer Products.
 - 2. General Electric Co.; Electrical Distribution & Protection Div.
 - 3. Square D.
 - 4. Siemens.
- B. Front-Connected, Front-Accessible Switchboard: Panel-mounted main lugs, panel-mounted branches, and sections rear aligned.
- C. The Main Switchboard shall have continuous fully rated horizontal main bus throughout the lineup. Main and feeder breakers shall be draw-out style air powered. Feeder breakers will not be dual type arrangement in one section but shall be single feeder breakers in two sections.
- D. Nominal System Voltage: 480Y/277 V.
- E. Indoor Enclosure: Steel, NEMA 250, Type 1.
- F. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- G. Outdoor Enclosure: Steel, NEMA 250, Type 3R.
- H. Enclosure Finish for Outdoor Units: Factory-applied finish in manufacturer's standard color, undersurfaces treated with corrosion-resistant undercoating.
- I. Barriers: Between adjacent switchboard sections.
- J. Utility Metering Compartment: Fabricated compartment and section complying with utility company's requirements. If separate vertical section is required for utility metering, match and align with basic switchboard.
- K. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- L. Where rear access is required for switchboard, provide Removable Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard. Where switchboards are mounted with rear of switchboard against wall, rear access shall not be required.
- M. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- N. Pull Box on Top of Switchboard:
 - 1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
 - 2. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.

3. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
 4. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.
- O. Buses and Connections: Three phase, four wire, unless otherwise indicated.
1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.
 - a. If bus is copper, use copper for feeder circuit-breaker line connections.
 2. Ground Bus: 1/4-by-2-inch-minimum-size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 3. Contact Surfaces of Buses: Silver plated.
 4. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 5. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
 6. Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.
- P. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
- ### 2.3 TRANSIENT VOLTAGE SUPPRESSION DEVICES
- A. IEEE C62.41, integrally mounted, plug-in-style, solid-state, parallel-connected, sine-wave tracking suppression and filtering modules.
- B. Minimum single-impulse current rating shall be as follows:
1. Line to Neutral: 100,000 A.
 2. Line to Ground: 100,000 A.
 3. Neutral to Ground: 50,000 A.
- C. Protection modes shall be as follows:
1. Line to neutral.
 2. Line to ground.
 3. Neutral to ground.
- D. EMI/RFI Noise Attenuation Using 50-ohm Insertion Loss Test: 55 dB at 100 kHz.
- E. Maximum Category C combination wave clamping voltage shall not exceed 1000 V, line to neutral and line to ground on 277/480 V systems.

- F. Maximum UL 1449 clamping levels shall not exceed 800 V, line to neutral and line to ground on 277/480 V systems.
- G. Withstand Capabilities: 3000 Category C surges with less than 5 percent change in clamping voltage.
- H. Accessories:
 - 1. Form-C contacts, one normally open and one normally closed, for remote monitoring of system operation. Contacts to reverse position on failure of any surge diversion module.
 - 2. Audible alarm activated on failure of any surge diversion module.
 - 3. Six-digit transient-counter set to total transient surges that deviate from the sine-wave envelope by more than 125 V.

2.4 OVERCURRENT PROTECTIVE DEVICES

- A. Feeder Switchboard Breakers shall be draw-out air power breakers for MSB-A with integral energy reduction maintenance switches with and molded-Case Circuit Breaker (MCCB) for DP-A: 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^2t response (MSB-A circuit breakers only).
 - 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. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
 - 7. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical 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. 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.
- B. Main Switchboard Breaker shall be a draw-out air power breaker for MSB-A and an Insulated-Case Circuit Breaker (ICCB) for DP-A: 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
1. Fixed circuit-breaker mounting.
 2. Two-step, stored-energy closing.
 3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long and short time adjustments.
 - d. Ground-fault pickup level, time delay, and I squared t response
 4. Remote trip indication and control.
 5. 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 below.
 6. Control Voltage: 120-VAC.

2.5 INSTRUMENTATION

- A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:
1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
 2. Current Transformers: Ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments.
 3. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondaries to ground overcurrent relays to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker ground-fault protection.
- B. Multifunction Digital-Metering Monitor: One meter or more as required to accomplish the requirements below. Where these requirements describe the same features already identified the most stringent accuracy or functional parameters shall apply.
1. For each switchboard provide a digital line Power Quality Meter & Analyzer device having the features and functions specified below.
 2. The meter shall provide direct reading metered or calculated values of the items listed below and shall auto range between units, kilounits and megaunits for all metered values. The device shall be capable of displaying:

- a. AC current (amperes) in A, B, and C phase, 3-phase average, Neutral (N) and Ground (G) (provide neutral and ground current transformer). Accuracy +/- 0.2%.
 - b. AC voltage (volts) for A-B, B-C and C-A, phase average, A-N, B-N and C-N, average phase to N, and N to G. Accuracy +/- 0.2%.
 - c. Real Power (Watts), Reactive Power (vars), Apparent Power (VA), Real Energy (WH), Reactive Energy (VARH), Apparent Energy (VAH) for each phase and system. Accuracy +/- 0.4%. Forward/Reverse indication shall be provided.
 - d. Frequency (Hertz) Accuracy +/- 0.4%.
 - e. Demand values for System Current (Amperes), System Real Power (Watts), System Reactive Power (vars), and System Apparent Power (VA).
 - f. Power Factor for both Displacement and Apparent.
 - g. Percent Total Harmonic Distortion (THD) for all Currents and Voltages.
 - h. K-Factor, Transformer Derating Factor, and Crest Factor.
3. The meter shall provide the following advanced analysis features:
- a. Onboard logging capability, including the ability to log a total of 24 parameters with intervals ranging from 0.13 seconds (every 8 cycles) to twice a week (5,040 minutes). Separate trends shall be available.
 - b. Trend Analysis Screens displaying the minimum and maximum values for each metered value, with all parameters time stamped to 10 millisecond resolution.
 - c. Time-of-use metering capability to store energy usage data for time-of-use revenue metering. Provide complete programmability for schedules.
 - d. Demand Analysis Screens displaying present demand and peak demands for phase currents and power. Peak demands shall display time and date stamped to within
 - e. Harmonic Analysis Screens shall be capable of being function key triggered to capture a high-speed waveform of two (2) cycles of data sampled at 128 samples per cycle, simultaneously recording all currents and voltages. Data captured shall include the magnitude and the direction of the harmonic source from 1st through the 50th harmonic.
 - f. Event/Alarm Analysis Screens shall display data recorded for up to ten (10) event/alarm conditions. For each event/alarm a description of the event/alarm, date, and time of event/alarm shall be recorded (10 mS resolution).
 - g. The meter shall be capable of transmitting all data at time of the event via communications to a personal computer for creating and displaying wave forms.
 - h. The meter shall have the ability to store the meter events in non-volatile memory. Each event will be date and time stamped with 10 millisecond accuracy. The meter shall provide the ability to view the events via the local display or via communications.
 - i. Event/Alarm Condition Levels shall be capable of being triggered by conditions when the programmed threshold is exceeded. All shall have programmable time delays from 0.1 to 60 seconds except voltage disturbance which shall be programmable from 0 to 3,600 cycles.
4. The meter shall be capable of receiving the following inputs:

- a. Instrument Transformers: Input ranges of the MM6 shall accommodate external current transformers with ranges from 10,000/5 through 5/5 amperes. Provide external current transformers for each phase, neutral and ground circuit with rating as indicated on the drawing or sized for incoming service or associated feeder. The meter shall be capable of over ranging up to eight (8) times nominal current rating. Potential transformers shall be self included and fused for up to 600 volts with potential connections suitable for 3-phase 100V, 208/220/240V, 380/416V, 460/575V. Above 600V, provide fused external potential transformers for up to 500 kV.
 - b. Control Power: The meter shall be capable of being supplied from the monitored incoming AC line up to 600 volts without the need for a separate AC control circuit. The device shall also be capable of being supplied from a separate control power source when indicated on the drawings (input range of 100 to 240V AC, 100 to 250V DC, or 24 to 48V DC).
 - c. Dry Contacts: Three (3) dry discrete input contacts shall be capable of being monitored which may be programmed by the user to perform any of the following functions. The status of the input contacts shall be locally displayable and accessible through the communications port.
 - 1) Trigger an Event/Alarm Analysis including Harmonic Analysis information for display on the device and information for Waveform Analysis and display at a personal computer.
 - 2) Act as a synchronizing pulse input to synchronize demand windows with a utility provided synchronizing pulse.
 - 3) Actuate a relay output.
 - 4) Reset a relay output, peak demand, Minimum/Maximum, or Event Analysis records.
5. Furnish Relay Output Contacts with four (4) Form C (NO/NC) relay output contacts which shall be capable of being independently programmed for the following functions:
- a. Act as a kWh, kVARh, or kVAh pulse initiator output.
 - b. Actuate on one (1) or more Event/Alarm conditions, including discrete inputs and Communication Command signal.
6. Furnish one (1) 0 to 20 mA analog input and four (4) 0 to 20 mA outputs.
7. The device shall be fully programmable from the faceplate, including alarm relay and power quality (e.g., harmonic distortion) settings. Programming shall be password protected.
8. Make provisions for an addressable communication card capable of transmitting all data, remotely controlling and programming the MM6 over a compatible two-wire local area network (LAN) to a central personal computer for storage, analysis, display and printout. The network shall also be capable of transmitting data in RS-232c format via a translator module. There shall also be an option to connect the MM6 to an Ethernet network via either a 10Base-T copper cable or fiber optic cable.
9. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

10. Server Configuration and Internet Remote Monitoring:

- a. Initial network parameters set using a standard Web browser. Connect via a local operator interface, or an RJ-45 port accessible from front of equipment.
- b. Network server shall be factory programmed with embedded HTML-formatted Web pages that are user configurable and that provide detailed communication diagnostic information for serial and Ethernet ports as status of RS-485 network; with internal memory management information pages for viewing using a standard Web browser.
- c. Login: Password protected; password administration accessible from the LAN using a standard Web browser.
- d. Operating Software: Suitable for local access; firewall protected.
- e. Server Configuration and Internet Remote Monitoring shall be a complete and fully commissioned system with demonstration and training provided to the Owner.

2.6 CONTROL POWER

- A. Control Circuits: 120 V, supplied through secondary disconnecting devices from control-power transformer.
- B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- C. 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.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.2 EXAMINATION

- A. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Install switchboards and accessories according to NEMA PB 2.1 and NECA 40.
- B. Install and anchor switchboards level on concrete bases, 4-inch nominal thickness. Concrete base is specified in Division 26 Section "Common Work Results for Electrical," and concrete materials and installation requirements are specified in Division 3.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- E. Install spare-fuse cabinet.

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."
- B. Switchboard Nameplates: Label each switchboard compartment with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.1.1 Visual and Mechanical Inspection, 7.1.2.4 Insulation Resistance Tests, 7.5.1.1.1 Visual and Mechanical Inspection, 7.6.1.1.1 Visual and Mechanical Inspection, 7.9, 7.10.1.1 Visual and Mechanical Inspection, 7.11.1 Visual and Mechanical Inspection, and 7.14 as appropriate. 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.

3.6 CLEANING

- A. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION

SECTION 26 2416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. RFI: Radio-frequency interference.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details for types other than NEMA 250, Type 1.
 - b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of panelboards and overcurrent protective devices.
 - d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports including the following:
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
 - D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
 - E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 2. Time-current curves, including selectable ranges for each type of overcurrent protective device.
- 1.5 QUALITY ASSURANCE
- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.
 - B. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
 - C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - D. Comply with NEMA PB 1.
 - E. Comply with NFPA 70.
- 1.6 PROJECT CONDITIONS
- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 1. Ambient Temperature: Not exceeding 104 deg F.
 2. Altitude: Not exceeding 6600 feet.
 - B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 1. Ambient temperatures within limits specified.
 2. Altitude not exceeding 6600 feet.

- 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 Owner no fewer than seven days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.

1.7 COORDINATION

- 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, and encumbrances to workspace clearance requirements.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
 - a. Eaton Corporation; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Protection Div.
 - c. Square D.

2.2 MANUFACTURED UNITS

- A. Enclosures: Flush- and surface-mounted cabinets. NEMA PB 1, Type 1.
 - 1. Rated for environmental conditions at installed location.
 - a. Outdoor Locations: NEMA 250, Type 3R.
 - b. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - d. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.
 - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

4. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
 5. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.
 - 6.
- B. Phase and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
 3. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.
 4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
 5. Split Bus: Vertical buses divided into individual vertical sections.
 - 6.
- C. Conductor Connectors: Suitable for use with conductor material.
1. Main and Neutral Lugs: Mechanical type.
 2. Ground Lugs and Bus Configured Terminators: Mechanical type.
 3. Feed-Through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 4. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
 - 5.
- D. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.
- E. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.
- 2.3 PANELBOARD SHORT-CIRCUIT RATING
- A. Fully rated to interrupt symmetrical short-circuit current available at terminals.
 - B. Provide 10,000 A.I.C. for all 120/208V panelboards, unless otherwise noted.
 - C. Provide 18,000 A.I.C. for all 277/480V panelboards, unless otherwise noted.
- 2.4 DISTRIBUTION PANELBOARDS
- A. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.
 - B. Main Overcurrent Protective Devices: Circuit breaker.
 - C. Branch Overcurrent Protective Devices:

1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
3. Fused switches.

2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.6 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: 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-unit circuit breakers shall have RMS sensing; field-replaceable rating plug; and with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I²t response.
 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
 6. GFCI Circuit Breakers: Single- and two-pole configurations with [5] [30]-mA trip sensitivity.
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
 1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 3. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at [55] [75] percent of rated voltage.
 4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Mount top of trim 74 inches above finished floor, unless otherwise indicated.
- C. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- D. Install overcurrent protective devices and controllers.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.
- E. Install filler plates in unused spaces.
- F. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Contractor shall identify room numbers and type of load served on directories as required by NEC Sections 408.4 and 110.22.
- C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding."
- B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.
- B. Perform the following field tests and inspections and prepare test reports:
1. Perform work stated in NETA ATS, Section 7.5 Visual and Mechanical Inspection for switches and Section 7.6.1.1.1 Visual and Mechanical Inspection for molded-case circuit breakers. 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.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
1. Measure as directed during period of normal system loading.
 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION

SECTION 26 2726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Single and duplex receptacles, ground-fault circuit interrupters, integral surge suppression units, and isolated-ground receptacles.
 - 2. Single- and double-pole snap switches and dimmer switches.
 - 3. Device wall plates.
 - 4. Pin and sleeve connectors and receptacles.
 - 5. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.
- B. Related Sections include the following:
 - 1. Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. PVC: Polyvinyl chloride.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.

- D. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1.6 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Wiring Devices:
 - a. Bryant Electric, Inc./Hubbell Subsidiary.
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Mfg. Company Inc.
 - d. Pass & Seymour/Legrand; Wiring Devices Div.
 - 2. Wiring Devices for Hazardous (Classified) Locations:
 - a. Crouse-Hinds/Cooper Industries, Inc.; Arrow Hart Wiring Devices.
 - b. EGS/Appleton Electric Company.
 - c. Killark Electric Manufacturing Co./Hubbell Incorporated.
 - 3. Multioutlet Assemblies:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. Wiremold Company (The).
 - 4. Poke-Through, Floor Service Outlets and Telephone/Power Poles:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. Pass & Seymour/Legrand; Wiring Devices Div.
 - c. Square D/Groupe Schneider NA.

- d. Thomas & Betts Corporation.
- e. Wiremold Company (The).

2.2 RECEPTACLES

- A. Straight-Blade-Type Receptacles: Comply with NEMA WD 1, NEMA WD 6, DSCC W-C-596G, and UL 498.
- B. Straight-Blade and Locking Receptacles: Heavy-Duty grade.
- C. Straight-Blade Receptacles: Hospital grade.
- D. GFCI Receptacles: Straight blade, -through type, Heavy-Duty grade, with integral NEMA WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a 2-3/4-inch- deep outlet box without an adapter.
- E. Isolated-Ground Receptacles: Straight blade, Heavy-Duty grade, duplex receptacle, with equipment grounding contacts connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap.
 - 1. Devices: Listed and labeled as isolated-ground receptacles.
 - 2. Isolation Method: Integral to receptacle construction and not dependent on removable parts.
- F. TVSS Receptacles: Straight blade, NEMA WD 6, Configuration 5-20R, with integral TVSS in line to ground, line to neutral, and neutral to ground.
 - 1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp level rating of 500 volts and minimum single transient pulse energy dissipation of 140 J line to neutral, and 70 J line to ground and neutral to ground.
 - 2. Active TVSS Indication: Visual only with light visible in face of device to indicate device is "active" or "no longer in service."
 - 3. Receptacle Type: Heavy-Duty grade.
 - 4. Identification: Distinctive marking on face of device to denote TVSS-type unit.
- G. Industrial Heavy-Duty Pin and Sleeve Devices: Comply with IEC 309-1.
- H. Hazardous (Classified) Location Receptacles: Comply with NEMA FB 11.
- I. Combination Straight-Blade with USB Power Supply Receptacles: Hubbell model #USB15X2XX. No substitutions.

2.3 PENDANT CORD/CONNECTOR DEVICES

- A. Description: Matching, locking-type plug and receptacle body connector, NEMA WD 6, Configurations L5-20P and L5-20R, Heavy-Duty grade.
 - 1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.

2. 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.

2.4 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.5 SWITCHES

- A. Single- and Double-Pole Switches: Comply with DSCC W-C-896F and UL 20.
- B. Snap Switches: Heavy-Duty grade, quiet type.
- C. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.
 1. Switch: 20 A, 120/277-V ac.
 2. Receptacle: NEMA WD 6, Configuration 5-15R.
- D. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters.
 1. Control: Continuously adjustable slider; with single-pole or three-way switching to suit connections.
 2. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable toggle switch, or slider; single pole with soft tap or other quiet switch; EMI/RFI filter to eliminate interference; and 5-inch wire connecting leads.
 3. 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.

2.6 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
 1. Plate-Securing Screws: Metal with head color to match plate finish.
 2. Material for Finished Spaces: Grey, Smooth, high-impact thermoplastic.
 3. Material for Unfinished Spaces: Grey, Smooth, high-impact thermoplastic.
 4. Material for Club Mabee: Black, Smooth, high-impact thermoplastic
 5. Material for Wet Locations: Metallic with spring-loaded lift cover, and listed and labeled for use in "wet locations" as "in-use" type.

6. All finishes to be confirmed by Architect.

2.7 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Rectangular.
- D. Power Receptacle: NEMA WD 6, Configuration 5-20R, gray finish, unless otherwise indicated.
- E. Voice and Data Communication Outlet: Refer to drawings.

2.8 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.
 1. Service Outlet Assembly: Flush type with four simplex receptacles and space for four SYSTIMAX RJ-45 jacks. Refer to Voice and Data Communication 270500.
 2. Size: Selected to fit nominal 4-inch cored holes in floor and matched to floor thickness.
 3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
 4. Closure Plug: Arranged to close unused 4-inch cored openings and reestablish fire rating of floor.
 5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors; and a minimum of four, 4-pair, Category 6 SYSTIMAX voice and data communication cables. Refer to Voice and Data Communication 270500.

2.9 MULTIOUTLET ASSEMBLIES

- A. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- B. Raceway Material: Metal, with manufacturer's standard finish.
- C. Wire: No. 12 AWG.

2.10 FINISHES

- A. Color:
 1. Wiring Devices Connected to Normal Power System: White, unless otherwise indicated or required by NFPA 70.
 2. Wiring Devices Connected to Emergency Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70.

3. TVSS Devices: As selected by Architect.
4. Isolated-Ground Receptacles: White, with orange triangle on face.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install devices and assemblies level, plumb, and square with building lines.
- B. Install wall dimmers to achieve indicated rating after derating for ganging according to manufacturer's written instructions.
- C. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' written instructions.
- D. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates. Piecing together single-gang faceplates for multigang installations shall be unacceptable.
- E. Remove wall plates and protect devices and assemblies during painting.
- F. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.
- G. Install stainless steel faceplates in all food service areas.
- H. Install GFI outlets in locations required by NEC 210.8.

3.2 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding."
- B. Connect wiring according to Division 26 Section "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 and UL 486B.

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
 2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

- B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION

SECTION 26 2813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Cartridge fuses rated 600 V and less for use in switches panelboards switchboards controllers and motor-control centers.

1.3 SUBMITTALS

- A. Product Data: Include the following for each fuse type indicated:
 - 1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 2. Let-through current curves for fuses with current-limiting characteristics.
 - 3. Time-current curves, coordination charts and tables, and related data.
 - 4. Fuse size for elevator feeders and elevator disconnect switches.
- B. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - 1. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - 2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
- C. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Division 1 Section " Operation and Maintenance Data," include the following:
 - a. Let-through current curves for fuses with current-limiting characteristics.
 - b. Time-current curves, coordination charts and tables, and related data.
 - c. Ambient temperature adjustment information.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses from a single manufacturer.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NEMA FU 1.
- D. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Bussman, Inc.
 - 2. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.
 - 3. Ferraz Shawmut, Inc.
 - 4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

- A. Service Entrance: Class L, fast acting L.
- B. Feeders: Class RK1.
- C. Motor Branch Circuits: Class RK1, time delay.
- D. Other Branch Circuits: Class RK1.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

- A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION

SECTION 26 2816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
 - 1. Fusible switches.
 - 2. No fusible switches.
 - 3. Enclosures.

1.3 DEFINITIONS

- A. GD: General duty.
- B. GFCI: Ground-fault circuit interrupter.
- C. HD: Heavy duty.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
 - 1. Enclosure types and details
 - 2. Current and voltage ratings.
 - 3. Short-circuit current rating.
 - 4. Features, characteristics, ratings, and factory settings of individual over current protective devices and auxiliary components.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports including the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Manufacturer's field service report.

E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current curves, including selectable ranges for each type of circuit breaker.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

- A. Manufacturers:
1. Eaton Corporation; Cutler-Hammer Products.
 2. General Electric Co.; Electrical Distribution & Control Division.
 3. Square D/Group Schneider.
- B. Fusible Switch, 1200 A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. No fusible Switch, 1200 A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- D. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.

2.3 FUSED POWER CIRCUIT DEVICES

- A. Bolted-Pressure Contact Switch: UL 977; operating mechanism shall use a rotary-mechanical-bolting action to produce and maintain high-clamping pressure on the switch blade after it engages the stationary contacts.
1. Manufacturers:
 - a. Boltswitch, Inc.
 - b. Eaton Corporation; Cutler-Hammer Products.
 - c. Pringle Electrical Mfg. Co.
 - d. Square D/Group Schneider.

2.4 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

- A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
 2. General Electric Co.; Electrical Distribution & Control Division.
 3. Moeller Electric Corporation.
 4. Square D/Group Schneider.
- B. Molded-Case Circuit Breaker: NEMA AB 1, 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-Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I²t response.
 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller and 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 and trip activation on fuse opening or on opening of fuse compartment door.
 6. GFCI Circuit Breakers: Single- and two-pole configurations with [30]-mA trip sensitivity.
- C. Molded-Case Circuit-Breaker Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and conductor material.
 3. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 4. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at [55] [75] percent of rated voltage.
 6. Under voltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional with field-adjustable 0.1- to 0.6-second time delay.
 7. Auxiliary Switch: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 8. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 9. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

- D. Molded-Case Switches: Molded-case circuit breaker with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- E. Molded-Case Switch Accessories:
 - 1. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and material of conductors.
 - 2. Application Listing: Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 3. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage. Provide "dummy" trip unit where required for proper operation.
 - 4. Under voltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay. Provide "dummy" trip unit where required for proper operation.
 - 5. Auxiliary Switch: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 6. Key Interlock Kit: Externally mounted to prohibit operation; key shall be removable only when switch is in off position.

2.5 ENCLOSURES

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
 - 1. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - 4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

3.3 INSTALLATION

- A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
- B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification."
- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 Section "Identification."

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance testing as follows:
 - 1. Inspect mechanical and electrical connections.
 - 2. Verify switch and relay type and labeling verification.
 - 3. Verify rating of installed fuses.
 - 4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. 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.

3.6 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.7 CLEANING

- A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.
- B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION

SECTION 26 2913 - ENCLOSED CONTROLLERS

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 enclosed controllers rated 600 V and less:
 - 1. Full-voltage manual.
 - 2. Full-voltage magnetic.
 - 3. Reduced-voltage magnetic.
- B. Related Section:
 - 1. Division 26 Section "Variable-Frequency Motor Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on variable torque loads in ranges up to 200 hp.

1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.
- G. SCR: Silicon-controlled rectifier.

1.4 SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

- B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
 - 1. Show tabulations of the following:
 - a. Each installed unit's type and details.
 - b. Factory-installed devices.
 - c. Nameplate legends.
 - d. Short-circuit current rating of integrated unit.
 - e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.
 - f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
 - C. Field quality-control reports.
 - D. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for enclosed controllers and installed components.
 - 2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
 - 3. Manufacturer's written instructions for setting field-adjustable overload relays.
 - 4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.
 - E. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- 1.5 QUALITY ASSURANCE
- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - B. Comply with NFPA 70.
- 1.6 STORAGE, AND HANDLING
- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.

- B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in 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 no fewer than 7 days in advance of proposed interruption of electrical systems.
 - 2. Indicate method of providing temporary utilities.
 - 3. Do not proceed with interruption of electrical systems without Architect's written permission.
 - 4. Comply with NFPA 70E.

1.8 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

- A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

- B. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing.
 3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
 4. Surface mounting.
 5. Green pilot light.
- C. Magnetic Controllers: Full voltage, across the line, electrically held.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Square D; a brand of Schneider Electric.
 2. Configuration: Nonreversing.
 3. Contactor Coils: Pressure-encapsulated type.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 6. Bimetallic Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 10 or Class 20 tripping characteristic.
 - c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - d. Ambient compensated.
 7. External overload reset push button.
- D. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Square D; a brand of Schneider Electric.
 2. Fusible Disconnecting Means:
 - a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class RK1 time delay fuses.

- b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.2 REDUCED-VOLTAGE MAGNETIC CONTROLLERS

- A. General Requirements for Reduced-Voltage Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A; closed-transition; adjustable time delay on transition.
- B. Reduced-Voltage Magnetic Controllers: Reduced voltage, electrically held.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - c. Square D; a brand of Schneider Electric.
 - 2. Configuration:
 - a. Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank. Closed transition.
 - 3. Contactor Coils: Pressure-encapsulated type.
 - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
 - 4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
 - 5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - 6. Bimetallic Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 10 or Class 20 tripping characteristic.
 - c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - d. Ambient compensated.
 - 7. External overload reset push button.
- C. Combination Reduced-Voltage Magnetic Controller: Factory-assembled combination of reduced-voltage magnetic controller, OCPD, and disconnecting means.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

- c. Square D; a brand of Schneider Electric.
2. Fusible Disconnecting Means:
 - a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class RK1, time delay.
 - b. indicated fuses.
 - c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3. Nonfusible Disconnecting Means:
 - a. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.3 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
 1. Dry and Clean Indoor Locations: Type 1.
 2. Outdoor Locations: Type 3R.
 3. Kitchen Areas: Type 4X, stainless steel.
 4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.4 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
 1. Pilot Lights: Heavy-duty, oil tight type.
 - a. Pilot Lights: LED types; colors as indicated; push to test.
 - b. Provide green "On" or "Run" lamp indicating starter operation.
 2. Heavy-duty hand-off-automatic switch and other automatic-control devices.
 3. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 4. Connect selector switches with motor-control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.
- B. N.C. and N.O. auxiliary contact(s).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Common Work Results for Electrical."
 - 1. Floor-Mounted Controllers: Install enclosed controllers on 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Division 03.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in each fusible-switch enclosed controller.
- D. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."
- E. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- G. Comply with NECA 1.
- H. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Electrical Identification."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved nameplate.
 - 3. Label each enclosure-mounted control and pilot device.

3.3 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers and remote devices and facility's central control system. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control selection devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
 - 2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.4 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Tests and Inspections:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation.
 - 2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
 - 3. Test continuity of each circuit.
 - 4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).
 - 5. Test each motor for proper phase rotation.
 - 6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Enclosed controllers will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

3.6 PROTECTION

- A. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

END OF SECTION

SECTION 26 2923 - VARIABLE FREQUENCY CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes solid-state, PWM, VFCs for speed control of three-phase, squirrel-cage induction motors.

1.3 DEFINITIONS

- A. BMS: Building management system.
- B. IGBT: Integrated gate bipolar transistor.
- C. LAN: Local area network.
- D. PID: Control action, proportional plus integral plus derivative.
- E. PWM: Pulse-width modulated.
- F. VFC: Variable frequency controller.

1.4 SUBMITTALS

- A. Product Data: For each type of VFC. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.
- B. Shop Drawings: For each VFC.
 - 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. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit current rating of integrated unit.
 - d. Features, characteristics, ratings, and factory settings of each motor-control center unit.
 - 2. Wiring Diagrams: Power, signal, and control wiring for VFCs. Provide schematic wiring diagram for each type of VFC.

- C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs where pipe and ducts are prohibited. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- D. Qualification Data: For manufacturer and testing agency.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For VFCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for VFCs and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. Source Limitations: Obtain VFCs of a single type through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with NFPA 70.
- F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, minimum clearances between VFCs, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver VFCs in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.

- B. Store VFCs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFCs from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. If stored in areas subject to weather, cover VFCs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: 0 to 40 deg C.
 - 2. Humidity: Less than 90 percent (noncondensing).
 - 3. Altitude: Not exceeding 3300 feet.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.8 COORDINATION

- A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.
- D. Coordinate features of VFCs, installed units, and accessory devices with pilot devices and control circuits to which they connect.
- E. Coordinate features, accessories, and functions of each VFC and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB.
 - 2. Reliance.
 - 3. Siemens Energy and Automation; Industrial Products Division.
 - 4. Toshiba.

2.2 VARIABLE FREQUENCY CONTROLLERS

- A. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.
1. Provide unit suitable for operation of premium-efficiency motor as defined by NEMA MG 1.
- B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- C. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.
- D. Unit Operating Requirements:
1. Input ac voltage tolerance of 380 to 500 V, plus or minus 10 percent.
 2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
 3. Minimum Efficiency: 96 percent at 60 Hz, full load.
 4. Minimum Displacement Primary-Side Power Factor: 96 percent.
 5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
 6. Starting Torque: 100 percent of rated torque or as indicated.
 7. Speed Regulation: Plus or minus 1 percent.
- E. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
1. Electrical Signal: 4 to 20 mA at 24 V.
 2. Pneumatic Signal: 3 to 15 psig (20 to 104 kPa).
- F. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 3. Acceleration: 2 to a minimum of 22 seconds.
 4. Deceleration: 2 to a minimum of 22 seconds.
 5. Current Limit: 50 to a minimum of 110 percent of maximum rating.
- G. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors.
 2. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
 3. Motor Overload Relay: Adjustable and capable of NEMA 250, Class 10 performance.
 4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
 5. Instantaneous line-to-line and line-to-ground overcurrent trips.
 6. Loss-of-phase protection.
 7. Reverse-phase protection.
 8. Short-circuit protection.
 9. Motor overtemperature fault.
- H. Multiple-Motor Capability: Controller suitable for service to multiple motors and having a separate overload relay and protection for each controlled motor. Overload relay shall shut off controller and motors served by it when overload relay is tripped.
- I. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

- J. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.
- K. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- L. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- M. Input Line Conditioning: Provide line reactor or isolation transformer necessary to comply with IEEE 519 with 35,000A SYM fault current and 100kVA of other non-linear total load.
- N. VFC Output Filtering: Verify that voltage does not exceeds motor pulse-withstand capability.
- O. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
 - 1. Power on.
 - 2. Run.
 - 3. Overvoltage.
 - 4. Line fault.
 - 5. Overcurrent.
 - 6. External fault.
- P. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.
- Q. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
 - 1. Output frequency (Hz).
 - 2. Motor speed (rpm).
 - 3. Motor status (running, stop, fault).
 - 4. Motor current (amperes).
 - 5. Motor torque (percent).
 - 6. Fault or alarming status (code).
 - 7. PID feedback signal (percent).
 - 8. DC-link voltage (VDC).
 - 9. Set-point frequency (Hz).
 - 10. Motor output voltage (V).
- R. Control Signal Interface:
 - 1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
 - 2. Pneumatic Input Signal Interface: 3 to 15 psig.
 - 3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
 - a. 0 to 10-V dc.
 - b. 0-20 or 4-20 mA.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
 - e. RS485.
 - f. Keypad display for local hand operation.
 - 4. Output Signal Interface:
 - a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:

- 1) Output frequency (Hz).
 - 2) Output current (load).
 - 3) DC-link voltage (VDC).
 - 4) Motor torque (percent).
 - 5) Motor speed (rpm).
 - 6) Set-point frequency (Hz).
5. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
- a. Motor running.
 - b. Set-point speed reached.
 - c. Fault and warning indication (overtemperature or overcurrent).
 - d. PID high- or low-speed limits reached.
- S. Communications: Provide an RS485 interface allowing VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.
- T. Manual Bypass: Magnetic contactor arranged to safely transfer motor between controller output and bypass controller circuit when motor is at zero speed. Controller-off-bypass selector switch sets mode, and indicator lights give indication of mode selected. Unit shall be capable of stable operation (starting, stopping, and running), with motor completely disconnected from controller (no load).
- U. Integral Disconnecting Means: NEMA AB 1, molded-case switch or NEMA KS 1, nonfusible switch with lockable handle.
- V. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

2.3 ENCLOSURES

- A. NEMA 250, TYPE 1

2.4 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
- C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- D. Control Relays: Auxiliary and adjustable time-delay relays.
- E. Standard Displays:
1. Output frequency (Hz).
 2. Set-point frequency (Hz).
 3. Motor current (amperes).
 4. DC-link voltage (VDC).
 5. Motor torque (percent).
 6. Motor speed (rpm).
 7. Motor output voltage (V).

- F. Historical Logging Information and Displays:
 - 1. Real-time clock with current time and date.
 - 2. Running log of total power versus time.
 - 3. Total run time.
 - 4. Fault log, maintaining last four faults with time and date stamp for each.

2.5 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested VFCs before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFCs for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Select features of each VFC to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.
- B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

- A. See Division 26 Section "Common Work Results for Electrical " for general installation requirements.
- B. Anchor each VFC assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.
- C. Install VFCs on concrete bases.
- D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- E. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

3.4 CONCRETE BASES

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.
- B. Concrete base is specified in Division 26 Section "Common Work Results for Electrical," and concrete materials and installation requirements are specified in Division 3.

3.5 IDENTIFICATION

- A. Identify VFCs, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."
- B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.6 CONTROL WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 - 2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.7 CONNECTIONS

- A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Ground equipment according to Division 26 "Grounding and Bonding."

3.8 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. 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.

3.9 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

END OF SECTION

SECTION 26 3213 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes packaged engine-generator sets for emergency and standby power supply with the following features:
 - 1. Diesel engine.
 - 2. Unit-mounted cooling system.
 - 3. Unit-mounted control and monitoring.
 - 4. Performance requirements for sensitive loads.
 - 5. Outdoor enclosure.
- B. Related Sections include the following:
 - 1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3 DEFINITIONS

- A. **Operational Bandwidth:** The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.4 SUBMITTALS

- A. **Product Data:** For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
 - 1. Thermal damage curve for generator.
 - 2. Time-current characteristic curves for generator protective device.
- B. **Shop Drawings:** Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, the method of field assembly, components, and location and size of each field connection.
 - 1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
 - 2. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
 - 3. Wiring Diagrams: Power, signal, and control wiring.

4. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 5. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Qualification Data: For manufacturer.
- D. Source quality-control test reports.
1. Certified summary of prototype-unit test report.
 2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
 3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
 4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
 5. Report of sound generation.
 6. Report of exhaust emissions showing compliance with applicable regulations.
 7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
1. List of tools and replacement items recommended shall be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
- G. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
1. Maintenance Proximity: Not more than four hours normal travel time from Installer's place of business to Project site.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with ASME B15.1.

- F. Comply with NFPA 37.
- G. Comply with NFPA 70.
- H. Comply with NFPA 99.
- I. Comply with NFPA 110 requirements for Level 1 emergency power supply system.
- J. Comply with UL 2200.
- K. Engine Exhaust Emissions: Comply with applicable federal, state and local government requirements.
- L. Noise Emission: Comply with applicable state and local government requirements for maximum noise level due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
- M. IEEE446-Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
- N. ICE8528 part 4. Control Systems for Generator Sets.

1.6 PROJECT CONDITIONS

- A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - 1. Ambient Temperature: 5 to 40 deg C.
 - 2. Altitude: Sea level to 725'.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate size and location of roof curbs, equipment supports, and wall penetrations for remote radiators.
- C. Coordinate louvers and exhaust with Mechanical Contractor for orientation of Generator. This is for connection of exhaust, air exhaust from radiator and natural gas connection.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One year from date of Substantial Completion.

1.9 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fuses: One for every 10 of each type and rating, but no less than one of each.
 2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Blue Star Power Systems, Inc.
 2. Taylor Power Systems, Inc.
 3. Approved Engineering Alternate

2.2 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
- C. Capacities and Characteristics:
1. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing. Generator shall have ratings as shown on drawings or as required to supply loads appearing in Generator Load Table with a maximum of 25% voltage drop during starting conditions.
 2. Output Connections: Three-phase, four wire.

3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
 - a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
 - a. Provide permanent magnet excitation for power source to voltage regulator.
10. Start Time: Comply with NFPA 110, Type 10(10 Seconds), System requirements.

2.3 ENGINE

- A. Fuel: Fuel oil, Grade DF-2 .
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 1250 f/min.
- D. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- E. Engine Fuel System:
1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
 2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.
- G. Governor: Adjustable isochronous, with speed sensing.
- H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.
1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 3. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 4. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
 - a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- I. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
1. Minimum sound attenuation of 25 dB at 500 Hz.
 2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 85dBA or less.
- J. Muffler Mounting: Muffler and piping shall be mounted inside generator enclosure.
- K. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- L. Starting System: 12-V electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 65-A minimum continuous rating.
8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
 - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
 - e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
9. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet or unit mounted.

2.4 FUEL OIL STORAGE

- A. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:

1. Tank level indicator with direct reading magnetic gauge with a hermetically sealed vacuum tested dial.
2. Capacity: Fuel for 72 hours continuous operation at 75 percent rated power output. Minimum size shall be 2000 gallons.
3. Vandal-resistant and lockable fill cap.
4. Emergency vent shall be sized according to NFPA 30 based on 100% of the primary tank. Zinc plated emergency pressure relief vent cap.
5. Containment Provisions: Comply with requirements of authorities having jurisdiction.
6. Low Fuel Level Switch connected for both remote and local annunciation.

2.5 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.
- B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.
- C. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
 1. AC voltmeter.
 2. AC ammeter.
 3. AC frequency meter.
 4. DC voltmeter (alternator battery charging).
 5. Engine-coolant temperature gage.
 6. Engine lubricating-oil pressure gage.
 7. Running-time meter.
 8. Ammeter, voltmeter, phase-selector switches.
 9. Generator overload.
 10. Fuel tank high-level shutdown of fuel supply alarm.
- D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.
- E. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals.
- F. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel. Remote Annunciator panel shall include:
 1. Overcrank shutdown.
 2. Coolant low-temperature alarm.
 3. Control switch not in auto position.

4. Battery-charger malfunction alarm.
5. Battery low-voltage alarm.
6. Engine high-temperature shutdown.
7. Lube-oil, low-pressure shutdown.
8. Overspeed shutdown.
9. Remote emergency-stop shutdown.
10. Engine high-temperature prealarm.
11. Lube-oil, low-pressure prealarm.
12. Low coolant level.
13. Fuel tank, low-fuel level.

- G. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.6 REMOTE ANNUNCIATOR AND CONTROL SYSTEM (INTERNET ACCESS)

- A. Functional Description: Include the capability to monitor and control all generator functions required for Common Remote Audible Alarm.
- B. Provide all monitoring and control functions identified above through Ethernet Local area network based on IEEE 802.3 standards. Provide Ethernet RJ type jack at generator.
- C. Provide necessary software for PC Window's based system to accomplish the Remote Annunciator and Control described in 2.5A and 2.5B.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Molded-case, electronic-trip type; 80 percent rated; complying with UL 489.
1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
 2. Trip Settings: Selected to coordinate with generator thermal damage curve.
 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
 4. Mounting: Adjacent to or integrated with control and monitoring panel.
- B. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H or Class F.

- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Enclosure: Drip-proof, open skid mounted package.

2.9 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Prefabricated or preengineered walk-in enclosure with the following features:
 - 1. Construction: Galvanized-steel, metal-clad, integral structural-steel-framed building erected on concrete foundation. Refer to FINISHES for painting color. Maximum dimensions of enclosure shall be 38'6" in length and 10'6" in width. All sides shall be vertical surfaces aligned with outside structural base to form uninterrupted uniform exterior appearance. Doors shall be located as necessary for access with a minimum of two double doors on each side.
 - 2. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
 - 3. Space Heater: Thermostatically controlled and sized to prevent condensation.
 - 4. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
 - 5. Hinged Doors: With padlocking provisions.
 - 6. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents. Ventilation air shall be discharged vertically through plenum concealed from horizontal exterior view.
 - 7. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components. Plenum attached to radiator discharge shall be constructed to direct air vertically.
 - 8. Muffler Location: Within enclosure. Exhaust shall be discharged inside ventilation plenum without affecting causing excessive heat inside plenum. If possible, top of exhaust pipe shall be concealed from horizontal view.
 - 9. Acoustical: The maximum sound level measured 7 meters horizontally, in any direction, from enclosure shall be 80dBA at ground level. This will be measured when generator is running at a minimum of 75% load and include all components of sound when engine is running.
 - 10. Auxiliary Power: Generator shall include a 208V panel inside enclosure to supply generator auxiliary circuits.
- B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
 - 1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
 - 2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

- C. Interior Lights with Switch: Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
 - 1. AC lighting system and connection point for operation when remote source is available.
- D. Convenience Outlets: Factory wired. Arrange for external electrical connection.
- E. Muffler: Mount inside enclosure.
- F. Instrument Transformers: Mounted within generator enclosure.
- G. Voltage Regulator: Solid-state type, separate from exciter, to provide performance as specified.
 - 1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
- H. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- J. Subtransient Reactance: 12 percent, maximum.

2.10 FINISHES

- A. Outdoor Enclosure: Owner selected color applied at factory according to manufacturer's standard painting procedure. Finish shall be applied over corrosion-resistant pretreatment and compatible primer.

2.11 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - 1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 - 1. Test components and accessories furnished with installed unit that are not identical to those on the tested prototype to demonstrate compatibility and reliability.
 - 2. Full load run.
 - 3. Maximum power.
 - 4. Voltage regulation.
 - 5. Transient and steady--state governing.
 - 6. Single-step load pickup.
 - 7. Safety shutdown.
 - 8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.

9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
- B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
- B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- C. Install packaged engine generator with elastomeric isolator pads having a minimum deflection of 1 inch on 4-inch-high concrete base. Secure sets to anchor bolts installed in concrete bases.
- D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in Mechanical Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
- C. Connect engine exhaust pipe to engine with flexible connector.
- D. Connect fuel piping to engines with a gate valve and union and flexible connector.
 1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems outside the building are specified in Division 2 Section "Fuel Oil Distribution."
 2. Diesel fuel piping, valves, and specialties inside the building are specified in Division 23 Section "Fuel Oil Piping."
- E. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 IDENTIFICATION

- A. Identify system components according Mechanical Identification and Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. **Manufacturer's Field Service:** Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

- 1. **Manufacturer's Field Service:** Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

- B. **Tests and Inspections:**

- 1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection (except those indicated to be optional) for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
 - 3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
 - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - d. Verify that measurements are within manufacturer's specifications.
 - 4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 - 5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.

- C. Coordinate tests with tests for transfer switches and run them concurrently.

- D. **Operational Test:** After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

- E. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- F. Remove and replace malfunctioning units and retest as specified above.

- G. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- H. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generator. Include a minimum of four hours of Owner's maintenance personnel training and demonstration by factory-authorized service representative.

END OF SECTION

SECTION 26 3353 – STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions of the BP Contract apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Three-phase, on-line, double-conversion, static-type, UPS units with the following features:
 - a. Surge suppression.
 - b. Input harmonics reduction.
 - c. Rectifier-charger.
 - d. Inverter.
 - e. Static bypass transfer switch.
 - f. Battery and battery disconnect device.
 - g. Internal and external maintenance bypass/isolation switch.
 - h. Battery monitoring.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. LCD: Liquid-crystal display.
- C. LED: Light-emitting diode.
- D. PC: Personal computer.
- E. THD: Total harmonic distortion.
- F. UPS: Uninterruptible power supply.

1.4 PERFORMANCE REQUIREMENTS

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include data on features, components, ratings, and performance.
- B. Shop Drawings: For UPS. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, components, and location and identification of each field connection. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
 2. Wiring Diagrams: For power, signal, and control wiring.
 3. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 4. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 5. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Factory Test Reports: Comply with specified requirements.
- D. Performance Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.
- E. Operation and Maintenance Data: For UPS units to include in emergency, operation, and maintenance manuals.
- F. Warranties: Sample of special warranties.

1.6QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: Listed and labeled under UL 1778 by an NRTL.
- C. NFPA Compliance: Mark UPS components as suitable for installation in computer rooms according to NFPA 75.

1.7WARRANTY

- A. Special Battery Warranties: Specified form in which manufacturer and Installer agree to repair or replace UPS system storage batteries that fail in materials or workmanship within specified warranty period.

1. Warranted Cycle Life for Premium Valve-Regulated, Lead-calcium Batteries: Equal to or greater than that represented in manufacturer's published table, including figures corresponding to the following, based on annual average battery temperature of 77 deg F (25 deg C):

Discharge Rate	Discharge Duration	Discharge End Voltage	Cycle Life
8 hours	8 hours	1.67	40 cycles
30 minutes	30 minutes	1.67	125 cycles
15 minutes	1.5 minutes	1.67	750 cycles

1.8EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fuses: One for every of each type and rating, but no fewer than one of each.
 2. Cabinet Ventilation Filters: One complete set(s).

PART 2 - PRODUCTS

2.1 OPERATIONAL REQUIREMENTS

- A. Automatic operation includes the following:
1. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.
 2. Abnormal Supply Conditions: If normal supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, the battery supplies energy to maintain constant, regulated inverter power output to the load without switching or disturbance.
 3. If normal power fails, energy supplied by the battery through the inverter continues supply-regulated power to the load without switching or disturbance.
 4. When power is restored at the normal supply terminals of the system, controls automatically synchronize the inverter with the external source before transferring the load. The rectifier-charger then supplies power to the load through the inverter and simultaneously recharges the battery.
 5. If the battery becomes discharged and normal supply is available, the rectifier-charger charges the battery. On reaching full charge, the rectifier-charger automatically shifts to float-charge mode.
 6. If any element of the UPS system fails and power is available at the normal supply terminals of the system, the static bypass transfer switch switches the load to the normal ac supply circuit without disturbance or interruption.
 7. If a fault occurs in the system supplied by the UPS, and current flows in excess of the overload rating of the UPS system, the static bypass transfer switch operates to bypass the fault current to the normal ac supply circuit for fault clearing.
 8. When the fault has cleared, the static bypass transfer switch returns the load to the UPS system.
 9. If the battery is disconnected, the UPS continues to supply power to the load with no degradation of its regulation of voltage and frequency of the output bus.
- B. Manual operation includes the following:
1. Turning the inverter off causes the static bypass transfer switch to transfer the load directly to the normal ac supply circuit without disturbance or interruption.
- C. Maintenance Bypass/Isolation Switch(Internal) Operation: Switch is interlocked so it cannot be operated unless the static bypass transfer switch is in the bypass mode. Device provides manual selection among the three conditions in subparagraphs below without interrupting supply to the load during switching:
1. Full Isolation: Load is supplied, bypassing the UPS. Normal UPS ac input circuit, static bypass transfer switch, and UPS load terminals are completely disconnected from external circuits.

- D. Environmental Conditions: The UPS shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage or degradation of operating capability, except battery performance.
1. Ambient Temperature for Electronic Components: 32 to 104 deg F (0 to 40 deg C).
 2. Ambient Temperature for Battery: 41 to 95 deg F (5 to 35 deg C).
 3. Relative Humidity: 0 to 95 percent, noncondensing.
 4. Altitude: Sea level to 4000 feet (1220 m).

2.2 PERFORMANCE REQUIREMENTS

- A. The UPS shall perform as specified in this article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a load crest factor of 3.0, under the following conditions or combinations of the following conditions:
1. Inverter is switched to battery source.
 2. Steady-state ac input voltage deviates up to plus or minus 10 percent from nominal voltage.
 3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
 4. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
 5. Load is 50 percent unbalanced continuously.
- B. Minimum Duration of Supply: If battery is sole energy source supplying rated full UPS load (50kW) current at unity power factor, duration of supply is 20 minutes.
- C. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state ac input voltage varies plus 10, minus 20 percent from nominal voltage.
- D. Overall UPS Efficiency: Equal to or greater than 3 percent at 100 percent load, 3 percent at 75 percent load, and 3 percent at 50 percent load.
- E. Maximum Acoustical Noise: , 62dba "A" weighting, emanating from any UPS component under any condition of normal operation, measured 3' from nearest surface of component enclosure.
- F. Maximum Energizing Inrush Current: Six times the full-load current.
- G. Maximum AC Output-Voltage Regulation for Loads up to 50 Percent Unbalanced: Plus or minus 2 percent over the full range of battery voltage.
- H. Output Frequency: 60 Hz, plus or minus 0.5 percent over the full range of input voltage, load, and battery voltage.
- I. Limitation of harmonic distortion of input current to the UPS shall be as follows:
1. Description: Either a tuned harmonic filter or an arrangement of rectifier-charger circuits shall limit THD to 5 percent, maximum, at rated full UPS load current, for power sources with X/R ratio between 2 and 30.

2. Description: THD is limited to a maximum of 32 percent, at rated full UPS load current, for power sources with X/R ratio between 2 and 30.
- J. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent rms total and 3 percent rms for any single harmonic, for 100 percent rated nonlinear load current with a load crest factor of 3.0.
- K. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent rms total and 3 percent rms for any single harmonic, for rated full load with THD up to 50 percent, with a load crest factor of 3.0.
- L. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of rated full load for 10 minutes, and 150 percent for 30 seconds in all operating modes.
- M. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage shall remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 100 ms:
 1. 50 Percent: Plus or minus 5 percent.
 2. 100 Percent: Plus or minus 5 percent.
 3. Loss of AC Input Power: Plus or minus 1 percent.
 4. Restoration of AC Input Power: Plus or minus 1 percent.
- N. Input Power Factor: A minimum of .95 lagging when supply voltage and current are at nominal rated values and the UPS is supplying rated full-load current.
- O. EMI Emissions: Comply with FCC Rules and Regulations and with 47 CFR 15 for Class A equipment.

2.3 UPS SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Liebert Corporation; a division of Emerson.
 2. APC Corporation; a division of Schneider
- B. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.
- C. Enclosures: Comply with NEMA 250, Type 1, unless otherwise indicated.
- D. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.
- E. Surge Suppression: Protect internal UPS components from surges that enter at each ac power input connection including main disconnect switch, static bypass transfer switch, and maintenance bypass/isolation switch. Protect rectifier-charger, inverter, controls, and output components.
 1. Use factory-installed surge suppressors tested according to IEEE C62.41.1 and IEEE C62.41.2, Category B.
 2. Additional Surge Protection: Protect internal UPS components from low-frequency, high-energy voltage surges described in IEEE C62.41.1 and IEEE C62.41.2. Design

the circuits connecting with external power sources and select circuit elements, conductors, conventional surge suppressors, and rectifier components and controls so input assemblies will have adequate mechanical strength and thermal and current-carrying capacity to withstand stresses imposed by 40-Hz, 180 percent voltage surges described in IEEE C62.41.1 and IEEE C62.41.2.

- F. Maintainability Features: Mount rectifier-charger and inverter sections and the static bypass transfer switch on modular plug-ins, readily accessible for maintenance.
- G. UPS Cabinet Ventilation: Redundant fans or blowers draw in ambient air near the bottom of cabinet and discharge it near the top rear.

2.4 RECTIFIER-CHARGER

- A. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.
- B. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.
- C. Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.
 - 1. Response Time: Field adjustable for maximum compatibility with local generator-set power source.
- D. Battery Float-Charging Conditions: Comply with battery manufacturer's written instructions for battery terminal voltage and charging current required for maximum battery life.

2.5 INVERTER

- A. Description: Pulse-width modulated, with sinusoidal output. Include a bypass phase synchronization window adjustment to optimize compatibility with local engine-generator-set power source.

2.6 STATIC BYPASS TRANSFER SWITCH

- A. Description: Solid-state switching device providing uninterrupted transfer. A contactor or electrically operated circuit breaker automatically provides electrical isolation for the switch.
- B. Switch Rating: Continuous duty at the rated full UPS load current, minimum.

2.7 BATTERY

- A. Description: Valve-regulated, premium, heavy-duty, recombinant, lead-calcium units; factory assembled in an isolated compartment or in a separate matching cabinet, complete with battery disconnect switch.

2.8 CONTROLS AND INDICATIONS

- A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.
- B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include audible signals and visual displays.
- C. Indications: Plain-language messages on a digital LCD or LED.
 - 1. Quantitative indications shall include the following:
 - a. Input voltage, each phase, line to line.
 - b. Input current, each phase, line to line.
 - c. Bypass input voltage, each phase, line to line.
 - d. Bypass input frequency.
 - e. System output voltage, each phase, line to line.
 - f. System output current, each phase.
 - g. System output frequency.
 - h. DC bus voltage.
 - i. Battery current and direction (charge/discharge).
 - j. Elapsed time discharging battery.
 - 2. Basic status condition indications shall include the following:
 - a. Normal operation.
 - b. Load-on bypass.
 - c. Load-on battery.
 - d. Inverter off.
 - e. Alarm condition.
 - 3. Alarm indications shall include the following:
 - a. Bypass ac input overvoltage or undervoltage.
 - b. Bypass ac input overfrequency or underfrequency.
 - c. Bypass ac input and inverter out of synchronization.
 - d. Bypass ac input wrong-phase rotation.
 - e. Bypass ac input single-phase condition.
 - f. Bypass ac input filter fuse blown.
 - g. Internal frequency standard in use.
 - h. Battery system alarm.
 - i. Control power failure.
 - j. Fan failure.
 - k. UPS overload.
 - l. Battery-charging control faulty.
 - m. Input overvoltage or undervoltage.
 - n. Input transformer overtemperature.
 - o. Input circuit breaker tripped.
 - p. Input wrong-phase rotation.
 - q. Input single-phase condition.
 - r. Approaching end of battery operation.
 - s. Battery undervoltage shutdown.
 - t. Maximum battery voltage.
 - u. Inverter fuse blown.
 - v. Inverter transformer overtemperature.
 - w. Inverter overtemperature.
 - x. Static bypass transfer switch overtemperature.

- y. Inverter power supply fault.
- z. Inverter transistors out of saturation.
- aa. Identification of faulty inverter section/leg.
- bb. Inverter output overvoltage or undervoltage.
- cc. UPS overload shutdown.
- dd. Inverter current sensor fault.
- ee. Inverter output contactor open.
- ff. Inverter current limit.
- 4. Controls shall include the following:
 - a. Inverter on-off.
 - b. UPS start.
 - c. Battery test.
 - d. Alarm silence/reset.
 - e. Output-voltage adjustment.
- D. Dry-form "C" contacts shall be available for remote indication of the following conditions:
 - 1. UPS on battery.
 - 2. UPS on-line.
 - 3. UPS load-on bypass.
 - 4. UPS in alarm condition.
 - 5. UPS off (maintenance bypass closed).
- E. Emergency Power Off Switch: Capable of local operation and operation by means of activation by external dry contacts.

2.9 MAINTENANCE BYPASS/ISOLATION SWITCH

- A. Description: Manually operated switch or arrangement of switching devices with mechanically actuated contact mechanism arranged to route the flow of power to the load around the rectifier-charger, inverter, and static bypass transfer switch.
 - 1. Switch shall be electrically and mechanically interlocked to prevent interrupting power to the load when switching to bypass mode.
 - 2. Switch shall electrically isolate other UPS components to permit safe servicing.
- B. Comply with NEMA PB 2 and UL 891.
- C. Switch Rating: Continuous duty at rated full UPS load current.
- D. Mounting Provisions: Separate wall- or floor-mounted unit.
- E. Key interlock requires unlocking maintenance bypass/isolation switch before switching from normal position with key that is released only when the UPS is bypassed by the static bypass transfer switch. Lock is designed specifically for mechanical and electrical component interlocking.

2.10 BATTERY-CYCLE WARRANTY MONITORING

- A. Description: Electronic device, acceptable to battery manufacturer as a basis for warranty action, for monitoring of charge-discharge cycle history of batteries covered by cycle-life warranties.

- B. Performance: Automatically measures and records each discharge event, classifies it according to duration category, and totals discharges according to warranty criteria, displaying remaining warranted battery life on front panel display.
- C. Additional monitoring functions and features shall include the following:
 - 1. Measuring and Recording: Total voltage at battery terminals; initiates alarm for excursions outside the proper float-voltage level.
 - 2. Monitors: Ambient temperature at battery; initiates alarm if temperature deviates from normally acceptable range.
 - 3. Keypad on Device Front Panel: Provides access to monitored data using front panel display.
 - 4. Alarm Contacts: Arranged to initiate local and remote alarm for battery discharge events.
 - 5. Memory: Stores recorded data in nonvolatile electronic memory.
 - 6. RS-232 Port: Permits downloading of data to a portable PC.
 - 7. Modem: Makes measurements and recorded data accessible to a remote PC via telephone line. Computer is not specified in this Section.

2.11 SOURCE QUALITY CONTROL

- A. Factory test complete UPS system before shipment. Use simulated battery testing. Include the following:
 - 1. Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
 - 2. Full-load test.
 - 3. Transient-load response test.
 - 4. Overload test.
 - 5. Power failure test.
- B. Observation of Test: Give 14 days' advance notice of tests and provide opportunity for Owner's representative to observe tests at Owner's choice.
- C. Report test results. Include the following data:
 - 1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
 - 2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
 - 3. List of instruments and equipment used in factory tests.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for conditions affecting performance of the UPS.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2INSTALLATION

- A. Equipment Mounting: Install UPS on concrete base. Comply with requirements for concrete base Cast-in-Place Concrete ."
 - 1. 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.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 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.
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- C. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.

3.3GROUNDING

- A. Separately Derived Systems: If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer.

3.4IDENTIFICATION

- A. Identify components and wiring according to Division 26 Section "Identification for Electrical Systems."
 - 1. Identify each battery cell individually.

3.5BATTERY EQUALIZATION

- A. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.

3.6FIELD 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. Tests and Inspections:

1. Comply with manufacturer's written instructions.
 2. Inspect interiors of enclosures, including the following:
 - a. Integrity of mechanical and electrical connections.
 - b. Component type and labeling verification.
 - c. Ratings of installed components.
 3. Inspect batteries and chargers according to requirements in NETA Acceptance Testing Specifications.
 4. Test manual and automatic operational features and system protective and alarm functions.
 5. Test communication of status and alarms to remote monitoring equipment.
 6. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. The temporary load bank shall be provided and connected by the electrical contractor. Use instruments calibrated within the previous 12 months according to NIST standards.
 - a. Simulate malfunctions to verify protective device operation.
 - b. Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.
 - c. Test harmonic content of input and output current less than 25, 50, and 100 percent of rated loads.
 - d. Test output voltage under specified transient-load conditions.
 - e. Test efficiency at 50, 75, and 100 percent of rated loads.
 - f. Test remote status and alarm panel functions.
 - g. Test battery-monitoring system functions.
- D. The UPS system will be considered defective if it does not pass tests and inspections.
- E. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.
- F. Prepare test and inspection reports.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain the UPS.

END OF SECTION

SECTION 26 3600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes transfer switches rated 600 V and less, including the following:
 - 1. Automatic transfer switches.
 - 2. Remote annunciation systems.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
 - 1. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Features and operating sequences, both automatic and manual.
 - 2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.
- B. Source Limitations: Obtain automatic transfer switches and remote annunciators through one source from a single manufacturer.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NEMA ICS 1.
- E. Comply with NFPA 70.
- F. Comply with NFPA 99.
- G. Comply with NFPA 110, Level 1.
- H. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Transfer switch manufacturer shall be the same as the generator manufacturer. Subject to compliance with requirements, provide products by one of the following:
 - 1. Contactor Transfer Switches:
 - a. Blue Star Power Systems, Inc.
 - b. Taylor Power Systems, Inc.
 - c. Asco Power Technologies, Inc.
 - d. Engineering Approved Alternate

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
 - 1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
- C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

- D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
 - 2. Switch Action: Double throw; mechanically held in both directions.
 - 3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.
- G. Neutral Switching. Four pole switches are required with switched neutral.
- H. ATS will be mounted indoors and consequently, does not require heater.
- I. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.
- J. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Electrical Identification."
 - 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
 - 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 - 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- K. Enclosures: General-purpose NEMA 250, Type 12, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.
- C. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.
- D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

- E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- F. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.
- G. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.
- H. Automatic Transfer-Switch Features:
 - 1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
 - 2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
 - 3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
 - 4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
 - 5. Test Switch: Simulate normal-source failure.
 - 6. Switch-Position Pilot Lights: Indicate source to which load is connected.
 - 7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
 - 8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
 - 9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
 - 10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
 - 11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
 - 12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - b. Push-button programming control with digital display of settings.
 - c. Integral battery operation of time switch when normal control power is not available.

2.4 REMOTE ANNUNCIATOR AND CONTROL SYSTEM

- A. Functional Description: Include the following functions for indicated transfer switches:
 1. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
 2. Indication of switch position.
 3. Indication of switch in test mode.
 4. Indication of failure of digital communication link.
 5. Key-switch or user-code access to control functions of panel.
 6. Control of switch-test initiation.
- B. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically reverts to stand-alone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.
- C. Remote Annunciation and Control Panel: Solid-state components. Include the following features:
 1. Controls and indicating lights grouped together for each transfer switch.
 2. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
 3. Digital Communication Capability: Matched to that of transfer switches supervised.
 4. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.
- D. Provide at the Generator dry-contact indicating any alarm or failure condition.

2.5 REMOTE ANNUNCIATOR AND CONTROL SYSTEM (INTERNET ACCESS)

- A. Functional Description: Provide remote monitoring capability for the following functions:
 1. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
 2. Indication of switch position.
 3. Indication of switch in test mode.

4. Indication of failure of digital communication link.
 5. Key-switch or user-code access to control functions of panel.
 6. Control of switch-test initiation.
- B. Provide all monitoring and control functions identified above through Ethernet Local area network based on IEEE 802.3 standards. Provide Ethernet RJ type jack at transfer switch.
- C. Provide necessary software for PC Window's based system to accomplish the Remote Annunciator and Control described in 2.5A and 2.5B.

2.6 SOURCE QUALITY CONTROL

- A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Design each fastener and support to carry seismic loads.
- B. Floor-Mounting Switch: Anchor to floor by bolting.
1. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support.
- C. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.
- D. Identify components according to Division 26 Section "Identification for Electrical Systems."
- E. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
 2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
 5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
 - f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
- B. Coordinate tests with tests of generator and run them concurrently.
- C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- D. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain automatic transfer switch. Include a minimum of two hours of Owner's maintenance personnel training and demonstration by factory-authorized service representative.

- B. Coordinate this training with that for generator equipment.

END OF SECTION

SECTION 26 4313 - TRANSIENT VOLTAGE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes transient voltage surge suppressors for low-voltage power, control, and communication equipment.
- B. Related Sections include the following:
 - 1. Division 26 Section "Wiring Devices" for devices with integral transient voltage surge suppressors.
 - 2. Division 26 Section "Panelboards" for factory-installed transient voltage surge suppressors.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
- B. Product Certificates: Signed by manufacturers of transient voltage suppression devices, certifying that products furnished comply with the following testing and labeling requirements:
 - 1. UL 1283 certification.
 - 2. UL 1449 listing and classification.
- C. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Failed test results and corrective action taken to achieve requirements.
- D. Maintenance Data: For transient voltage suppression devices to include in maintenance manuals specified in Division 1.
- E. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.
- B. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.
- C. Product Options: Drawings indicate size, dimensional requirements, and electrical performance of suppressors and are based on the specific system indicated. Other manufacturers' products complying with requirements may be considered. Refer to Division 26 Section "Grounding and Bonding."
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. IEEE Compliance: Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide for Surge Suppressor Testing."
- F. NEMA Compliance: Comply with NEMA LS 1, "Low Voltage Surge Protective Devices."
- G. UL Compliance: Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Transient Voltage Surge Suppressors."

1.5 PROJECT CONDITIONS

- A. Placing into Service: Do not energize or connect service entrance equipment, panelboards, or control terminals to their sources until the surge protective devices are installed and connected.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
- C. Service Conditions: Rate surge protective devices for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
 - 2. Operating Temperature: 30 to 120 deg F.

3. Humidity: 0 to 85 percent, noncondensing.
4. Altitude: Less than 20,000 feet above sea level.

1.6 COORDINATION

- A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.
- B. Coordinate surge protective devices with Division 26 Section "Electrical Power Monitoring and Control."

1.7 WARRANTY

- A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of surge suppressors that fail in materials or workmanship within five years from date of Substantial Completion.
- C. Special Warranty for Plug-in Cord-Connected Surge Suppressors: Written warranty, executed by manufacturer agreeing to repair or replace electronic equipment connected to circuits protected by surge suppressors.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Manufacturers of a Broad Line of Suppressors:
 - a. Advanced Protection Technologies, Inc.
 - b. Atlantic Scientific Corp.
 - c. Current Technology, Inc.
 - d. Cutler-Hammer, Inc.

- e. Entelec, Inc.
- f. Innovative Technology, Inc.
- g. Intermatic, Inc.
- h. LEA International.
- i. Leviton Manufacturing Co. Inc.
- j. Liebert Corp.
- k. Northern Technologies.
- l. Siemens Energy & Automation.
- m. Square D Co.
- n. Sutton Designs, Inc.
- o. Transtector Systems, Inc.
- p. Tycor International, Inc.
- q. United Power, Inc.
- r. Zero Surge Inc.

2. Manufacturers of Category A and Telephone/Data Line Suppressors:

- a. MCG Electronics, Inc.
- b. NTE Electronics, Inc.
- c. Telebyte Technology, Inc.

2.2 SERVICE ENTRANCE SUPPRESSORS

A. Surge Protective Device Description: Non-modular type with the following features and accessories:

- 1. LED indicator lights for power and protection status.
- 2. Audible alarm, with silencing switch, to indicate when protection has failed.
- 3. One set of dry contacts rated at 5 a, 250-V ac, for remote monitoring of protection status.

B. Surge Protective Device Description: Modular design with field-replaceable modules and the following features and accessories:

- 1. Fuses, rated at 200-kA interrupting capacity.
- 2. Fabrication using bolted compression lugs for internal wiring.
- 3. Integral disconnect switch.
- 4. Redundant suppression circuits.
- 5. Redundant replaceable modules.
- 6. Arrangement with copper busbars and for bolted connections to phase buses, neutral bus, and ground bus.
- 7. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
- 8. Red and green LED indicator lights for power and protection status.
- 9. Audible alarm, with silencing switch, to indicate when protection has failed.
- 10. One set of dry contacts rated at 5 a and 250-V ac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
- 11. Surge-event operations counter.

C. Peak Single-Impulse Surge Current Rating: 160kA per phase.

- D. Connection Means: Permanently wired.
- E. Protection modes and UL 1449 clamping voltage for grounded wye circuits with voltages of 480Y/277 and 208Y/120; 3-phase, 4-wire circuits, shall be as follows:
 - 1. Line to Neutral: 800 V for 480Y/277 400 V for 208Y/120.
 - 2. Line to Ground: 800 V for 480Y/277 400 V for 208Y/120.
 - 3. Neutral to Ground: 800 V for 480Y/277 400 V for 208Y/120.

2.3 PANELBOARD SUPPRESSORS

- A. Surge Protective Device Description: Non-modular type with the following features and accessories:
 - 1. LED indicator lights for power and protection status.
 - 2. Audible alarm, with silencing switch, to indicate when protection has failed.
 - 3. One set of dry contacts rated at 5 a, 250-V ac, for remote monitoring of protection status.
- B. Surge Protective Device Description: Modular design with field-replaceable modules and the following features and accessories:
 - 1. Fuses, rated at 200-kA interrupting capacity.
 - 2. Fabrication using bolted compression lugs for internal wiring.
 - 3. Integral disconnect switch.
 - 4. Redundant suppression circuits.
 - 5. Redundant replaceable modules.
 - 6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - 7. Red and green LED indicator lights for power and protection status.
 - 8. Audible alarm, with silencing switch, to indicate when protection has failed.
 - 9. One set of dry contacts rated at 5 A, 250-V, ac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
 - 10. Surge-event operations counter.
- C. Peak Single-Impulse Surge Current Rating: 80 kA per phase.
- D. Protection modes and UL 1449 clamping voltage for grounded wye circuits with voltages of 480Y/277 and 208Y/120; 3-phase, 4-wire circuits, shall be as follows:
 - 1. Line to Neutral: 800 V for 480Y/277 400 V for 208Y/120.
 - 2. Line to Ground: 800 V for 480Y/277 400 V for 208Y/120.
 - 3. Neutral to Ground: 800 V for 480Y/277 400 V for 208Y/120.
- E. Protection modes and UL 1449 clamping voltage for 240/120 V, single-phase, 3-wire circuits, shall be as follows:
 - 1. Line to Neutral: 400 V.
 - 2. Line to Ground: 400 V.
 - 3. Neutral to Ground: 400 V.

- F. Protection modes and UL 1449 clamping voltage for 240/120 V, 3-phase, 4-wire circuits, with high leg shall be as follows:
 - 1. Line to Neutral: 400 V, 800 V from high leg.
 - 2. Line to Ground: 400 V.
 - 3. Neutral to Ground: 400 V.

2.4 AUXILIARY PANEL SUPPRESSORS

- A. Surge Protective Device Description: Unit type, panel-mounted design with the following features and accessories:
 - 1. LED indicator lights for power and protection status.
 - 2. Audible alarm, with silencing switch, to indicate when protection has failed.
 - 3. One set of dry contacts rated at 5 A, 250-V ac, for remote monitoring of protection status.
 - 4. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - 5. Red and green LED indicator lights for power and protection status.
- B. Peak Single-Impulse Surge Current Rating: 120kA per phase.
- C. Protection modes and UL 1449 clamping voltage for grounded wye circuits with voltages of 480Y/277 and 208Y/120; 3-phase, 4-wire circuits, shall be as follows:
 - 1. Line to Neutral: 800 V for 480Y/277 400 V for 208Y/120.
 - 2. Line to Ground: 800 V for 480Y/277 400 V for 208Y/120.
 - 3. Neutral to Ground: 800 V for 480Y/277 400 V for 208Y/120.
- D. Protection modes and UL 1449 clamping voltage for 240/120 V, single-phase, 3-wire circuits, shall be as follows:
 - 1. Line to Neutral: 400 V.
 - 2. Line to Ground: 400 V.
 - 3. Neutral to Ground: 400 V.
- E. Protection modes and UL 1449 clamping voltage for 240/120 V, 3-phase, 4-wire circuits, with high leg shall be as follows:
 - 1. Line to Neutral: 400 V, 800 V from high leg.
 - 2. Line to Ground: 400 V.
 - 3. Neutral to Ground: 400 V.

2.5 ENCLOSURES

- A. NEMA 250, with type matching the enclosure of panel or device being protected.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTIVE DEVICES

- A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.
- B. Install devices for panelboard and auxiliary panels with conductors between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
 - 1. Provide multipole, 15-A circuit breaker as a dedicated disconnect for the suppressor, unless otherwise indicated.

3.2 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified testing agency to perform the following field quality-control testing:
- B. Testing: Engage a qualified testing agency to perform the following field quality-control testing:
- C. Testing: Perform the following field quality-control testing:
 - 1. After installing surge protective devices, but before electrical circuitry has been energized, test for compliance with requirements.
 - 2. Complete startup checks according to manufacturer's written instructions.
 - 3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.19. Certify compliance with test parameters.
- D. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

END OF SECTION

SECTION 26 5119 - 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. Linear industrial.
4. Recessed linear.
5. Strip light.
6. Surface mount, linear.
7. Suspended, linear.
8. Suspended, nonlinear.
9. Emergency Lighting Units.
10. Exit Signs.
11. Materials.
12. Finishes.
13. Luminaire support.

- 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, 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 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. Samples: For each luminaire and for each color and texture with standard factory-applied finish.
- D. 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.

- E. Samples for Verification: For each type of luminaire.
 - 1. Include Samples of luminaires and accessories to verify finish selection.
- F. 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 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.
 - g. Occupancy sensors.
 - 7. Moldings.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. 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 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: ten 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 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. Standards:
 - 1. ENERGY STAR certified.
 - 2. California Title 24 compliant.
 - 3. UL Listing: Listed for damp location.
 - 4. Recessed luminaires shall comply with NEMA LE 4.
 - 5. User Replaceable Lamps:
 - a. Bulb shape complying with ANSI C78.79.
 - b. Lamp base complying with ANSI C81.61.
- C. CRI of minimum 80. CCT of 4000K.
- D. Rated lamp life of 50,000 hours to L70.
- E. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- F. Internal driver.
- G. Nominal Operating Voltage: 120VAC.
 - 1. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
- H. Housings:
 - 1. Rolled steel housing and extruded aluminum heat sink.
 - 2. White finish.

2.2 CYLINDER

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Lighting, an Eaton business.
2. GE Lighting Solutions.
3. Lightolier; a Philips group brand.
4. Lithonia Lighting; Acuity Brands Lighting, Inc.
5. OSRAM SYLVANIA.

- B. Minimum 250 lumens. Minimum allowable efficacy of 80 lumens per watt.
- C. With integral mounting provisions.

2.3 DOWNLIGHT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Lighting, an Eaton business.
 2. GE Lighting Solutions.
 3. Lightolier; a Philips group brand.
 4. Lithonia Lighting; Acuity Brands Lighting, Inc.
 5. OSRAM SYLVANIA.

- B. Minimum 1000 lumens. Minimum allowable efficacy of 80 lumens per watt.
- C. Universal mounting bracket.
- D. Integral junction box with conduit fittings.
- E. Optics:
1. Fixed lens.
 2. Medium light distribution.

2.4 LINEAR INDUSTRIAL

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Lighting, an Eaton business.
 2. GE Lighting Solutions.
 3. Lithonia Lighting; Acuity Brands Lighting, Inc.
 4. OSRAM SYLVANIA.
- B. Minimum 5000 lumens. Minimum allowable efficacy of 80 lumens per watt.

2.5 RECESSED LINEAR

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Lighting, an Eaton business.
 - 2. GE Lighting Solutions.
 - 3. Lithonia Lighting; Acuity Brands Lighting, Inc.
 - 4. OSRAM SYLVANIA.
- B. Minimum 1500 lumens. Minimum allowable efficacy of 85 lumens per watt.
- C. Integral junction box with conduit fittings.

2.6 STRIP LIGHT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Lighting, an Eaton business.
 - 2. GE Lighting Solutions.
 - 3. Lithonia Lighting; Acuity Brands Lighting, Inc.
 - 4. OSRAM SYLVANIA.
 - 5. Philips Lighting Company.
- B. Minimum 750 lumens. Minimum allowable efficacy of 75 lumens per watt.
- C. Integral junction box with conduit fittings.

2.7 SUSPENDED, LINEAR

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Lighting, an Eaton business.
 - 2. GE Lighting Solutions.
 - 3. Lightolier; a Philips group brand.
 - 4. Lithonia Lighting; Acuity Brands Lighting, Inc.
 - 5. OSRAM SYLVANIA.
- B. Minimum 1500 lumens. Minimum allowable efficacy of 85 lumens per watt.

2.8 SUSPENDED, NONLINEAR

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Lighting, an Eaton business.
 2. Lithonia Lighting; Acuity Brands Lighting, Inc.
 3. Phillips.
- B. Minimum 1500 lumens. Minimum allowable efficacy of 85 lumens per watt.
- C. Integral junction box with conduit fittings.

2.9 EXIT SIGNS

- A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 - g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.
3. Master/Remote Sign Configurations:
- a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply 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.

2.10 EMERGENCY LIGHTING UNITS

A. Description: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

2.11 Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.12 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. 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.

C. 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.

- D. Housings:
 - 1. Rolled steel housing and extruded-aluminum heat sink.
 - 2. White power-coat or painted finish.

- E. 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 for all luminaires.

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. 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 vertical force of 400 percent of luminaire weight.
- E. Flush-Mounted Luminaire Support:
 - 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 Luminaire Support:
 - 1. Attached to structural members in walls.
 - 2. Do not attach luminaires directly to gypsum board.
- G. Ceiling-Mounted Luminaire Support:
 - 1. Ceiling mount with two 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 120 (6 m) in length.
 - 2. Ceiling mount with pendant mount with 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 120 inches (6 m) in length.
 - 3. Ceiling mount with hook mount.

H. 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.

I. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 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 2 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

SECTION 26 5600 - 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 260925 "Wireless Networked Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

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 SUBMITTALS

- A. Product Data: For each luminaire, arranged in the order of lighting unit designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of fixture, including dimensions and verification of indicated parameters.

2. Luminaire dimensions, effective projected area, details of attaching luminaires, accessories, and installation and construction details.
 3. Luminaire materials.
 4. Photoelectric relays.
 5. LED drivers.
 6. Electrical and energy-efficiency data for drivers.
- B. Wiring Diagrams: Power, signal, and control wiring.
- C. Samples for Verification: For exterior luminaires designated for sample submission in the Exterior Luminaire Schedule.
1. Driver: 120-V models of specified driver types.
 2. Finishes: For each finished metal used in support components.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For luminaires to include in maintenance manuals.
- F. Warranties: Special warranties specified in this Section

1.5 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.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.7 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.

1.8 COORDINATION

- A. Coordinate exterior luminaires with mounting and wind load.

1.9 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship; corrode; or fade, stain, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period: 5 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 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. UL Compliance: Comply with UL 1598 and listed for wet location.
- D. Lamp base complying with ANSI C81.61.
- E. Bulb shape complying with ANSI C79.1.

- F. CRI of minimum 70. CCT of 4000K
- G. L70 lamp life of 50,000 hours.
- H. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- I. Internal driver.
- J. Nominal Operating Voltage: 120VAC
- K. In-line Fusing: Separate in-line fuse for each luminaire.
- L. Lamp Rating: Lamp marked for outdoor use.
- M. Source Limitations: Obtain luminaires from single source from a single manufacturer.

2.2 LUMINAIRE TYPES

A. Area and Site:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Gardco
 - b. Holophane
 - c. Beacon
 - d. McGraw-Edison
2. Luminaire Shape: Rectangular.
3. Mounting: Pole.
4. Luminaire-Mounting Height: As shown on plans.
5. Distribution: As shown on plans.
6. Diffusers and Globes: Clear, UV-stabilized acrylic.
7. Housings:
 - a. Extruded-aluminum housing and heat sink.
 - b. Black finish to be confirmed with architect.

B. Wall Mount/Canopy:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Ligman
 - b. Engineer Approved Alternate
2. Shape: Rectangular/Linear.
3. Dimensions: 10 inches (263mm) in diameter.
4. Diffusers and Globes: Tempered Glass.

5. Housings:
 - a. Extruded-aluminum housing and heat sink.
 - b. Black finish to be confirmed with architect

C. Monument Sign:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Color Kinetics
 - b. Engineer Approved Alternate
2. Shape: Linear.
3. Dimensions: 12 inches (263mm) in diameter.
4. Diffusers and Globes: Tempered Glass.
5. Housings:
 - a. Extruded-aluminum housing and heat sink.
6. Black finish to be confirmed with architect

2.3 MATERIALS

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Sheet Metal Components: Corrosion-resistant aluminum. 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.

2.4 FINISHES

- A. Field Painting Finish: Manufacturer's standard prime-coat finish ready for field painting.

- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match process and color of pole or support.

- C. Factory-Painted 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, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - 2. Interior Surfaces: Apply one coat of bituminous paint on interior of pole, or otherwise treat to prevent corrosion.
 - 3. 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 color.
 - c. Color: As selected by Architect from manufacturer's full range.

- D. 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; 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.

2.5 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 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. Install lamps in each luminaire.
- C. Fasten luminaire to structural support.
- D. 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.

E. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.

F. Wiring Method: Install cables in raceways. Conceal raceways and cables.

G. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.

H. Coordinate layout and installation of luminaires with other construction.

I. 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.

J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 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- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. 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. 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.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to 2 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

SECTION 26 5700 – ELECTRICAL REQUIREMENTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes electrical requirements and provisions for wiring systems to be used as signal pathways for voice and high-speed data transmission.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. CATV: Cable Television.

1.4 SUBMITTALS

- A. Product Data: Include data on features, ratings, and performance for each component specified.
- B. Shop Drawings: Include dimensioned plan and elevation views of each individual component. Show equipment assemblies, method of field assembly, workspace requirements, and access for cable connections.
 - 1. Conduit riser diagram including all AV Conduits.
 - 2. Routing of all conduit following the spacing requirements on the drawings.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate all work with Special Systems Contractor(s), Owner or Owner's Representative and Architect.

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

- A. General: Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum future performance.

2.2 MOUNTING ELEMENTS

- A. Raceways and Boxes: Comply with Division 26 Section "Raceways and Boxes."

2.3 COMMUNICATION OUTLETS

- A. Phone Outlet, Data Outlet or Combination Data/Phone Outlet: +18" A.F.F. U.O.N. Provide 4" square extra deep box with single gang raised cover (mud ring) and 1" conduit stubbed into accessible ceiling space. Provide a pull string in conduit and protective bushing at end of conduit. Provide one dedicated conduit per outlet. In rooms/areas with gypboard ceiling or unaccessible ceiling provide a 4" square extra deep box with single gang raised cover (mud ring) and 1" continuous conduit routed to the nearest accessible ceiling. Provide a pull string in conduit and protective bushing at end of conduit.
- B. CATV Outlet: +18" A.F.F. U.O.N. Provide 4" square extra deep box with single gang raised cover (mud ring) and 1" conduit stubbed into accessible ceiling space. Provide a pull string in conduit and protective bushing at end of conduit. Provide one dedicated conduit per outlet. In rooms/areas with gypboard ceiling or unaccessible ceiling provide a 4" square extra deep box with single gang raised cover (mud ring) and 1" continuous conduit routed to the nearest accessible ceiling. Provide a pull string in conduit and protective bushing at end of conduit.
- C. Wireless Access Point (WAP): In gypboard ceilings, provide manufacturer recommended recessed junction box. In lay-in ceilings, provide caddy bar support, Erico model #512A or Engineer approved equal, and manufacturer recommended recessed junction box for wireless device support. Furnish with QuickPort in-ceiling bracket, Leviton model #49223-CBC or Engineer approved equal.
- D. Communication outlet installed in surface metallic raceway and multi-outlet system: Refer to drawings for conduit routing, outlet boxes and other provisions required to provide transitions into surface metallic raceway systems. Provide outlets in surface metallic raceway for communication outlets, refer to Division 26 Section "Surface Metallic Raceway and Multi-outlet System". Refer to Table A for conduit size.

- E. Conduit sizes for conduits with multiple cables - Table A

Number of Voice/Data Cables*	Conduit Trade Size for Electrical Metallic Tubing (EMT)
1-4	1"
5-7	1 1/4"
8	Two 1"
9-15	Two 1 1/4"
16-23	Three 1 1/4"
* Note that voice cables and data cables shall have same OD for purpose of this fill table.	

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Raceways/Conduits for Communications Wiring Method: Provide raceways for all communications wiring, except where installed in accessible ceilings. Minimum conduit size shall be 1 inch, unless otherwise noted.
- B. Refer to Division 27 Section "Voice/Data Communications Systems" for other raceway/conduit requirements.
- C. Provide one spare conduit with pull string of equal or greater size for every four conduits routed from communication room to common area for future. Label conduit as "Spare Communications" at each end and every 40'-0" intervals.
- D. Install all conduits parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible. Conduits shall be mounted as high as possible in open structure areas to minimize visibility. Coordinate exact requirements with Architect.
- E. Separation of Wires: Comply with TIA/EIA rules for separating unshielded copper voice and data communication cabling from potential EMI sources, including electrical power lines and equipment, coordinate with Owner.
- F. Cover edges of cable pass-through holes in chassis, racks, boxes, etc., with rubber grommets or Brady GRNY nylon grommetting.

- G. Mount equipment and enclosures plumb and square. Permanently installed equipment to be firmly and safely held in place.

3.3 GROUNDING

- A. Comply with Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Refer to Communications Grounding Riser Diagram for detailed grounding information.

3.4 INSTALLATION STANDARDS

- A. Comply with requirements in TIA/EIA Standards.

3.5 IDENTIFICATION

- A. Comply with applicable requirements in Division 27 Section "Voice/Data Communications Systems", and TIA/EIA Standards.

END OF SECTION

SECTION 26 5800 – FIRE ALARM ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes electrical requirements and provisions for fire alarm systems.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.

1.4 SUBMITTALS

- A. Product Data: Include data on features, ratings, and performance for each component specified.
- B. Shop Drawings: Include dimensioned plan and elevation views of each individual component. Show equipment assemblies, method of field assembly, workspace requirements, and access for cable connections.
 - 1. Conduit riser diagram including all Fire Alarm Conduits.
 - 2. Routing of all conduit following the spacing requirements on the drawings.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate all work with Fire Alarm Contractor, Owner or Owner's Representative and Architect.

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

- A. General: Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum future performance.

2.2 MOUNTING ELEMENTS

- A. Raceways and Boxes: Comply with Division 26 Section "Raceways and Boxes for Electrical Systems."

2.3 FIRE ALARM DEVICE OUTLETS

- A. Wall-mounted Fire Alarm Pull Station Outlet: +46" A.F.F. U.O.N. Provide 4" square extra deep box with single gang raised cover (mud ring) and 3/4" conduit stubbed into accessible ceiling space. Provide a pull string in conduit and single-gang junction box at end of conduit. Provide one dedicated conduit per outlet. In rooms/areas with gypboard ceiling or unaccessible ceiling provide a 4" square extra deep box with single gang raised cover (mud ring) and 3/4" continuous conduit routed to the nearest accessible ceiling. Provide a pull string in conduit and single-gang junction box at end of conduit.
- B. Wall-mounted Strobe Light Outlet: +80" A.F.F. U.O.N. Provide 4" square extra deep box with single gang raised cover (mud ring) and 3/4" conduit stubbed into accessible ceiling space. Provide a pull string in conduit and single-gang junction box at end of conduit. Provide one dedicated conduit per outlet. In rooms/areas with gypboard ceiling or unaccessible ceiling provide a 4" square extra deep box with single gang raised cover (mud ring) and 3/4" continuous conduit routed to the nearest accessible ceiling. Provide a pull string in conduit and single-gang junction box at end of conduit.
- C. Wall-mounted Speaker Outlet: +80" A.F.F. U.O.N. Provide 4" square 1 1/2" deep box with 1 1/2" extension ring and 3/4" conduit stubbed into accessible ceiling space. Provide a pull string in conduit and single-gang junction box at end of conduit. Provide one dedicated conduit per outlet. In rooms/areas with gypboard ceiling or unaccessible ceiling provide a 4" square 1 1/2" deep box with 1 1/2" extension ring and 3/4" continuous conduit routed to the nearest accessible ceiling. Provide a pull string in conduit and single-gang junction box at end of conduit.
- D. Wall-mounted Combination Strobe Light/Speaker Outlet: +80" A.F.F. U.O.N. Provide 4" square 1 1/2" deep box with 1 1/2" extension ring and 3/4" conduit stubbed into accessible ceiling space. Provide a pull string in conduit and single-gang junction box at end of conduit. Provide one dedicated conduit per outlet. In rooms/areas with gypboard ceiling or unaccessible ceiling provide a 4" square 1 1/2" deep box with 1 1/2" extension ring and 3/4" continuous conduit routed to the nearest accessible ceiling. Provide a pull string in conduit and single-gang junction box at end of conduit.
- E. Ceiling-mounted Strobe Light Outlet: In gypboard ceilings, provide 4" square extra deep box with single gang raised cover and 3/4" continuous conduit routed to the nearest accessible ceiling. Provide a pull string in conduit and single-gang junction box at end

of conduit. In lay-in ceilings, provide caddy bar support, Erico model #512 or Engineer approved equal and 4" square extra deep box with single gang raised cover.

- F. Ceiling-mounted Combination Strobe Light/Speaker Outlet: In gypboard ceilings, provide 4" square 1 1/2" deep box with 1 1/2" extension ring and 3/4" continuous conduit routed to the nearest accessible ceiling. Provide a pull string in conduit and single-gang junction box at end of conduit. In lay-in ceilings, provide caddy bar support, Erico model #512HD or Engineer approved equal and 4" square 1 1/2" deep box with 1 1/2" extension ring.
- G. Ceiling-mounted Smoke Detector: In gypboard ceilings, provide 4" square extra deep box with round ring and 3/4" continuous conduit routed to the nearest accessible ceiling. Provide a pull string in conduit and single-gang junction box at end of conduit. In lay-in ceilings, provide caddy bar support, Erico model #512 or Engineer approved equal and 4" square extra deep box with round ring.
- H. Ceiling-mounted Heat Detector: In gypboard ceilings, provide 4" square extra deep box with round ring and 3/4" continuous conduit routed to the nearest accessible ceiling. Provide a pull string in conduit and single-gang junction box at end of conduit. In lay-in ceilings, provide caddy bar support, Erico model #512 or Engineer approved equal and 4" square extra deep box with round ring.
- I. Duct-mounted Smoke Detector: Provide mounting components/modules in accordance with fire alarm manufacturer recommendations and ductwork, coordinate with Fire Alarm Contractor and Mechanical.
- J. Monitoring Module Outlet: Provide 4" square extra deep box with single gang raised cover.
- K. Remote Annunciator: Provide standard pre-fabricated 6-gang outlet box from fire alarm manufacturer, coordinate with Fire Alarm Contractor.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Raceways/Conduits for Fire Alarm Wiring Method: Provide raceways for all fire alarm wiring.
- B. Refer to Division 28 Section "Addressable Fire Alarm Systems" for other raceway/conduit requirements.
- C. Provide one spare conduit with pull string of equal or greater size for every six conduits routed from fire alarm control panel or fire alarm power supply to common area for

future. Label conduit as "Spare Fire Alarm" and provide red painted band at each end and every 40'-0" intervals.

- D. Install all conduits parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible. Conduits shall be mounted as high as possible in open structure areas to minimize visibility. Coordinate exact requirements with Architect.
- E. Install all fire alarm conduit risers with wall or floor penetrations in accordance with the National Electrical Code (NEC) Article 760.52. Coordinate all riser requirements and locations with Fire Alarm Contractor. Seal all penetrations accordingly.
- F. Separation of Wire Pathways: Follow manufacturer recommendations for separating unshielded cabling from potential EMI sources, including electrical power lines and equipment, coordinate with Fire Alarm Contractor.

3.3 GROUNDING

- A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

END OF SECTION

SECTION 28 31 11 - FIRE ALARM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes fire alarm systems.
- B. Related Sections include the following:
 - 1. Division 8 Section "Openings" for door closers and holders with associated smoke detectors, electric door locks, and release devices that interface with the fire alarm system.

1.3 DEFINITIONS

- A. FACP: Fire alarm control panel.
- B. LED: Light-emitting diode.
- C. NICET: National Institute for Certification in Engineering Technologies.
- D. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.4 SYSTEM DESCRIPTION

- A. Noncoded, analog-addressable system; automatic sensitivity control of certain smoke detectors; and multiplexed signal transmission dedicated to fire alarm service only. System shall incorporate a mass notification system to alert emergency information to entire facility.
 - 1. All fire alarm equipment shall be provided from a single manufacturer.

1.5 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 72.
- B. Fire alarm signal initiation shall be by one or more of the following devices:
 - 1. Manual stations.
 - 2. Heat detectors.
 - 3. Smoke detectors.
 - 4. Verified automatic alarm operation of smoke detectors.
 - 5. Automatic sprinkler system water flow.

- C. Fire alarm signal shall initiate the following actions:
 - 1. Alarm notification appliances shall operate continuously.
 - 2. Identify alarm at the FACP and remote annunciators.
 - 3. De-energize electromagnetic door holders.
 - 4. Transmit an alarm signal to the remote alarm receiving station.
 - 5. Unlock electric door locks in designated egress paths.
 - 6. Release fire and smoke doors held open by magnetic door holders.
 - 7. Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.
 - 8. Close smoke dampers in air ducts of system serving zone where alarm was initiated.
 - 9. Activate smoke-control system (smoke management) at firefighters' smoke-control system panel.
 - 10. Record events in the system memory.

- D. Supervisory signal initiation shall be by one or more of the following devices or actions:
 - 1. Operation of a fire-protection system valve tamper.
 - 2. Duct smoke detectors.

- E. System trouble signal initiation shall be by one or more of the following devices or actions:
 - 1. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
 - 2. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.
 - 3. Loss of primary power at the FACP.
 - 4. Ground or a single break in FACP internal circuits.
 - 5. Abnormal ac voltage at the FACP.
 - 6. A break in standby battery circuitry.
 - 7. Failure of battery charging.
 - 8. Abnormal position of any switch at the FACP or annunciator.
 - 9. Fire-pump power failure, including a dead-phase or phase-reversal condition.

- F. System Trouble and Supervisory Signal Actions: Ring trouble bell and annunciate at the FACP and remote annunciators. Record the event on system printer.

1.6 SUBMITTALS

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

- B. Shop Drawings:
 - 1. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire alarm system design.
 - b. Fire alarm certified by NICET, minimum Level III.
 - 2. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
 - 3. Device Address List: Coordinate with final system programming.
 - 4. System riser diagram with device addresses, conduit sizes, and cable and wire types and sizes.

5. Wiring Diagrams: Power, signal, and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show wiring color code.
 6. Batteries: Size calculations.
 7. Duct Smoke Detectors: Performance parameters and installation details for each detector, verifying that each detector is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 8. Ductwork Coordination Drawings: Plans, sections, and elevations of ducts, drawn to scale and coordinating the installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, the detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
 9. Floor Plans: Indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.
- C. Qualification Data: For Installer.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For fire alarm system to include in emergency, operation, and maintenance manuals. Comply with NFPA 72, Appendix A, recommendations for Owner's manual. Include abbreviated operating instructions for mounting at the FACP.
- F. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals specified in Division 1 Section "Submittals," make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Architect for review.
- G. Documentation:
1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Owner, Architect, and authorities having jurisdiction.
 2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 72 to Owner, Architect, and authorities having jurisdiction. Format of the written sequence of operation shall be the optional input/output matrix.
 - a. Electronic media may be provided to Architect and authorities having jurisdiction.
- 1.7 QUALITY ASSURANCE
- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Personnel certified by NICET as Fire Alarm Level II.

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B.
 - 1. Smoke, Fire, and Flame Detectors: Quantity equal to 10 percent of amount of each type installed, but not less than 1 unit of each type.
 - 2. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but not less than 1 unit of each type.
 - 3. Keys and Tools: One extra set for access to locked and tamperproofed components.
 - 4. Audible and Visual Notification Appliances: One of each type installed.
 - 5. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. FACP and Equipment:
 - a. Edwards Systems Technology Inc.
 - b. Fire Control Instruments, Inc.; a GE-Honeywell Company.
 - c. Grinnell Fire Protection; a Tyco International Company.
 - d. NOTIFIER; a GE-Honeywell Company.
 - e. Siemens Building Technologies, Inc.; a Cerberus Division.
 - f. SimplexGrinnell LP; a Tyco International Company.
 - 2. Wire and Cable:
 - a. Comtran Corporation.
 - b. Helix/HiTemp Cables, Inc.; a Draka USA Company.
 - c. Rockbestos-Suprenant Cable Corporation; a Marmon Group Company.
 - d. West Penn Wire/CDT; a division of Cable Design Technologies.
 - e. Windy City Wire, Cable and Technology Products, LLC.

2.2 FACP

- A. General Description:
 - 1. Modular, power-limited design with electronic modules, UL 864 listed.

2. Addressable initiation devices that communicate device identity and status.
 - a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at the FACP.
 - b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
 3. Addressable control circuits for operation of mechanical equipment.
- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP 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.
- C. Circuits:
1. Signaling Line Circuits: NFPA 72, Class B, Style 4.
 2. Notification-Appliance Circuits: NFPA 72, Class B, Style Y.
 3. Actuation of alarm notification appliances, annunciation, elevator recall, shall occur within 10 seconds after the activation of an initiating device.
 4. Electrical monitoring for the integrity of wiring external to the FACP for mechanical equipment shutdown and magnetic door-holding circuits is not required, provided a break in the circuit will cause doors to close and mechanical equipment to shut down.
- D. Smoke-Alarm Verification:
1. Initiate audible and visible indication of an "alarm verification" signal at the FACP.
 2. Activate a listed and approved "alarm verification" sequence at the FACP and the detector.
 3. Record events by the system printer.
 4. Sound general alarm if the alarm is verified.
 5. Cancel FACP indication and system reset if the alarm is not verified.
- E. Notification-Appliance Circuit: The audio alarm signal shall consist of an alarm tone.
- F. Elevator Controls: Heat detector operation shuts down elevator power by operating a shunt trip in a circuit breaker feeding the elevator.
- G. Elevator Controls: Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shuts down elevators associated with the location without time delay.
1. A field-mounted relay actuated by the fire detector or the FACP closes the shunt trip circuit and operates building notification appliances and annunciator.
- H. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply.

- I. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the FACP and remote annunciators, after initiating devices are restored to normal.
 - 1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
 - 2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
 - 3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.

- J. Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require the entry of a password. The FACP and annunciators shall display a test indication while the test is underway. If testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.

- K. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and control of changes in 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 make a print-out of the final adjusted values on the system printer.

- L. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, trouble, and supervisory signals to a remote alarm station through a digital alarm communicator transmitter and telephone lines.

- M. 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 the 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.

- N. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signal, supervisory and digital alarm communicator transmitter shall be powered by the 24-V dc source.
 - 1. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the power-supply module rating.
 - 2. Power supply shall have a dedicated fused safety switch for this connection at the service entrance equipment. Paint the switch box red and identify it with "FIRE ALARM SYSTEM POWER."

- O. Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.
 - 1. Batteries: Sealed, valve-regulated, recombinant lead acid.
 - 2. Battery and Charger Capacity: Comply with NFPA 72.

- P. Surge Protection:

1. Install surge protection on normal ac power for the FACP and its accessories. Comply with Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" for auxiliary panel suppressors.
2. Install surge protectors recommended by FACP manufacturer. Install on all system wiring external to the building housing the FACP.

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.

2.3 MANUAL FIRE ALARM BOXES

- A. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. 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 the FACP.
 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 the FACP.
 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.

2.4 SYSTEM SMOKE DETECTORS

- A. General Description:
1. UL 268 listed, operating at 24-V dc, nominal.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
 3. Multipurpose type, containing the following:
 - a. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
 - b. Piezoelectric sounder rated at 88 dBA at 10 feet (3 m) according to UL 464.
 - c. Heat sensor, combination rate-of-rise and fixed temperature.
 4. 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 of 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 analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
 - a. Rate-of-rise temperature characteristic shall be selectable at the FACP for 15 or 20 deg F (8 or 11 deg C) per minute.
 - b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at the FACP to operate at 135 or 155 deg F (57 or 68 deg C).
 - c. Provide multiple levels of detection sensitivity for each sensor.

- B. Photoelectric Smoke Detectors:
 1. Sensor: LED or infrared light source with matching silicon-cell receiver.
 2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.

- C. Ionization Smoke Detector:
 1. Sensor: Responsive to both visible and invisible products of combustion. Self-compensating for changes in environmental conditions.
 2. Detector Sensitivity: Between 0.5 and 1.7 percent/foot (0.0016 and 0.0056 percent/mm) smoke obscuration when tested according to UL 268A.

- D. Duct Smoke Detectors:
 1. Photoelectric Smoke Detectors:
 - a. Sensor: LED or infrared light source with matching silicon-cell receiver.
 - b. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.
 2. Ionization Smoke Detectors:
 - a. Sensor: Responsive to both visible and invisible products of combustion. Self-compensating for changes in environmental conditions.
 - b. Detector Sensitivity: Between 0.5 and 1.7 percent/foot (0.0016 and 0.0056 percent/mm) smoke obscuration when tested according to UL 268A.
 3. UL 268A listed, operating at 24-V dc, nominal.
 4. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
 5. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.
 - a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 250 requirements for Type 4X.
 6. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
 7. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.
 8. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
 9. Each sensor shall have multiple levels of detection sensitivity.
 10. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
 11. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.5 HEAT DETECTORS

- A. General: UL 521 listed.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or rate-of-rise of temperature 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 the FACP.
- C. 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 the FACP.

2.6 NOTIFICATION APPLIANCES

- A. Description: 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.
- B. Speaker: Speaker notification appliances shall be listed to UL 1480.
 - 1. The speaker shall operate on a standard 25VRMS or 70.7VRMS NAC using twisted/shielded wire.
 - 2. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
 - 3. The speaker shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for General Signaling.
 - 4. The speaker installs directly to a 4" square, 1 1/2 in. deep electrical box with 1 1/2" extension.
- C. Audible/Visible: Combination Audible/Visible (A/V) Notification Appliances shall be listed to UL 1971 and UL 464. Refer to the above for speaker section of appliance. Refer to below for strobe section of appliance.
- D. Visible Alarm Devices: Xenon strobe lights listed under 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: Refer to drawings.
 - 2. Strobe Leads: Factory connected to screw terminals.

2.7 SPRINKLER SYSTEM REMOTE INDICATORS

- A. Remote status and alarm indicator and test stations, with LED indicating lights. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single-gang wall plate. A red, laminated, phenolic-resin identification

plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.8 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching door plate.
 - 1. Electromagnet: Requires 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.

2.9 REMOTE ANNUNCIATOR

- A. Description: Duplicate annunciator functions of the FACP for alarm, supervisory, and trouble indications. Also duplicate manual switching functions of the FACP, including acknowledging, silencing, resetting, and testing.
 - 1. Mounting: Flush cabinet, NEMA 250, Class 1.
- B. Display Type and Functional Performance: Alphanumeric display same as the FACP. Controls with associated LEDs permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACP.

2.10 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for wired applications with normally open contacts.
- B. Integral Relay: Capable of providing a direct signal to a circuit-breaker shunt trip for power shutdown.

2.11 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Listed and labeled according to UL 632.
- B. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising 2 lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.

- C. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.
- D. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.12 BROADCAST COMMUNICATOR TRANSMITTER

- A. Refer to drawings for specifications and requirements.
- B. Fire alarm system and broadcast interconnecting equipment are not required to be by the same manufacturer/vendor.

2.13 WIRE AND CABLE

- A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.
- B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG.
- C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
 - 1. Low-Voltage Circuits: No. 16 AWG, minimum.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum.
 - 3. Multiconductor Armored Cable: NFPA 70 Type MC, copper conductors, TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, UL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.
 - 4.

2.14 CARBON MONOXIDE DETECTORS

- 1.
- 2. Mounting: Adapter plate for outlet box mounting.
- 3. Testable by introducing test carbon monoxide into the sensing cell.
- 4. Detector shall provide alarm contacts and trouble contacts.
- 5. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
- 6. Comply with UL 2075.
- 7. Locate, mount, and wire according to manufacturer's written instructions.
- 8. Provide means for addressable connection to fire-alarm system.
- 9. Test button simulates an alarm condition.
- 10. The detector shall have a local audible alarm upon detection of carbon monoxide with a supervisory signal to the main Fire Alarm Control Panel.

2.15 APPROVALS

- A. The Early Warning Smoke Detection System must be of a type submitted to, tested, approved, and/or listed by one or more of Nationally Recognized Testing Laboratory (NRTL) as follows:
- B. UL (Underwriters Laboratories Inc, USA)
- C. ULC (Underwriters Laboratories Canada)
- D. FM (Factory Mutual), and FM approved for Hazardous Locations
- E. CSFM (California State Fire Marshall, USA)

2.16 CODES, STANDARDS, OR REGULATIONS

- A. The VEA smoke detector shall be installed to comply with local codes and standards or one or more of the following codes or standards:
 - 1. NFPA Standards, US
 - 2. NEC Standards, US

2.17 QUALITY ASSURANCE

- A. Manufacturer
 - 1. The manufacturer shall have a minimum of 35 years production experience in the design and manufacture of high sensitivity air sampling smoke detection systems.
 - 2. The manufacturer shall be certified as meeting ISO 9001:2008 for manufacturing.

2.18 EQUIPMENT SUPPLIER

- A. The equipment supplier shall be trained by the manufacturer to calculate/design, install, test and maintain the air sampling system and shall be able to produce a certificate stating such on request.

2.19 DOCUMENTATION

- A. The following documentation shall be supplied:
 - 1. Product data and site drawings shall be submitted and shall include pipe layout, operational calculations and performance criteria. Tools such as AutoCAD may be used to generate this material.
 - 2. A copy of the manufacturer's installation, operation and maintenance manuals shall be supplied upon completion of the installation.
 - 3. System commissioning data shall be supplied in a format recommended by the manufacturer and per the instructions provided by the manufacturer.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Smoke or Heat Detector Spacing:
 - 1. Smooth ceiling spacing shall not exceed the rating of the detector.
 - 2. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in NFPA 72.
 - 3. Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 72.
- B. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.
- C. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of the duct.
- D. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.
- E. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.
- F. 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.
- G. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- H. FACP and Firefighter's Smoke-Control Panel: Surface mount with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.
- I. Annunciator: Install with top of panel not more than 72 inches (1830 mm) above the finished floor.

3.2 WIRING INSTALLATION

- A. Install wiring according to the following:
 - 1. NECA 1.
 - 2. TIA/EIA 568-A.
- B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes for Electrical Systems."
 - 1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.
- C. Wiring Method:

1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
 2. Fire-Rated Cables: Use of 2-hour fire-rated fire alarm cables, NFPA 70 Types MI and CI, is not permitted.
 3. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or raceway 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 the fire alarm system to terminal blocks. Mark each terminal according to the 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 a different color-code 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 1-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.
- H. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Identification for Electrical Systems."
- B. Install instructions frame in a location visible from the FACP.
- C. Paint power-supply disconnect switch red and label "FIRE ALARM."

3.4 GROUNDING

- A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- D. Perform the following field tests and inspections and prepare test reports:
 - 1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.
 - 2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.
 - a. Include the existing system in tests and inspections.
 - 3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
 - 4. Testing: Follow procedure and record results complying with requirements in NFPA 72.
 - a. Detectors that are outside their marked sensitivity range shall be replaced.
 - 5. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.
- B. Follow-Up Tests and Inspections: After date of Substantial Completion, test the fire alarm system complying with testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for three monthly, and one quarterly, periods.
- C. Semiannual Test and Inspection: Six months after date of Substantial Completion, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- D. Annual Test and Inspection: One year after date of Substantial Completion, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 72.

Perform tests and inspections listed for monthly, quarterly, semiannual, and annual periods. Use forms developed for initial tests and inspections.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Refer to Division 1 Section "Closeout Procedures."

3.8 SYSTEM COMMISSIONING

- A. Detector commissioning
 - 1. The detector shall incorporate a push button to invoke self-learning modes to simplify commissioning including:
 - a. A learning mode that determines the reference flow (normalized flow) based on environmentally induced flow changes during the commissioning process.
 - b. Additionally, there shall be provision for a PC software tool to configure all user modifiable parameters of the all system devices.
- B. Commissioning Tests
 - 1. All necessary instrumentation, equipment, materials and labour shall be provided by the Contractor.
 - 2. The Contractor shall record all tests and system configuration to establish "Baseline Data" and a copy of these results shall be retained on site in the System Log Book as a part of required system documentation.
- C. Final Tests
 - 1. The contractor shall:
 - a. Place the detector in Smoke Test mode and measure the transport times by putting smoke in each sampling hole and by checking the transport times
 - b. Activate the appropriate Fire Alarm zones and advise all concerned that the system is fully operational.
 - c. Fill out the logbook and commissioning report accordingly.

3.9 MAINTENANCE

- A. Detector maintenance shall be carried out at stipulated intervals and as per local maintenance standards.
- B. Sample Filter
 - 1. The detector shall incorporate a filter with replaceable filter to remove large contaminants from the sampled air.
 - 2. The filter shall be accessible by opening and removing the front cover.
 - 3. Once accessible, the filter shall be removable and replaceable with the aid of a tool.
- C. Centralised Smoke Test

1. The detector shall incorporate a centralized smoke test facility to test the operation of smoke sensor module.
2. Place the detector in Centralize Smoke Test mode and perform a smoke test to ensure that smoke sensor module detects smoke.

END OF SECTION 28 31 11

**SECTION 311000
SITE CLEARING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Clearing and protection of vegetation.
- B. Removal of existing debris.

1.2 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Site Plan: Showing:
 - 1. Areas for temporary construction and field offices.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.1 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.

3.2 VEGETATION

- A. Do not remove or damage vegetation beyond the limits indicated on drawings.
- B. Install substantial, highly visible fences at least 3 feet high to prevent inadvertent damage to vegetation to remain:
 - 1. At vegetation removal limits.
- C. In areas where vegetation must be removed but no construction will occur other than previous paving, remove vegetation with minimum disturbance of the subsoil.
- D. 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.
 - 3. Sod: Re-use on site if possible; otherwise sell if marketable, and if not, treat as specified for other vegetation removed.
- E. 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.

3.3 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

**SECTION 313116
TERMITE CONTROL**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Termite exclusion materials.

1.2 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Indicate toxicants to be used, composition by percentage, dilution schedule, intended application rate.
- C. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements.
- D. Test Reports: Indicate regulatory agency approval reports when required.
- E. Manufacturer's Certificate: Certify that toxicants meet or exceed specified requirements.
- F. Certificate of compliance from authority having jurisdiction indicating approval of toxicants.
- G. Manufacturer's Instructions: Indicate caution requirement.
- H. Record and document moisture content of soil before application.
- I. Installer Qualifications: Company specializing in performing work of the type specified and with minimum three (3) years of documented experience.
- J. Maintenance Data: Indicate re-treatment schedule .
- K. Warranty: Submit warranty and ensure that forms have been completed in Owner's name.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing this type of work and:
 - 1. Having minimum of three (3) years documented experience.
 - 2. Approved by manufacturer of treatment materials.
 - 3. Licensed in the State in which the Project is located.

1.4 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year installer's warranty against damage to building caused by termites.
 - 1. Include coverage for repairs to building and to contents damaged due to building damage. Repair damage and, if required, re-treat.

PART 2 PRODUCTS

2.1 TERMITE EXCLUSION PARTICLE BARRIER

- A. Particle Barrier: Selected granular fill material; weight, granularity, hardness, and installed compaction prevent termite intrusion into foundations or structure without poisons or other chemicals.
 - 1. Products:
 - a. Polyguard Barrier Systems, Inc, a division of Polyguard Products, Inc; TERM Particle Barrier: www.polyguardbarriers.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
 - 2. Accessories: Manufacturer's compatible sealant and moisture barrier as recommended for complete installation.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that soil surfaces are unfrozen, sufficiently dry to absorb toxicant, and ready to receive treatment.
- B. Verify final grading is complete.

3.2 INSTALLATION - EXCLUSION SYSTEM

- A. Particle Barrier: Comply with manufacturer's written instructions.

3.3 PROTECTION

- A. Do not permit soil grading over treated work.
- B. Protect sheet materials from damage after completed installation. Repair damage with manufacturer's recommended products and according to the manufacturer's written instructions.

END OF SECTION

**SECTION 321723.13
PAINTED PAVEMENT MARKINGS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Parking lot markings, including parking bays, handicapped symbols, and curb markings.
- B. "No Parking" curb painting.

1.2 REFERENCE STANDARDS

- A. FS TT-P-1952 - Paint, Traffic and Airfield Marking, Waterborne 2015f (Validated 2020).
- B. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association Current Edition.
- C. FHWA MUTCD - Manual on Uniform Traffic Control Devices 2010, with Errata.

1.3 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Certificates: Submit for each batch of paint and glass beads stating compliance with specified requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver paint in containers of at least 5 gallons accompanied by batch certificate.
- B. Store products in manufacturer's unopened packaging until ready for installation.
- C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.5 FIELD CONDITIONS

- A. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Line and Zone Marking Paint: MPI (APL) No. 97 Latex Traffic Marking Paint; color(s) as indicated.
 - 1. Parking Lots: White.
 - 2. Handicapped Symbols: Blue.
- B. Paint For Obliterating Existing Markings: FS TT-P-1952; black for bituminous pavements, gray for portland cement pavements.
- C. Temporary Marking Tape: Preformed, reflective, pressure sensitive adhesive tape in color(s) required; Contractor is responsible for selection of material of sufficient durability as to perform satisfactorily during period for which its use is required.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Obliteration of existing markings using paint is acceptable in lieu of removal; apply the black paint in as many coats as necessary to completely obliterate the existing markings.
- D. Clean surfaces thoroughly prior to installation.
 - 1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.
 - 2. Completely remove rubber deposits, existing paint markings, and other coatings adhering to the pavement, by scraping, wire brushing, sandblasting, mechanical abrasion, or approved chemicals.
- E. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.
- F. Establish survey control points to determine locations and dimensions of markings; provide templates to control paint application by type and color at necessary intervals.
- G. Temporary Pavement Markings: When required or directed by Architect, apply temporary markings of the color(s), width(s) and length(s) as indicated or directed.
 - 1. After temporary marking has served its purpose, remove temporary marking by carefully controlled sandblasting, approved grinding equipment, or other approved method so that surface to which the marking was applied will not be damaged.
 - 2. At Contractor's option, temporary marking tape may used in lieu of temporary painted marking; remove unsatisfactory tape and replace with painted markings at no additional cost to Owner.

3.3 INSTALLATION

- A. Begin pavement marking as soon as practicable after surface has been cleaned and dried.
- B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F or more than 95 degrees F.
- C. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.
- D. Comply with FHWA MUTCD manual (<http://mutcd.fhwa.dot.gov>) for details not shown.
- E. Apply markings in locations determined by measurement from survey control points; preserve control points until after markings have been accepted.
- F. Apply uniformly painted markings of color(s), lengths, and widths as indicated on drawings true, sharp edges and ends.
 - 1. Apply paint in one coat only.
 - 2. Wet Film Thickness: 0.015 inch, minimum.
 - 3. Length Tolerance: Plus or minus 3 inches.
 - 4. Width Tolerance: Plus or minus 1/8 inch.
- G. Parking Lots: Apply parking space lines, entrance and exit arrows, painted curbs, and other markings indicated on drawings.
 - 1. Mark the International Handicapped Symbol at indicated parking spaces.
 - 2. Hand application by pneumatic spray is acceptable.
- H. Symbols: Use a suitable template that will provide a pavement marking with true, sharp edges and ends, of the design and size indicated.

3.4 DRYING, PROTECTION, AND REPLACEMENT

- A. Protect newly painted markings so that paint is not picked up by tires, smeared, or tracked.
- B. Provide barricades, warning signs, and flags as necessary to prevent traffic crossing newly painted markings.

- C. Allow paint to dry at least the minimum time specified by the applicable paint standard and not less than that recommended by the manufacturer.
- D. Remove and replace markings that are applied at less than minimum material rates; deviate from true alignment; exceed length and width tolerances; or show light spots, smears, or other deficiencies or irregularities.
- E. Remove markings in manner to avoid damage to the surface to which the marking was applied, using carefully controlled sand blasting, approved grinding equipment, or other approved method.
- F. Replace removed markings at no additional cost to Owner.

END OF SECTION